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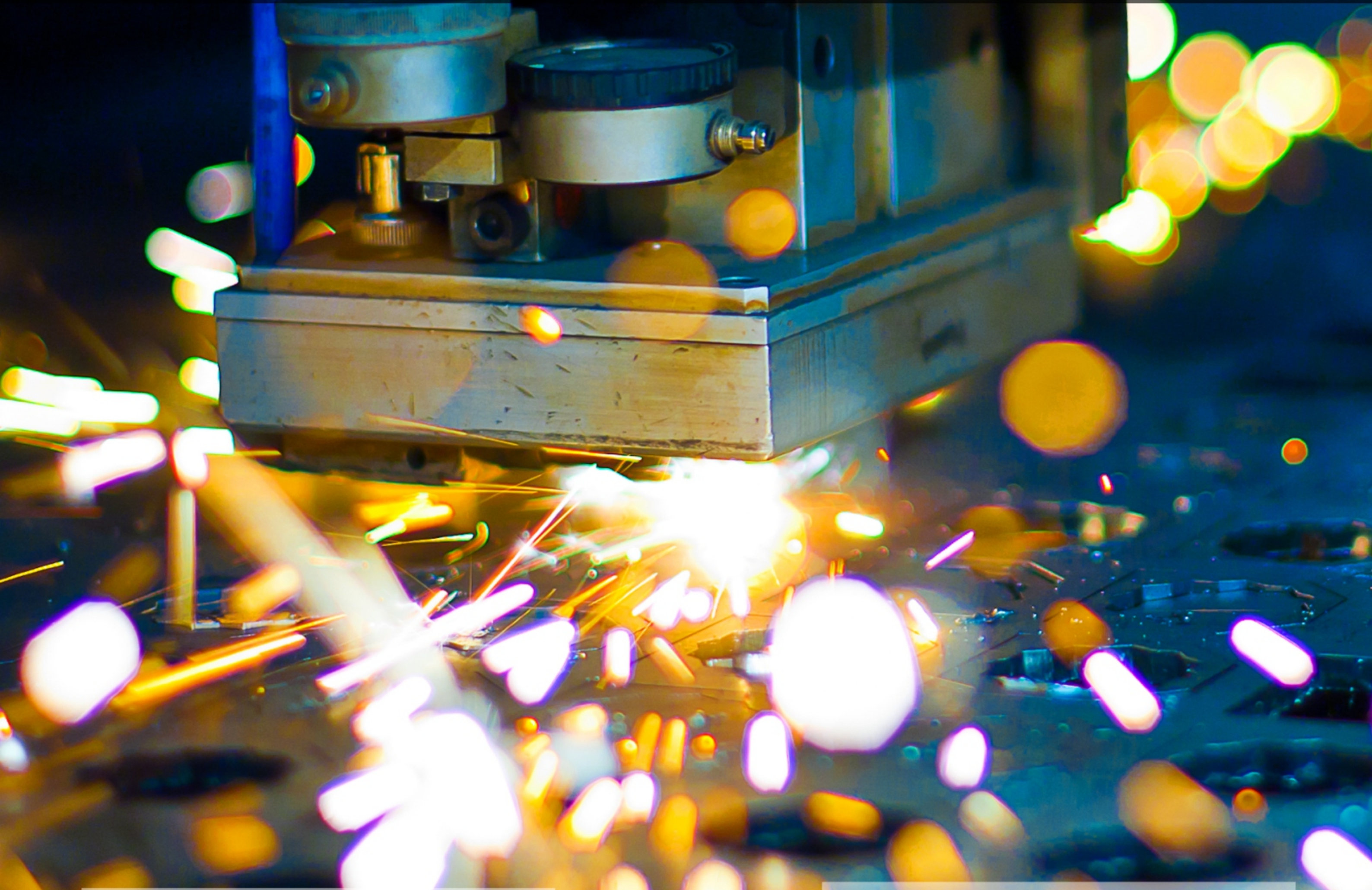

Highlights

- Triangular Fuzzy Membership
- Effect of Signal to Noise Ratio
- Adaptive Beamforming Techniques
- Spatial Directionality in Buildings

Discovering Thoughts, Inventing Future

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Comparative Study on Experimental 2 To 9 Triangular Fuzzy Membership Function Partitioned Type 1 Mamdani's FIS for G^2EDPS

Burak Omer Saracoglu

Abstract- There are some theories on how the World will end (e.g. super volcano eruption, massive star explosion, death of the Sun, asteroid impact, pandemic, nuclear war, climate change). Some of them can be prevented, because the cause is human by itself. For instance, spread of deadly diseases can be prevented by some quarantine zones and periods, nuclear wars by disarmament of weapon of mass destruction (zero weapons) and climate change by new life styles and acts (zero emissions: carbon dioxide CO_2, methane CH_4, nitrous oxide N_2O, fluorinated gases). Electricity generation plays a key role in zero emissions life styles and acts. A Global Grid can be designed, invested and operated by 100% renewable energy power plants on the World. Design and operation of this grid needs some very detailed electricity demand information. One of this information is the long term electricity demand prediction (PWh: Petawatt hours). This paper investigates an experimental Mamdani's type fuzzy inference system for the Global Grid electricity demand forecasting in this respect.

Keywords: global grid, electricity demand, fuzzy inference system, mamdani, prediction.

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COMPARATIVESTUDYONEXPERIMENTAL2TO9TRIANGULARFUZZYMEMBERSHIPFUNCTIONPARTITIONEDTYPE1MAMDANISFISFORG2EDPS

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Keywords: global grid, electricity demand, fuzzy inference system, mamdani, prediction.

I. Introduction

Scientists have some ideas on how the World will end. Most of these ideas are shared on public websites and TV programs. Some of these ideas are super volcano eruption, massive star explosion, death of the Sun, asteroid impact, pandemic, nuclear war and climate change (visit [1,2, 3]). These events can be grouped under two main sets. One of them is non-human caused events, the other one is human caused events. Super volcano eruption is an extreme natural event [4]. Massive star explosion, death of the Sun, asteroid impact are rare cosmic events [5]. Catastrophic effects of these events can't be prevented by humankind's present technological and technical capabilities. Pandemic is an indirectly human caused event. Nuclear war and climate change are two directly human caused events. Prevention of pandemic is possible today [6]. Prevention of a nuclear war is the simplest one. All weapons must be destroyed by a worldwide disarmament program (simplest thing on Earth according to author's point of view) [7, 8]. Solution of the climate change (global warming) problem is more complicated and difficult than the other ones. New technologies, techniques and approaches have to be developed and adopted in the short to mid period. Lifestyles and human habits have to be changed and accepted in the daily life (e.g. "infrastructure upgrade", "move closer to work", "consume less", "be efficient", "one child" [9]). Electricity generation can play a key role in this zero emissions life style. Electricity can possibly be generated from only renewable energy sources by today's technologies (no non-renewable power plants). This approach is nowadays technically possible by current technologies. Hydropower, geothermal, wind, solar, and ocean resources are sufficiently enough. Hence, scientific development studies of 100% renewable power grids have to be finalized and presented in short to mid terms. This research study contributes in this respect. There are already some futuristic conceptual recommended electricity grids. The European Supergrid [10], and the Global Grid Concepts [11] are two of them (see also [12, 13]). This research focuses on the Global Grid Concept that is described as "a grid spanning the whole planet and connecting most of the large power plants in the world" [11]. One of the important modeling steps of the Global Grid is the electricity demand prediction. Electricity grid demand forecasting time horizons are ranged from very short-range to long-range forecasting in the literature (see [14,15]).

This research study aims to focus on forecasts or forecasting in the period of 100 years ahead by Mamdani's fuzzy inference system (FIS) (fuzzy control system: FCS, fuzzy rule base system: FRBS, fuzzy expert system: FES, fuzzy logic controller: FLC, etc.), that can be used for strategic planning (e.g. grid design, interconnection, and expansion plans) of the Global Grid. It is believed that achievements on this respect can be gained by help of research findings on the historical

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data. Hence, this research study first contributes in this approach to the scientific studies.

Section 2 presents the literature review. Section 3 has the concise presentation of the preliminaries and the details of this comparative research study. Section 4 presents the concluding remarks and further research.

II. Literature Review

The literature review period was 20 days in almost 10 working hours conditions (from 11/06 to 01/07 2015). Some academic online database and journals were reviewed by some queries. The search queries were organized in a narrowing content. These queries were searched on 15 academic publication websites ("Fig. 1"). Only 40 papers amongst 38727 search results were long term electricity load and demand forecasting studies (eliminated duplications, triplications etc.).

No	Phrase 1	Operator	Phrase 2	Operator	Phrase 3	Operator	Phrase 4
1	FLIS[1]	and	Electricity				
2	FLIS[1]	and	Forecast				
3	FLIS[1]	and	Demand				
4	FLIS[1]	and	Electricity	and	Forecast		
5	FLIS[1]	and	Electricity	and	Demand		
6	FLIS[1]	and	Electricity	and	Forecast	and	Demand
7	FIS[2]	and	Electricity				
8	FIS[2]	and	Forecast				
9	FIS[2]	and	Demand				
10	FIS[2]	and	Electricity	and	Forecast		
11	FIS[2]	and	Electricity	and	Demand		
12	FIS[2]	and	Electricity	and	Forecast	and	Demand
13	FCS[3]	and	Electricity				
14	FCS[3]	and	Forecast				
15	FCS[3]	and	Demand				
16	FCS[3]	and	Electricity	and	Forecast		
17	FCS[3]	and	Electricity	and	Demand		
18	FCS[3]	and	Electricity	and	Forecast	and	Demand
19	FRS[4]	and	Electricity				
20	FRS[4]	and	Forecast				
21	FRS[4]	and	Demand				
22	FRS[4]	and	Electricity	and	Forecast		
23	FRS[4]	and	Electricity	and	Demand		
24	FRS[4]	and	Electricity	and	Forecast	and	Demand

Figure 1: 1Fuzzy Logic Inference System: FLIS, 2Fuzzy Inference System: FIS, 3Fuzzy Control System: FCS, 4Fuzzy Rule System: FRS searched on ACM Digital Library [14], ASCE Online Research Library [15], American Society of Mechanical Engineers [16], Cambridge Journals Online [17], Directory of Open Access Journals [18], Emerald Insight [19], Google Scholar [20], Hindawi Publishing Corporation [21], Inderscience Publishers [22], Journal of Industrial Engineering and Management [23], Science Direct [24], Springer [25], Taylor & Francis Online/Journals [26], Wiley-Blackwell/Wiley Online Library [27], World Scientific Publishing [28].

A few papers from this literature review are as following. Al-Ghandoor and Samhouri worked on five models by multivariate linear regression and adaptive neuro-fuzzy inference system in the industrial sector of Jordan from 1985 to 2004 (19 years) [31]. The square root of average squared error (RASE) for each model and average RASE of the linear regression and the neuro-fuzzy techniques were compared (unit: terajoule TJ). The linear regression RASEs were respectively presented as 132,15, 176,54, 168,19, 121,00, and 143,80 and the neuro-fuzzy RASEs were respectively presented as 94,75, 126,75, 175,00, 133,00, and 69,75. The average of the linear regression and the neuro-fuzzy techniques were given as 148, 34 and 119,85 [31]. Tasaodian et.al. worked with the adaptive-network-based fuzzy inference system (ANFIS) [32]. They investigated the long term electricity consumption of the Group of Eight (G8) Industrialized Nations (U.S.A, Canada, Germany, United Kingdom, Japan, France, Italy). They constructed a different model per country, so that they had several models. Their models had 0,005696, 0,011739, 0,013136, 0,00446, 0,007985, 0,012971 and 0,014929 MAPE (%) values respectively for the U.S.A, Canada, Germany, the United Kingdom, Japan, France, Italy. There were also some other interesting studies, which could be presented in a review study.

This literature review showed that some researchers worked in the electricity consumption prediction subject. However, none of them studied the Global Grid Concept until 01/07/2015. Moreover, none of them presented a comparative study of a type 1 Mamdani FIS with several triangular fuzzy membership functions. Hence, this study would most probably contribute to the scientific research studies in this field much.

III. Concise Preliminaries of Fuzzy Inference Systems

Overall structure of a generalized fuzzy rule base system is based on inputs, outputs, fuzzifier, inference system, defuzzifier, data, membership functions and rules as presented in "Fig. 2".

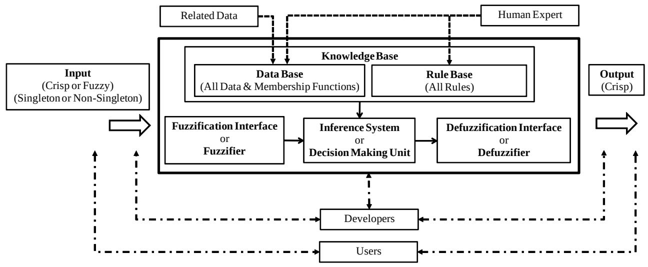

Figure 2: Generalized structure of FISs (added and drawn based on [33, 34, 35, 36, 37, 38])

This new representation of overall structure of a generalized fuzzy inference system (FIS) (Type 1 or Type 2 fuzzy) (Mamdani, or Takagi-Sugeno-Kang or others) is generalized and presented by this study based on FIS representations in the literature [see 33-38]. FISs are powerful to deal with ambiguity, imprecision, and unsharpness of data, information, and also reasoning, because mainly FISs are all based on fuzzy mathematics' principles. Henceforth, many real world problems can be modeled and solved by FISs. Critical issue and point with FISs is same critical issue and point with all fuzzy methods and approaches. As Liu and Lin underlines very clearly "fuzzy mathematics mainly deals with problems of the phenomenon with cognitive uncertainty by experience with the help of affiliation functions." [39]. As a result, natural situations and events can possibly be modeled precisely by fuzzy theory based models by experienced people. Here, experience is not only the experience about fuzzy modeling, but also about the natural phenomenon by itself (for instance: design of control systems of an autonomous unmanned aerial vehicle needs sufficient knowledge on aviation and flight principles). Thus, design process of fuzzy models needs timely efforts to get precise results. Fuzzy logic was proposed by Lotfi A. Zadeh (alive by 11/11/2015) (one of genius humans in his generation) in 1965 [40,41]. Ebrahim H. (Abe) Mamdani (another genius scientist passed away on 22/02/2010) came up with a very clever idea, Mamdani fuzzy inference, in 1974 to use Zadeh's fuzzy logic principles for control systems [42,43]. Afterwards, Kang, Larsen, Sugeno, Takagi, Tsukamoto and others followed Mamdani's research studies and proposals. They recommended some new fuzzy logic controller models (e.g. Sugeno, Takagi-Sugeno-Kang) [44, 45, 46]. Many studies underline that the most important design issue in FISs is its approximation capability [47, 48]. These studies also indicate very clearly that several membership function types satisfy FISs that can approximate any continuous function with an arbitrary accuracy [47, 48, 49]. Tatjewski (2007) warns about the most important points in FIS modeling as "defining the number of fuzzy sets and assigning a shape and values of parameter to the membership function of each set" and "defining the structure and parameters of functional consequents of individual rules" [49]. Main guidance in this respect is also given as "Too small a number of these sets and wrong positioning in relation to each other leads to unsatisfactory design of the fuzzy model, which does not satisfy the quality requirements and is too imprecise. Assuming too large a number of fuzzy sets leads to an oversized model with too many parameters; the design is then more difficult and the model is slower in operation" [49]. More importantly and mainly defining the aim and foundation of this research study, it is presented that "in practice it is still most efficient to take a human-made decision about the number of sets and their initial positioning, in an interactive mode, if necessary" [49]. The readers should mainly follow these three publications to understand the research aim of the current study. Several inference systems such as Larsen, and Sugeno can be preferred in FISs design. Mamdani's inference system or decision making unit is preferred in this experimental research study, because all previous studies in the literature mention that Mamdani's FIS is more suitable for human judgments and perceptions than other ones [50, 51].

Accordingly, this research study contributes in FISs applications for electricity demand prediction and shall hopefully be a start for a global research, development, demonstration, & deployment (RD^3) efforts of a Global Grid electricity demand prediction system (G2EDPS). This research study may be described with the quote: “Knowing is not enough; we must apply. Willing is not enough; we must do.” Goethe

IV. Comparison of Experimental FISs

This research study is one of the preliminary conceptual design studies of the G2EDPS (“Fig. 3”). Two experimental input variables (global population: world population and global land ocean annual mean temperature change: global annual temperature anomalies) and one experimental output variable (annual electricity consumption) are used in this research. Under these variables, only one node Mamdani's type FISs is modeled in this study. Same defuzzifier/reduction (centroide) is selected on the Fuzzy Toolbox 0.4.6 for the Scilab 5.5.2 for analyzing and deep understanding the triangular membership functions better.

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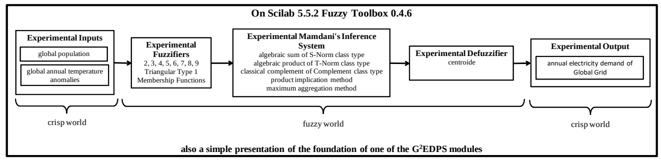
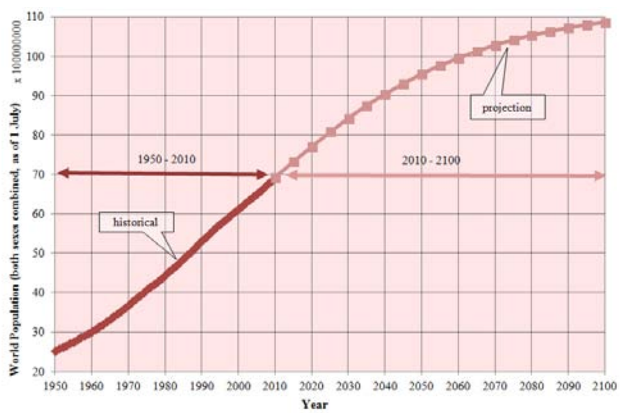


Figure 3: Structure of current experimental one node Mamdani's FIS

Historical data of world population (X1) and its projection data are taken from the official webpage of the Department of Economic and Social Affairs of the Population Division in the United Nations (visit [52]) ("Fig. 4" top). Historical data of global annual temperature anomalies (X2) is taken from the official webpage of the NASA Goddard Institute for Space Studies (GISS) Laboratory in the Earth Sciences Division (ESD) of National Aeronautics and Space Administration's (NASA) Goddard Space Flight Center (GSFC) (visit [53]). Projection data is taken from the Intergovernmental Panel on Climate Change, Annex II: Climate System Scenario Tables, Table AII.7.5, RCP2.6 (95%), RCP4.5 (95%), RCP6.0 (95%), RCP8.5 (95%), and SRES A1B (95%) predictions (see [54]) ("Fig. 4" middle). Historical data of annual electricity demand of Global Grid (Y) is calculated based on the official records at the International Energy Agency. Energy production (Mtoe: million tonnes of oil equivalent) is taken and converted to total global annual electricity demand (PWh: peta (1015) watt-hour) by coefficient of 0,0116300000 (Mtoe to PWh) in this analysis (visit [55, 56]) ("Fig. 4" bottom).



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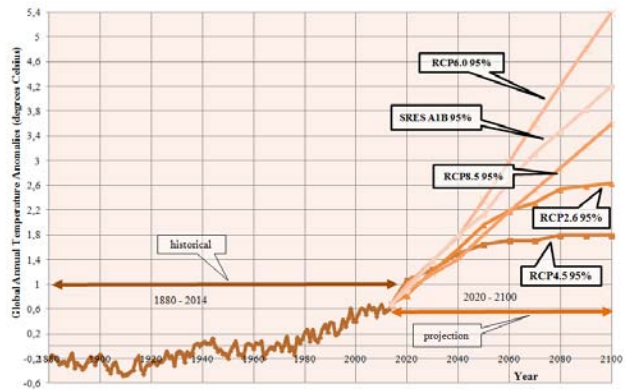

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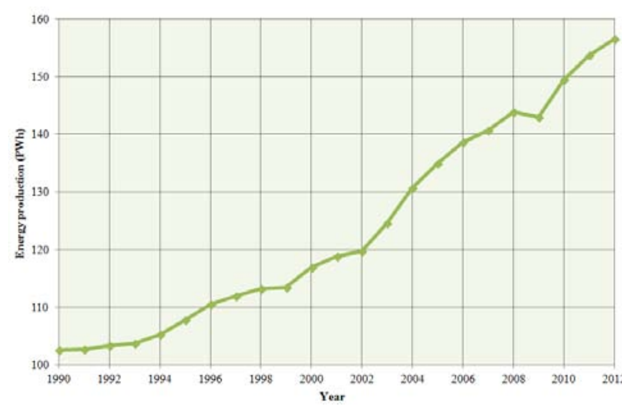
Data Series RCP2.6 95%: 0,62, 1,07, 1,24, 1,50, 1,65, 1,71, 1,71, 1,79, 1,79, 1,79

Data Series RCP4.5 95%: 0,59, 0,83, 1,22, 1,57, 1,97, 2,19, 2,32, 2,54, 2,59, 2,64

Data Series RCP6.0 95%: 0,64, 0,90, 1,17, 1,41, 1,81, 2,18, 2,52, 2,88, 3,24, 3,60

Data Series RCP8.5 95%: 0,62, 0,99, 1,39, 1,77, 2,37, 2,99, 3,61, 4,22, 4,81, 5,40 Data Series SRES A1B 95%: 0,62, 0,91, 1,38, 1,79, 2,14, 2,67, 3,12, 3,47, 3,84, 4,21



Data Series: 103, 103, 103, 104, 105, 108, 110, 112, 113, 113, 117, 119, 120, 125, 131, 135, 139, 141, 144, 143, 150, 154, 157

Figure 4: Inputs and output (world population historical and projection X1 for both sexes combined, as of 1 July (thousands) (top), global annual temperature anomalies historical and projection X2 (middle) in degrees Celsius (C°), historical annual electricity demand of Global Grid Y in peta watt-hour (bottom), visualization generated by the Microsoft Office Excel 2007 & the Paint.NET (see enclosed data, data series and graphics files)

Experimental triangular type 1 fuzzy membership functions (MF) are defined in a systematic manner. At first, two symmetrical MFs are defined and afterwards the number of MFs is increased one by one in a symmetrical design manner until nine MFs are constructed in this study. This almost automatic MFs generation approach is very easy and helpful for defining MFs for RD^3 engineers, but these MFs are not fine tuned in this study. These MFs are presented in the "Fig. 5".

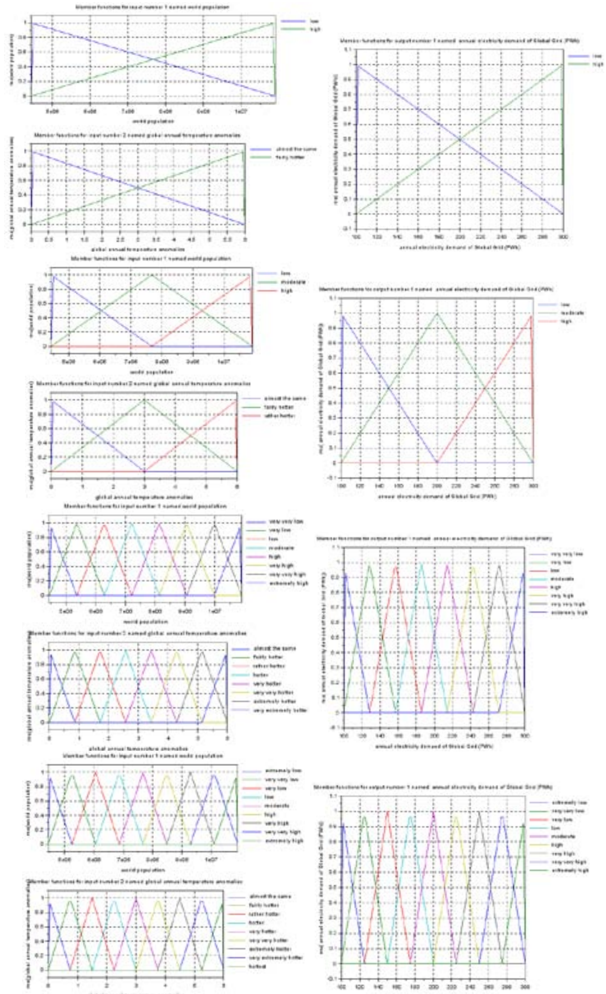


Figure 5: 2 to 9 triangular membership functions of current study, visualization generated by the Fuzzy Toolbox 0.4.6 on the Scilab 5.5.2 & the Paint.NET

The detailed investigations of this modeling section will be studied in the future research studies. Experimental Mamdani's type FIS rules are defined by human judgments (in other words expert judgments). This Mamdani's type FIS capability is the modeling power and flexibility in this research field. Some rules are the same for all MFs. Total number of MFs, total rules and total effective rules are presented in the EMS and "Fig. 6".

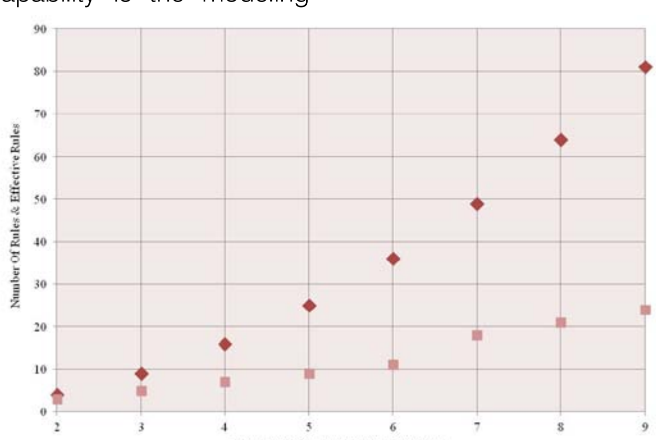


Figure 6: Number of membership functions, rules and effective rules in this study, visualization generated by the Microsoft Office Excel 2007 & the Paint.NET

When rule structure can be differentiated by inputs and output values, this rule is defined as effective rule. When two or more rules can be defined as only one rule by easily combining these two or more rules, then these rules are defined as only rule. For instance

Rule n: IF input1 is MF1 AND input2 is MF1 THEN output is MF1

Rule n+x: IF input1 is MF1 AND input2 is MF2 THEN output is MF1

These rules can be modelled as only one effective rule as

Rule n: IF input1 is MF1 AND input2 is less than or equal to MF1 THEN output is MF1

Detailed investigations of this modeling section will be studied in future research studies.

Scilab 5.5.2 SciFLT Model rules and scripts are also presented as in the "Tab. 1" and "Tab. 2". Readers can copy and paste to their Scilab 5.5.2 Console and run the models.

Table 1: Experimental Mamdani's type FIS rules per MFs partitions

MF* 2
R1: IF (world population IS low) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R2: IF (world population IS low) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R3: IF (world population IS high) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R4: IF (world population IS high) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
MF* 3
R1: IF (world population IS low) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R2: IF (world population IS low) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R3: IF (world population IS low) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R4: IF (world population IS moderate) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R5: IF (world population IS moderate) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R6: IF (world population IS moderate) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R7: IF (world population IS high) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R8: IF (world population IS high) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R9: IF (world population IS high) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
MF* 8
R1: IF (world population IS very very low) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R2: IF (world population IS very very low) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R3: IF (world population IS very very low) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R4: IF (world population IS very very low) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R5: IF (world population IS very very low) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R6: IF (world population IS very very low) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R7: IF (world population IS very very low) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R8: IF (world population IS very very low) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R9: IF (world population IS very low) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid

(PWh) IS very low) weigth=1
R10: IF (world population IS very low) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R11: IF (world population IS very low) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R12: IF (world population IS very low) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R13: IF (world population IS very low) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R14: IF (world population IS very low) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R15: IF (world population IS very low) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R16: IF (world population IS very low) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R17: IF (world population IS low) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R18: IF (world population IS low) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R19: IF (world population IS low) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R20: IF (world population IS low) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R21: IF (world population IS low) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R22: IF (world population IS low) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R23: IF (world population IS low) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R24: IF (world population IS low) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R25: IF (world population IS moderate) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R26: IF (world population IS moderate) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R27: IF (world population IS moderate) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R28: IF (world population IS moderate) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R29: IF (world population IS moderate) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R30: IF (world population IS moderate) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R31: IF (world population IS moderate) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R32: IF (world population IS moderate) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R33: IF (world population IS high) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R34: IF (world population IS high) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R35: IF (world population IS high) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R36: IF (world population IS high) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R37: IF (world population IS high) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R38: IF (world population IS high) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R39: IF (world population IS high) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R40: IF (world population IS high) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R41: IF (world population IS very high) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R42: IF (world population IS very high) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R43: IF (world population IS very high) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R44: IF (world population IS very high) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1

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R45: IF (world population IS very high) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R46: IF (world population IS very high) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R47: IF (world population IS very high) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R48: IF (world population IS very high) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R49: IF (world population IS very very high) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R50: IF (world population IS very very high) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R51: IF (world population IS very very high) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R52: IF (world population IS very very high) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R53: IF (world population IS very very high) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R54: IF (world population IS very very high) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R55: IF (world population IS very very high) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R56: IF (world population IS very very high) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R57: IF (world population IS extremely high) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R58: IF (world population IS extremely high) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R59: IF (world population IS extremely high) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R60: IF (world population IS extremely high) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R61: IF (world population IS extremely high) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R62: IF (world population IS extremely high) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R63: IF (world population IS extremely high) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R64: IF (world population IS extremely high) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
MF* 9
R1: IF (world population IS extremely low) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS extremely low) weigth=1
R2: IF (world population IS extremely low) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely low) weigth=1
R3: IF (world population IS extremely low) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely low) weigth=1
R4: IF (world population IS extremely low) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely low) weigth=1
R5: IF (world population IS extremely low) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely low) weigth=1
R6: IF (world population IS extremely low) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R7: IF (world population IS extremely low) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R8: IF (world population IS extremely low) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R9: IF (world population IS extremely low) AND (global annual temperature anomalies IS hottest) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R10: IF (world population IS very very low) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R11: IF (world population IS very very low) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R12: IF (world population IS very very low) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R13: IF (world population IS very very low) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very low) weigth=1
R14: IF (world population IS very very low) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid

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(PWh) IS very very low) weigth=1
R15: IF (world population IS very very low) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R16: IF (world population IS very very low) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R17: IF (world population IS very very low) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R18: IF (world population IS very very low) AND (global annual temperature anomalies IS hottest) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R19: IF (world population IS very low) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R20: IF (world population IS very low) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R21: IF (world population IS very low) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R22: IF (world population IS very low) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R23: IF (world population IS very low) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very low) weigth=1
R24: IF (world population IS very low) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R25: IF (world population IS very low) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R26: IF (world population IS very low) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R27: IF (world population IS very low) AND (global annual temperature anomalies IS hottest) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R28: IF (world population IS low) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R29: IF (world population IS low) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R30: IF (world population IS low) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R31: IF (world population IS low) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R32: IF (world population IS low) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS low) weigth=1
R33: IF (world population IS low) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R34: IF (world population IS low) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R35: IF (world population IS low) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R36: IF (world population IS low) AND (global annual temperature anomalies IS hottest) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R37: IF (world population IS moderate) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R38: IF (world population IS moderate) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R39: IF (world population IS moderate) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R40: IF (world population IS moderate) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R41: IF (world population IS moderate) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS moderate) weigth=1
R42: IF (world population IS moderate) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R43: IF (world population IS moderate) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R44: IF (world population IS moderate) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R45: IF (world population IS moderate) AND (global annual temperature anomalies IS hottest) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R46: IF (world population IS high) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R47: IF (world population IS high) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R48: IF (world population IS high) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R49: IF (world population IS high) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1

R50: IF (world population IS high) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS high) weigth=1
R51: IF (world population IS high) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R52: IF (world population IS high) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R53: IF (world population IS high) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R54: IF (world population IS high) AND (global annual temperature anomalies IS hottest) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R55: IF (world population IS very high) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R56: IF (world population IS very high) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R57: IF (world population IS very high) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R58: IF (world population IS very high) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R59: IF (world population IS very high) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very high) weigth=1
R60: IF (world population IS very high) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R61: IF (world population IS very high) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R62: IF (world population IS very high) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R63: IF (world population IS very high) AND (global annual temperature anomalies IS hottest) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R64: IF (world population IS very very high) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R65: IF (world population IS very very high) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R66: IF (world population IS very very high) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R67: IF (world population IS very very high) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R68: IF (world population IS very very high) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS very very high) weigth=1
R69: IF (world population IS very very high) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R70: IF (world population IS very very high) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R71: IF (world population IS very very high) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R72: IF (world population IS very very high) AND (global annual temperature anomalies IS hottest) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R73: IF (world population IS extremely high) AND (global annual temperature anomalies IS almost the same) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R74: IF (world population IS extremely high) AND (global annual temperature anomalies IS fairly hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R75: IF (world population IS extremely high) AND (global annual temperature anomalies IS rather hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R76: IF (world population IS extremely high) AND (global annual temperature anomalies IS hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R77: IF (world population IS extremely high) AND (global annual temperature anomalies IS very hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R78: IF (world population IS extremely high) AND (global annual temperature anomalies IS very very hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R79: IF (world population IS extremely high) AND (global annual temperature anomalies IS extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R80: IF (world population IS extremely high) AND (global annual temperature anomalies IS very extremely hotter) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1
R81: IF (world population IS extremely high) AND (global annual temperature anomalies IS hottest) THEN (annual electricity demand of Global Grid (PWh) IS extremely high) weigth=1

Table 2: Scripts for 5.5.2 Scilab Editor

```
// Experimental Type 1 Mamdani FIS Membership Functions (2 Triangular MF) Scilab 5.5.2 SciFLT Model
//Create a new fls structure.
EDGG2TMF=newfls();
//Add type, methods, parameters etc.
EDGG2TMF.name="paper"; EDGG2TMF.comment="Experimental FIS for electricity demand forecasting of Global Grid"; EDGG2TMF.type="m";
EDGG2TMF.SNorm="asum"; EDGG2TMF.TNorm="aprod"; EDGG2TMF.Comp="one"; EDGG2TMF.ImpMethod="prod";
EDGG2TMF.AggMethod="max"; EDGG2TMF.defuzzMethod="centroide";
//Add a new variable (X1:world population) to the fls and return it
EDGG2TMF=addvar(EDGG2TMF,"input","world population",[4440000 10900000]);
//Add a new member function to the fls structure
EDGG2TMF=addmf(EDGG2TMF,"input",1,"low","trimf",[4440000 4440000 10900000]);
EDGG2TMF=addmf(EDGG2TMF,"input",1,"high","trimf",[4440000 10900000 10900000]);
//Add a new variable (X2:global annual temperature anomalies) to the fls and return it
EDGG2TMF=addvar(EDGG2TMF,"input","global annual temperature anomalies",[0.00 6.00]);
//Add a new member function to the fls structure
EDGG2TMF=addmf(EDGG2TMF,"input",2,"almost the same","trimf",[0.00 0.00 6.00]); EDGG2TMF=addmf(EDGG2TMF,"input",2,"fairly hot-
ter","trimf",[0.00 6.00 6.00]);
//Add a new variable (Y:annual electricity demand of Global Grid) to the fls and return it
EDGG2TMF=addvar(EDGG2TMF,"output"," annual electricity demand of Global Grid (PWh)",[100.00 300.00]);
//Add a new member function to the fls structure
EDGG2TMF=addmf(EDGG2TMF,"output",1,"low","trimf",[100.00 100.00 300.00]);
EDGG2TMF=addmf(EDGG2TMF,"output",1,"high","trimf",[100.00 300.00 300.00]);
// Plot the fls input(s) or output(s) variable(s)
scf();clf();
plotvar(EDGG2TMF,"input",[1 2]);
scf();clf();
plotvar(EDGG2TMF,"output",1);
// Add rules and display them in verbose format.
EDGG2TMF=addrule(EDGG2TMF,[ 1 1 1 1 1; 1 2 2 1 1; 2 1 2 1 1; 2 2 2 1 1])
// Show the fls rules
printrule(EDGG2TMF);
//Save the structure as EDGG2TMF.fls
savefls(EDGG2TMF,"C:/Users");
//Plot the output as a function (the surface view: 3D) of the two inputs.
scf();clf();
plotsurf(EDGG2TMF,[1 2],[1],[0 0],[50 50],2);
//Get experimental FIS for electricity demand forecasting of Global Grid Scilab 5.5.2 SciFLT Model from EDGG2TMF.fls
EDGG2TMF=loadfls("C:/Users/");
//Historical forecasted electricity demand of Global Grid (from 1990 to 2010)
D1=evalfls([5320817 0.39], EDGG2TMF), D2=evalfls([5408909 0.38], EDGG2TMF), D3=evalfls([5494900 0.19], EDGG2TMF), D4=evalfls([5578865
0.21], EDGG2TMF), D5=evalfls([5661086 0.29], EDGG2TMF), D6=evalfls([5741822 0.43], EDGG2TMF), D7=evalfls([5821017 0.33], EDGG2TMF),
D8=evalfls([5898688 0.46], EDGG2TMF), D9=evalfls([5975304 0.62], EDGG2TMF), D10=evalfls([6051478 0.41], EDGG2TMF), D11=evalfls([6127700
0.41], EDGG2TMF), D12=evalfls([6204147 0.53], EDGG2TMF), D13=evalfls([6280854 0.62], EDGG2TMF), D14=evalfls([6357992 0.60],
EDGG2TMF), D15=evalfls([6435706 0.52], EDGG2TMF), D16=evalfls([6514095 0.66], EDGG2TMF), D17=evalfls([6593228 0.60], EDGG2TMF),
D18=evalfls([6673106 0.63], EDGG2TMF), D19=evalfls([6753649 0.49], EDGG2TMF), D20=evalfls([6834722 0.60], EDGG2TMF),
D21=evalfls([6916183 0.67], EDGG2TMF)
**********************************************************
// Experimental Type 1 Mamdani FIS Membership Functions (9 Triangular MF) Scilab 5.5.2 SciFLT Model
EDGG9TMF=newfls();
EDGG9TMF.name="paper";
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plotvar(EDGG9TMF,"input",[1 2]);
scf();clf();
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6 1 1; 5 8 7 1 1; 5 9 7 1 1; 6 1 6 1 1; 6 2 6 1 1; 6 3 6 1 1; 6 4 6 1 1; 6 5 6 1 1;6 6 7 1 1; 6 7 7 1 1;6 8 8 1 1; 6 9 8 1 1; 7 1 7 1 1;7 2 7 1 1; 7 3 7 1 1;7 4 7 1
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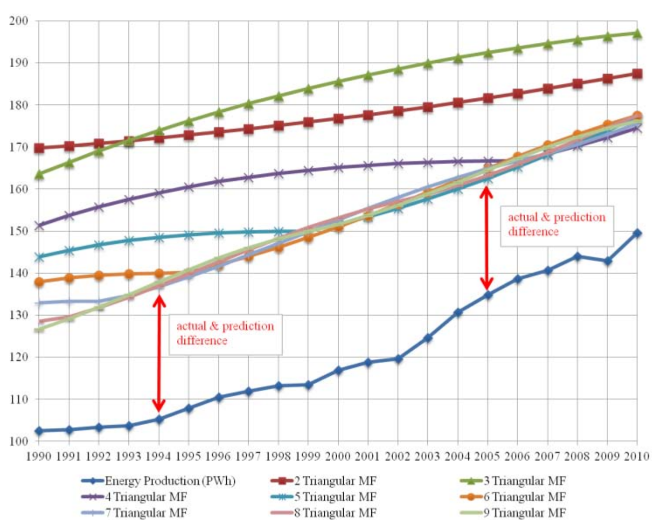

Figure 7: Historical and prediction data for 2 to 9 triangular MFs partitioned Global Grid electricity demand in this study, visualization generated by the Microsoft Office Excel 2007 & the Paint.NET

APE of 2 MFs model ranges between 0,25 and 0,66, so that MAP of this model is found as 0,66. MAPE of this model is calculated as 0,49. APE of 3 MFs model ranges between 0,32 and 0,65, so that MAP of this model is found as 0,65. MAPE of this model is calculated as 0,53. APE of 4 MFs model ranges between 0,17 and 0,52, so that MAP of this model is found as 0,52. MAPE of this model is calculated as 0,37. APE of 5 MFs model ranges between 0,18 and 0,42, so that MAP of this model is found as 0,42. MAPE of this model is calculated as 0,30. APE of 6 MFs model ranges between 0,19 and 0,35, so that MAP of this model is found as 0,35. MAPE of this model is calculated as 0,28. APE of 7 MFs model ranges between 0,17 and 0,32, so that MAP of this model is found as 0,32. MAPE of this model is calculated as 0,27. APE of 8 MFs model ranges between 0,19 and 0,33, so that MAP of this model is found as 0,33. MAPE of this model is calculated as 0,26. APE of 9 MFs model ranges between 0,18 and 0,32, so that MAP of this model is found as 0,32. MAPE of this model is calculated as 0,26 (see ESM). MAP and MAPE values are also given by "Fig. 8" in this main text.

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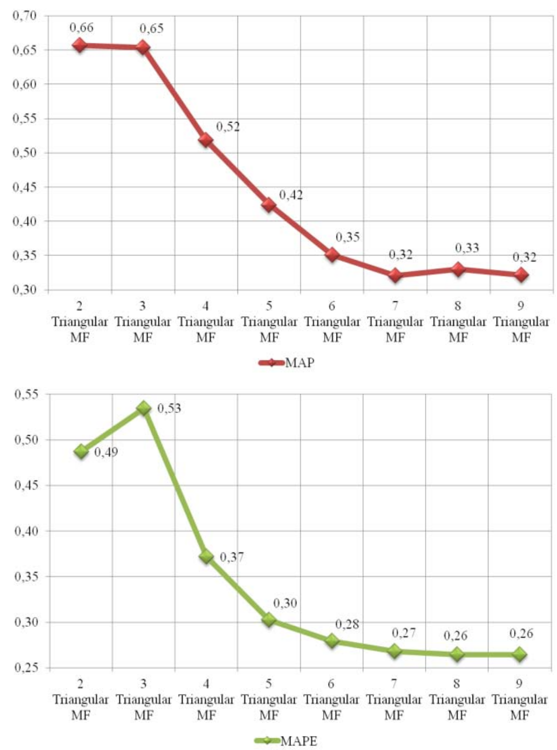
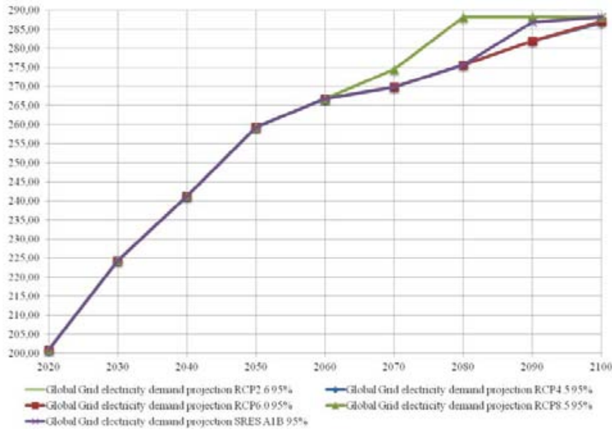


Figure 8: MAP and MAPE of 2 to 9 triangular MFs in this study, visualization generated by the Microsoft Office Excel 2007 & the Paint.NET

These findings show that MFs until 4, models improve their minimum APE values (from 0,25 for 2 MFs to 0,17 for 4 MFs), but after 4 MFs, models can not have any better minimum APE values. According to minimum APE values, RD3 engineers should work on 4 MFs in a worldwide RD3 study of a G2EDPS (for its main module and sub modules). Moreover, findings show that minimum MAP value can be reached with 7 MFs. After 7 MFs, MAP value is not better than 7 MFs (MAP is 0,33 for 8 MFs and 0,32 for 9 MFs). According to minimum MAP values, RD3 engineers should work on 7 MFs in a worldwide RD3 study. Finally, findings show that minimum MAPE value can be reached by 8 MFs. After 8 MFs, MAPE value is not better than 8 MFs (MAP is 0,26 for 9 MFs). According to minimum MAPE values, RD3 engineer should work on 8 MFs in a worldwide RD3 study. As a result, when basic principles of human psychological, cognition and short term memory limits are also considered by accounting magical number 7, and 7±2 rule [57,58], MF suggestion is made to RD3 engineers for investigating a 7 MFs model. Under these conditions, future Global Grid electricity demand from 2020 to 2100 are projected by only experimental 7 triangular type 1 membership function partitioned Mamdani type fuzzy inference system as presented in "Fig. 9" (see also ESM). Moreover, future projections are also presented by basis of historical error rates (maximum error rate of historical prediction) of experimental 7 triangular type 1 membership function partitioned Mamdani type fuzzy inference system (MAP: 0,32 in the negative direction which means less than model predictions).



Data Series Year: 2020, 2030, 2040, 2050, 2060, 2070, 2080, 2090, 2100

Data Series Population: 7716749, 8424937, 9038687, 9550945, 9957399, 10277339, 10524161, 10717401, 10853849

Data Series RCP2.6 95%: 1,07, 1,24, 1,50, 1,65, 1,71, 1,71, 1,79, 1,79, 1,79

Data Series RCP4.5 95%: 0,83, 1,22, 1,57, 1,97, 2,19, 2,32, 2,54, 2,59, 2,64

Data Series RCP6.0 95%: 0,90, 1,17, 1,41, 1,81, 2,18, 2,52, 2,88, 3,24, 3,60

Data Series RCP8.5 95%: 0,99, 1,39, 1,77, 2,37, 2,99, 3,61, 4,22, 4,81, 5,40

Data Series SRES A1B 95%: 0,91, 1,38, 1,79, 2,14, 2,67, 3,12, 3,47, 3,84, 4,21

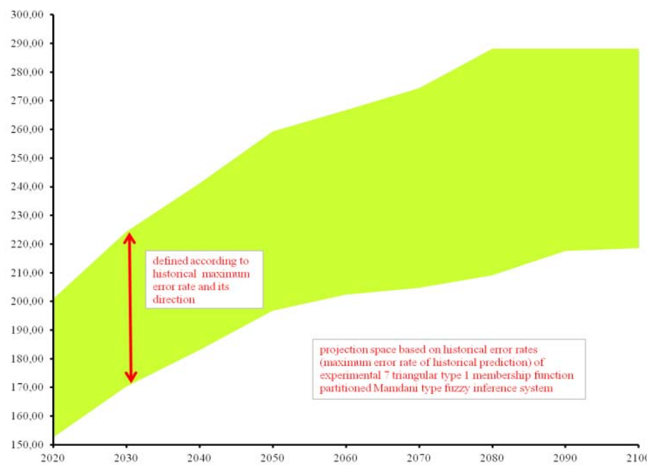


Figure 9: Long term 100 year Global Grid electricity demand prediction by experimental 7 triangular type 1 membership function partitioned Mamdani type fuzzy inference system (top), prediction space based on the maximum error rate on the historical actual values and predic-tions on historical data (bottom), visualization generated by the Microsoft Office Excel 2007 & the Paint.NET

V. Conclusions and Future Work

It is believed and hoped that this research paper focuses and defines one of the important real world problems well. One of the major contributions of this research study is the kick-off for a worldwide (RD3) study of a Global Grid electricity demand prediction system (G2EDPS) under a Global Grid Prediction Systems (G2PSs) (see [59]). Main design philosophy behind the eyes of G2EDPS is its modularity. G2EDPS modules will be consist of country (per country), multinational (several nations or countries), continental (per continent) and finally worldwide (world or globe) based approaches. Several prediction models and approaches for countries, multi-nations, continents and globe will be designed and integrated into this system. One of these modules is tried to be developed based on the type 1 Mamdani's fuzzy inference system principles. This research paper investigates a comparative study on experimental 2 to 9 triangular fuzzy membership function partitioned type 1 Mamdani Global Grid electricity demand forecasting fuzzy inference systems. The whole world (Global Grid electricity demand) is in focus of this approach. Fuzzy membership functions are developed in an almost automatic manner. Mamdani FIS is preferred to use its human judgment presentation capability. This expert decision and information transformation ability is observed very well during FIS rules definition. Three prediction performance measures as APE, MAP, and MAPE are checked in this study for comparison of these experimental 2 to 9 triangular fuzzy membership function partitioned type 1 Mamdani's FIS. According to MAP and MAPE values 7 membership functions are suggested to RD3 engineers. It is believed that several hundreds of these kinds of research studies should be finalized and presented for investigating the fuzzy inference systems as different modules of the G2EDPS in the future research studies.

VI. Acknowledgements

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References Références Referencias

1. Moss, L.: Mother Nature Network 11 ways the world (as we know it) could end. http://www.mnn.com/earth-matters/wilderness-resources/photos/11-ways-the-world-as-we-know-it-could-end/road-to#top-desktop (2011) (accessed in 29/10/2015)
2. Discovery Communications: How Will the World End? http://www.discovery.com/tv-shows/mayan-doomsday-prophecy/videos/how-the-world-will-end/ (accessed in 29/10/2015)
3. Channel Four Television Corporation: End of the World Night http://www.channel4.com/programmes/end-of-the-world-night (accessed in 29/10/2015)
4. National Geographic Society: Extreme Natural Events http://education.nationalgeographic.com/activity/extreme-natural-events/ (accessed in 29/10/2015)
5. Mashable: http://mashable.com/2013/01/07/ cosmic-events-doomsday/#9wUGoT0lu5qh (accessed in 29/10/2015)
6. Hughes, J.M., Wilson, M.E., Pike, B.L., Saylors, K.E., Fair, J.N., LeBreton, M., Tamoufe, U., Djoko, C.F., Rimoin, A.W., Wolfe, N.D., Wolfe, N. D. (2010). The origin and prevention of pandemics. Clinical Infectious Diseases, Vol.50, No.12, pp.1636-1640.
7. Nuclear Threat Initiative (NTI): Nuclear Disarmament Resource Collection http://www.nti.org/analysis/reports/nuclear-disarmament/ (accessed in 29/10/2015)
8. United Nations Office for Disarmament Affairs (UNODA): Nuclear Weapons http://www.un.org/disarmament/WMD/Nuclear/ (accessed in 29/10/2015)
9. Biello, D.: 10 Solutions for Climate Change Ten possibilities for staving off catastrophic climate change in the Scientific American http://www.scientificamerican.com/article/10-solutions-for-climate-change/ (2007) (accessed in 29/10/2015)
10. Friends of the Supergrid: Roadmap to the Supergrid Technologies Final Report. http://www.cesi.it/news_ideas/ideas/Documents/FOSG%20%20WG2%20Final-report.pdf (2012)
11. Chatzivasileiadis, S., Ernst, D., Andersson, G.: The Global Grid, Renewable Energy, Vol:57, pp.372–383. doi:10.1016/j.renene.2013.01.032. (2013)
12. Saracoglu, B.O.: An Experimental Fuzzy Expert System Based Application For The Go/No-Go Decisions To The Geospatial Investigation Studies Of The Regions Of The Very Large Concentrated Solar Power Plants In The European Supergrid Concept, The 18th Online World Conference on Soft-Computing in Industrial Applications (WSC18), Special Session 2 Application of Soft Computing in Energy Industry – Part 2, WSC18-SS2.1, 1-12 December 2014, http://www.fti.itb.ac.id/wsc18/tutorial/ (in publication)
13. Saracoglu, B.O.: An Experimental Fuzzy Weighted Average (Fuzzy WA) Aggregated Location Selection Model For The Very Large Photovoltaic Power Plants In The Globalgrid Concept In The Very Early Engineering Design Process Stages, The 18th Online World Conference on Soft-Computing in Industrial Applications (WSC18), Special Session 2 Application of Soft Computing in Energy Industry – Part 2, WSC18-SS2.2, 1-12 December 2014, http://www.fti.itb.ac.id/wsc18/tutorial/ (in publication)
14. Soliman, S.A., Al-Kandari, A.M.: Electrical load forecasting: modeling and model con-struction. Elsevier. (2010)
15. Chaturvedi, D.K.: Soft computing: techniques and its applications in electrical engineer-ing. Vol. 103. Springer. (2008)
16. ACM Digital Library, http://dl.acm.org/
17. ASCE Online Research Library, http://ascelibrary.org/
18. American Society of Mechanical Engineers, http://asmedigitalcollection.asme.org/
19. Cambridge Journals Online, http://journals.cambridge.org
20. Directory of Open Access Journals, http://doaj.org
21. Emerald Insight, http://www.emeraldinsight.com/
22. Google Scholar, http://scholar.google.com.tr/
23. Hindawi Publishing Corporation, http://www.hindawi.com/
24. Inderscience Publishers, http://www.inderscience.com/
25. Journal of Industrial Engineering and Management, http://www.jiem.org/index.php/jiem
26. Science Direct, http://www.sciencedirect.com
27. Springer, http://www.springer.com/gp/
28. Taylor & Francis Online/Journals, http://www.tandfonline.com/
29. Wiley-Blackwell/Wiley Online Library, http://onlinelibrary.wiley.com/

30. World Scientific Publishing, http://www.world scientific.com/
31. Al-Ghandoor, A., Samhouri, M: Electricity consumption in the industrial sector of Jordan: application of multivariate linear regression and adaptive neuro-fuzzy techniques. Jordan Journal of Mechanical and Industrial Engineering, Vol:3, No:1, pp.69–76. (2009)
32. Tasaodian, B., Anvarian, N., Azadeh, A., Saberi, M.: An Adaptive-Network-Based Fuzzy Inference System for Long-Term Electricity Consumption Forecasting (2008-2015): A Case Study of the Group of Eight (G8) Industrialized Nations: U.S.A, Canada, Germany, United Kingdom, Japan, France and Italy. The 11th Asia Pacific Industrial Engineering and Management Systems Conference, The 14th Asia Pacific Regional Meeting of International Foundation for Production Research. pp.1–12. (2010)
33. Liang-Cheng C., Hone-Jay C., Yi-Wen C.: A Fuzzy Inference System for the Conjunctive Use of Surface and Subsurface Water, Advances in Fuzzy Systems, Vol:2013, Article ID 128393, 10 pages, 2013. doi:10.1155/2013/128393
34. Fernández, A., Herrera, F.: Linguistic fuzzy rules in data mining: follow-up Mamdani fuzzy modeling principle. In Combining Experimentation and Theory (pp. 103-122). Springer Berlin Heidelberg. (2012)
35. Tzafestas, S.G., Raptis, S., Moschos, N.: A hybrid pricing expert system based on fuzzy reasoning. Foundations of Computing and Decision Sciences, Vol:24, No:4, pp.171-188. (1999)
36. Kumar, S., Narula, P., Ahmed, T.: Knowledge extraction from numerical data for the Mamdani type fuzzy systems: a BBO approach. Innovative Practices in Management and Information Technology for Excellence, Jagadhri, India. (2010)
37. Vekariya, R.M., Ravani, R.P.: Investment Casting Process Using Fuzzy Logic Modelling. International Journal of Mechanical Engineering and Robotics Research Vol:2, No:1, pp.232-241. (2013)
38. Sabo, C., Cohen, K., Fuzzy Logic Unmanned Air Vehicle Motion Planning, Advances in Fuzzy Systems, Vol: 2012, Article ID 989051, 14 pages, 2012. doi:10.1155/2012/989051
39. Liu, S., Lin, Y. Grey information: theory and practical applications. Springer Science & Business Media. ISBN-10: 1-85233-995-0 (2006).
40. Zadeh, L.A.: Fuzzy sets. Information and Control Vol. 8, pp.338–353. (1965)
41. Wikimedia Foundation-Lotfi A. Zadeh, http://en.wikipedia.org/wiki/Lotfi_A._Zadeh (accessed in 11/11/2015)
42. Mamdani, E.H.: Application of fuzzy algorithms for control of simple dynamic plant. Proceedings of the Institution of Electrical Engineers Vol. 121, Iss. 12, pp.1585–1588 (1974).
43. Aral, Y., Watanabe, T.: Professor Ebrahim H. Mamdani Memorial Issue. Fuji Technology Press Journal of Advanced Computational Intelligence and Intelligent Informatics. https://www.fujipress.jp/JACIII/open/JACII001600050000.pdf (accessed in 11/11/2015)
44. Wierman, M. J.: An Introduction to the Mathematics of Uncertainty including Set Theory, Logic, Probability, Fuzzy Sets, Rough Sets, and Evidence Theory. Center for the Mathe-matics of Uncertainty. Creighton University College of Arts and Sciences. (2010)
45. Takagi, T., Sugeno, M.: Fuzzy identification of systems and its applications to modeling and control. IEE Transactions on Systems, Man and Cybernetics Vol. 15, No: 1, 116–132 (1985).
46. Lee, C.C.: Fuzzy Logic in Control Systems: Fuzzy Logic Controller-Part I. IEE Transac-tions on Systems, Man and Cybernetics Vol. 20, No: 2, pp.404–418 .(1990)
47. Jin, Y.: Advanced Fuzzy Systems Design and Applications. Studies In Fuzziness And Soft Computing, Physica-Verlag Heidelberg New York (2003)
48. Reznik, L., Dimitrov, V. (Eds.): Fuzzy systems design: social and engineering applica-tions. Vol:17 Physica. (2013)
49. Tatjewski, P.: Advanced control of industrial processes: structures and algorithms. Springer Science & Business Media. (2007)
50. Cordon, O.: A historical review of evolutionary learning methods for Mamdani-type fuzzy rule-based systems: Designing interpretable genetic fuzzy systems. International Journal of Approximate Reasoning, 52, 894–913 (2011)
51. Alcala, R., Casillas, J., Cordon, O., Herrera, F., Zwir, S.J.I.: Techniques for Learning and Tuning Fuzzy Rule-Based Systems for Linguistic Modeling and their Application. Knowledge Engineering Systems, Techniques and Applications, 3, 889–941 (1999)
52. United Nations, Department of Economic and Social Affairs, Population Division, Population Estimates and Projections Section, World Population Prospects: The 2012 Revision, Excel Tables - Population Data, http://esa.un.org/unpd/wpp/Excel-Data/population.htm
53. NASA Goddard Institute for Space Studies (GISS) Laboratory, Earth Sciences Division (ESD), National Aeronautics and Space Administration (NASA), Goddard Space Flight Center (GSFC), GISS Surface Temperature Analysis, http://data.giss.nasa.gov/gistemp/abs_temp.html
54. IPCC, 2013: Annex II: Climate System Scenario Tables [Prather, M., G. Flato, P. Friedlingstein, C. Jones, J.-F. Lamarque, H. Liao and P. Rasch (eds.)]. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to

the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. (2013)

55. The International Energy Agency, Statistics, World Indicators, http://www.iea.org/statistics/statisticssearch/report/?country=WORLD&product=indicators&year=Select
56. The International Energy Agency, Unit Converter, http://www.iea.org/statistics/resources/unitconverter/ (accessed in 16/06/2015)
57. Miller, G.A.: The magical number seven, plus or minus two: some limits on our capacity for processing information. The Psychological Review, Vol: 63, pp.81–97. (1956)
58. Shiffrin, R.M., Nosofsky, R.M.: Seven plus or minus two: a commentary on capacity limitations. Psychological Review, Vol:101, No:2, pp.357–361. (1994)
59. Saracoglu, B.O.: Global Grid Electricity Demand Prediction System (G2EDPS), Global Grid Prediction Systems (G2PSs). https://www.researchgate.net/publication/289813050_Global_Grid_Prediction_Systems (2015)

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A Study on the Application of Spatial Directionality in Buildings

Xin Zhang

Abstract- In the early 20th century, Einstein put forward the theory of time and space ---- Four-dimensional space. This paper presents a new theory of space ----- Five-dimensional space (ie, three-dimensional space, time and visible light). Five-dimensional space has the characteristics of logic, directionality and artistry. The logicality of space refers to that the form and state of the space will change as the five parameters of space change. The spatial directionality refers to that people identify the direction in nature and architecture depending on the visible light and the reference system. The discussion and application of five-dimensional space and its directionality in the engineering design can create various interests and amusement. It will be convenient for users to recognize the spatial directionality of the building.

Keywords: five-dimensional space (5d-space, logicality, directionality, visible light, reference system.

GJRE-J Classification: FOR Code: 091599

ASTUDYONTHEAPPLICATIONOFSPATIALDIRECTIONALITYINBUILDINGS

Strictly as per the compliance and regulations of:

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Keywords: five-dimensional space (5d-space, logicality, directionality, visible light, reference system.

I. Overview

Five-dimensional space is a new concept of space which is to study the relationship between human being and natural (or architectural) space. People feel the space mainly from the visual sense while the condition of visual sense is the visible light. People feel the space not only from the various interfaces which constitute the space, but also from the space filled with visible photons ----- visible light. The wavelength range of the visible spectrum that most people's eyes can feel is 400 to 700 nm (nm) and the minimum brightness B_{min} is 3.1831×10^{-5} Nituo (nt), (which is equal to produce the luminous intensity of a candle at one square meter area along the normal direction, i.e: 1.0 nt = 1.0 cd /㎡) [1-2]. If the minimum brightness of visible light is less than B_{min}, the illumination produced by it is not sensible. Thus, people cannot feel the existence of that space. Einstein raised the theory of space and time---- Four-dimensional space[3] in the early twentieth century, which mainly studied the physical space. The five-dimensional space is primarily about the organic relationship between human being and architecture (space). It is real natural, logical and objective. Five-dimensional space is composed of three-dimensional space (ie, geometric space), time and visible light (five parameters). It has the characteristics of logicality, directionality, stability, continuity, limitation, variability and artistry. Five-dimensional space, human being, three-dimensional space, the relationship between visible light and time are shown in Fig.1. The purpose of studying five-dimensional space is to create suitable architectural art space for people to live and enjoy their life.

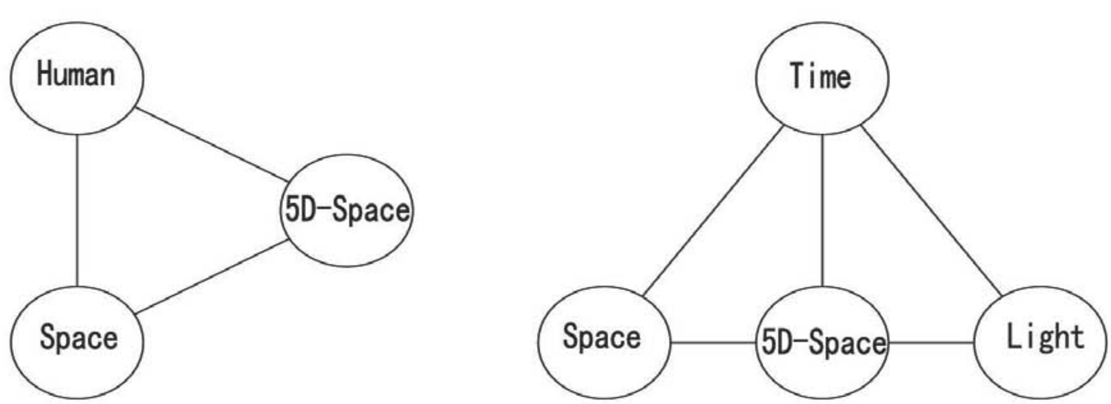

Fig.1: The relationship between human being and space

Bruno Zevi stated in "Theory of Architectural Space "[4] (p. 34): "If the cubism confirms that the building is four-dimensional, then our current way to show the space is already perfect. But we further asserted that the building has more space dimensions than the four-dimensions. "

The famous architect Le Corbusier[5] mentioned in the book that: "The architecture is a

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refined, correct and excellent treatment for a variety of objects in the sunshine. Our eyes are born to watch the image in a light. Cube, cone, sphere, cylinder, pyramid and so on are the main body mainly expressed by the light. These images are clear, tactile and not vague. For this reason, they can be called a beautiful image, the most beautiful image. Everyone has agreed to this view, whether he is a child, a savage, or a metaphysician. This is the essence of formative art".

Polish architect M Devarovsky mentioned in the book "Sunshine and Architecture" [6]: "Any sculptor will not allow buyers to transform their creation of sculpture. But when the sunshine creates a contingency of artistic effect, changes the modeling expression of the art works, and often reduce their artistic values to a large extent, no sculptor can protest against this. Light condition change will cause various light and shadow combination effect on sculptures. So it is better to consider the effects of light beforehand in the design than to let a skewed image appear accidentally.

All of the above theories on building space are from well-known architects although they did not mention the theory of five-dimensional space. But their arguments mentioned both the time and the light and its relation with three-dimensional space constituting artistic space.

Bruno Zevi mentioned the idea of buildings with more spaces than the four-dimensional space. Le Corbusier proposed the relationship between light, the eyes of man and the objects (spaces) of various shapes. And he identified it as the essence of the formative art phenomenon. The Polish architect Mdevalovsky proposed the relationship between art and the sunshine. These arguments are similar to the five-dimensional space concept raised by the author. In other words, although the author raised the new concept of five-dimensional space in April 6, 2001 for the first time, people have similar understanding of the five-dimensional space long time ago.

II. The Logicality of Space

According to the theory of five-dimensional space, the relationship between human being and natural space or architecture is a five-dimensional space. First of all, let's discuss the logicality of five-dimensional space. It is believed that the logical space must be a five-dimensional space and a logical space must be a natural space; Non-logical space is certainly not a five-dimensional space. That is to say: five-dimensional space is a visual space but visual space is not necessarily a five-dimensional space. For example, the space inside the mirror is a visual space but it is not a five-dimensional space. People's feeling on the real space of nature is an objective reality. The phenomena that occur in a five-dimensional space system are logical and cannot be replicated, eg: Seen from a train window, the space outside the window is dynamic.

When people stay in a room, they feel the space is static because all the interfaces of the room are static. The various interfaces outside the window on a running train are changing all the time while the interfaces in a room do not change with the time. Another example is that people's feeling is different when they stand in front of a small building model and a real building with the same shape. This phenomenon, i.e: the change of spatial parameters directly changed the spatial state and form, is the characteristic of five-dimensional space logicality. On the contrary, a space without logicality must be non-five-dimensional space. Movie or television can be understood as a four-dimensional relationship because they get visual effect on a plane via changeable patterns by the light and time. It is non-stereoscopic but with three-dimensional sense and without depth dimension. A photo can be understood as a three-dimensional space, i.e: a static graphic or image formed by planar two-dimensional graphic and light.

In addition, two abstract spatial concepts are presented here: one is two-dimensional space, i.e: When a person (suppose a blindman) hears a description of a music or language on a space, he will feel he is in that space. In the story (see Supplementary Material 1) of Boya Yu and Ziqi Zhong [7], Boya Yu's music play of the mountains and rivers made Ziqi Zhong feel the existence of that space. Such space feeling has only two parameters: time and sound. It can be called two-dimensional space. The other is one-dimensional space, i.e: the space that a person feels in his sleep. It sometimes has mountains and rivers, rivers and lakes, pavilions, bridges and others. This space is called dream space, which has only one parameter---time. All spaces discussed here, from one-dimensional to four-dimensional, are not directional. Only five-dimensional space has directionality.

III. The Spatial Directionality

The spatial directionality discussed here is limited to those in natural space or architectural space for human being to recognize the east, west, south, north (or front, rear, left, right). It does not involve the directionality of "up" (or "down"), as well as the identification of directionality in universal space. Since the gravitation always points to the center of the earth, no matter where a person stays and/or whether the space a person stays has any visible light, he can easily recognize upward or downward directionality by his own sense of gravity. The five-dimensional space directionality is based on the light and reference system. The so-called reference system is similar to the reference space [8], which can be understood as a reference object, such as: the urban survey coordinate system widely used in architectural engineering design.

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Regarding the spatial directionality, let's study the following occasions: First, in a cloudy day or dark night, when people (take a windowless car) come to a new street in a new city. If they do not watch road sign(with road name and direction) and also do not watch compass, people will lose their way; Second, some people living in an old city for a long time may lose their direction if the old city is re-planned and re-constructed since all roads and buildings are changed; Third, people will lose their sense of direction when they drive to an underground (three level) parking area and meet an emergency power outage---all lighting equipment do not work plus people did not bring any lighting tools with them.

The three reasons for people lose their sense of direction for above three occasions: First, sky and the sun for people to identify the direction are clouded, plus people are not familiar with surrounding roads and buildings. Hence, the reference system for identifying the direction was not established; Second, the reference system for identifying the direction is changed. The reference objects with original memory (buildings and roads) were changed. The reference system to distinguish the direction is different from the original position; Third, all visible lights are lost in underground parking area. People are unable to identify the direction of the space.

On the Earth, the directionality of the five-dimensional space discussed by the author is relative. It is relative to the earth's terrain, features and the sun, moon and stars that people can see, and the Earth's north and southpole magnetic field that people cannot see. The directionality of the five-dimensional space is based on a certain reference system. If people stay at a corner of the universe or space where they cannot see the sun, stars and the moon, also can not feel the gravity of the Earth or other planets, people won't distinguish the directionality of surrounding space. The north-south direction of the earth is mainly determined by the Earth's magnetic field, such as: the compass is an equipment invented by the ancestor of the Chinese people according to the Earth's magnetic field to know the direction.

There are three prerequisites for the author to discuss the directionality of the five-dimensional space: one is to discuss the relationship between human being and natural (or architectural) space; Second is visible light; Third is reference system. That is to say, light is the necessary condition of five-dimensional space with directionality while the reference system is the sufficient condition of five-dimensional space with directionality. If different shapes of buildings can be used as a reference system but without any light, people cannot identify the direction. On the contrary, If only the light is available but without reference system, it is also unable for people to distinguish the direction of space. For example, it is difficult for a person to identify the East, West, South, North direction on the vast sea or the vast grasslands if he does not have the compass, the sun, the moon and the Big Dipper.

Why is light a necessary condition for the five-dimensional space with directionality? This is because the ordinary light seen by the human eye has two important characteristics: one is that light does not change direction in the same medium (the Fermat principle) [9] and radiates at a straight line(With the exception of Einstein's theory of light bending) [10]); Second, the speed of light is very fast. The speed of light in air or space is 299,838.882 (km / s) ≌300,000 (km / s) [11]. Therefore, light is a necessary condition for the directionality of space. If the light is not a straight line, people may be wrong on the direction of the space. And if the light transmission speed is not 300,000 km per second, but 30m per second or less. Then the speed of the car on the road must not exceed 30m per second, otherwise the moving car will collide with the object or car ahead. When the car's speed is 30m per second, the driver can only see the object within 30 meters in front of him and cannot see farther ahead, which means the driver goes ahead of the light. It is not difficult to understand this assumption since the visibility is only 50m or 100m when the car is driving in a heavy fog. In this case, the driver cannot drive the car too fast and the traffic department will set a speed limit on the expressway. If the visibility is too low due to heavy fog, the traffic department will close the expressway. Similarly in the waterway, the event of fog will generally stop the sailing of ships to prevent collision accident.

Thus, when the relationship between human being and space is discussed, only five-dimensional space has the characteristics of directionality. Visible light is a necessary condition while reference system is a sufficient condition for distinguishing the directionality of space. Only when these two conditions exist, people can distinguish the directionality of space.

IV. Application of Spatial Directionality

The spatial directionality can be divided into: (1) directional space; (2) non-directional space. The directional space can be divided into: (a) Identifiable directional space; (b) Difficult identifiable directional space; (c) Directional space with target; (d) Azimuth directional space. Directional space with target refers to people can find their goal (or destination, Such as Beijing) relying on the surrounding terrain, features and topography and other reference systems when they go to some place(such as Beijing, China) from a location (such as Shanghai, China). The layout of Sun Yat-sen Mausoleum, Nanjing, Jiangsu, China is a good example with obvious target directionality. The mausoleum building locates at the high point of the base and thus people can see it in a very far distance. See Fig.2.

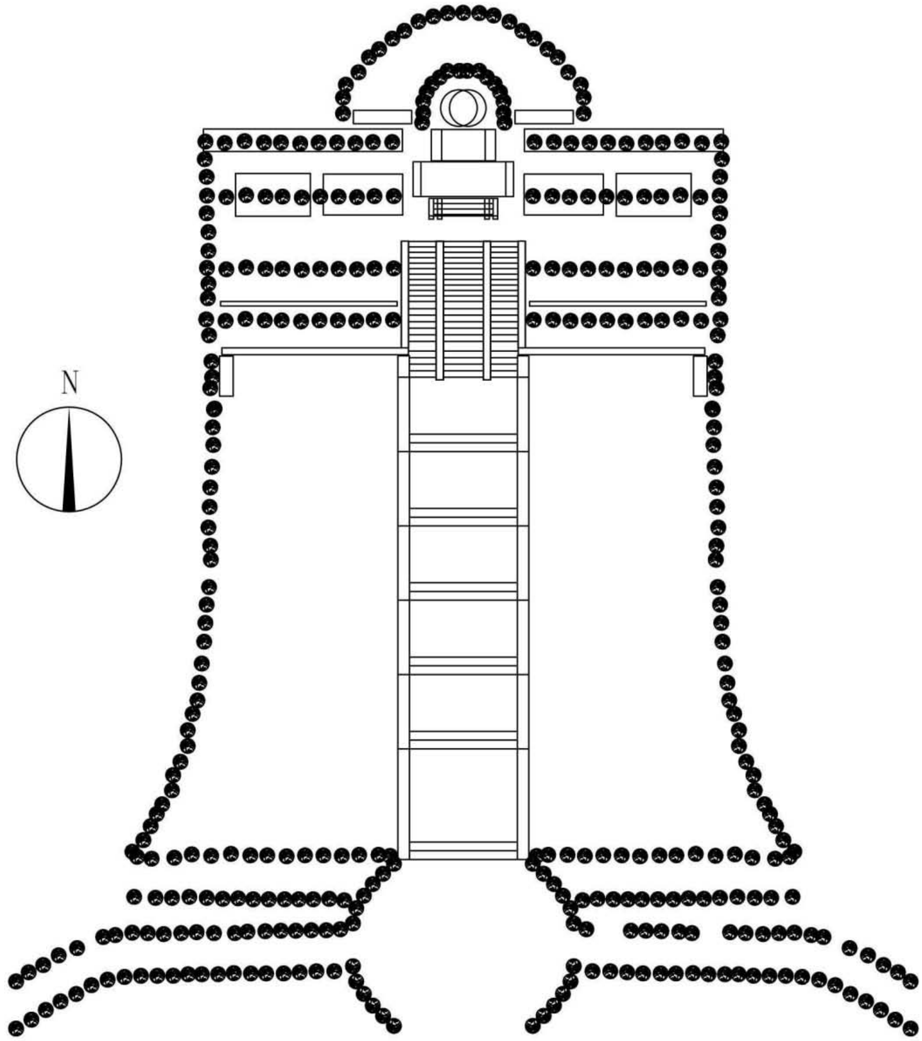

Fig. 2: Schematic diagram of the Sun Yat-sen Mausoleum in Nanjing, China

Oriented directionality refers to that people at a place (or in a space) can identify the East, West, South, North without needing a compass by means of the surrounding buildings, roads and other reference system, such as: road (and buildings) layout in Beijing and Xi'an city, which are basically aligned in a parallel and crossing way of east, west, south, north. The directionality of this urban layout is so obvious that people can easily identify the East, West, South, North whether they are at any road in Beijing or Xi'an city. It belongs to the identifiable directionality space, as shown in Fig.3 and Fig.4.

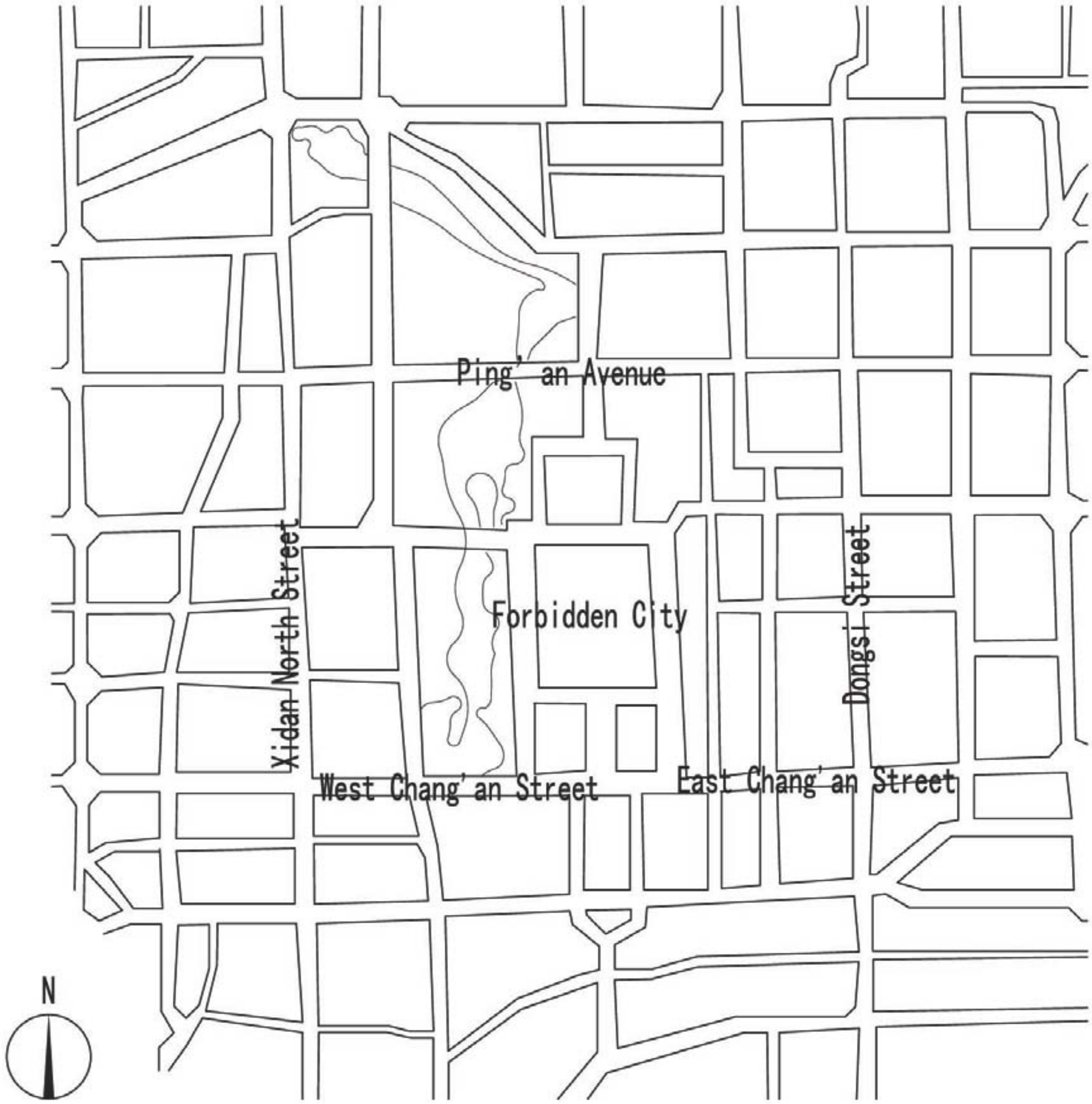

Fig. 3: Map of Beijing (Partial), China

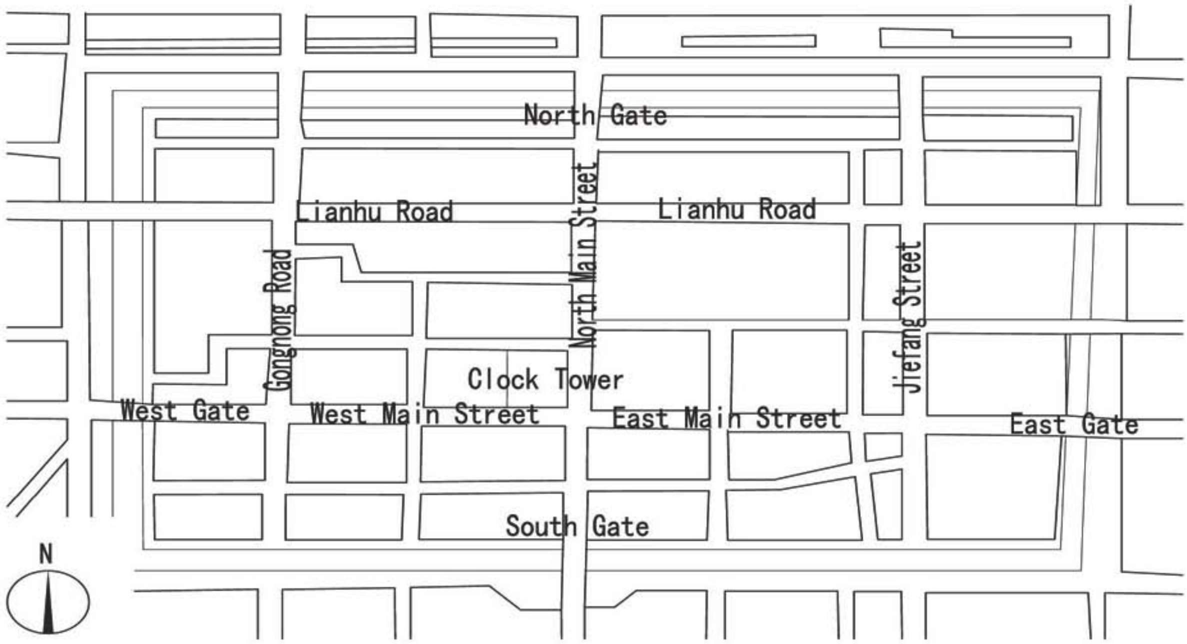

Fig. 4: Map of Xi'an (Partial), China

Another example is Shanghai, China. Some roads are in acute angle-shaped layout with north-south axis while some vertical and horizontal roads are not orthogonal. The oriented directionality of this kind of urban space is not obvious, or, difficult to identify the direction. People are easy to get lost in such an urban space, as shown in Fig.5.

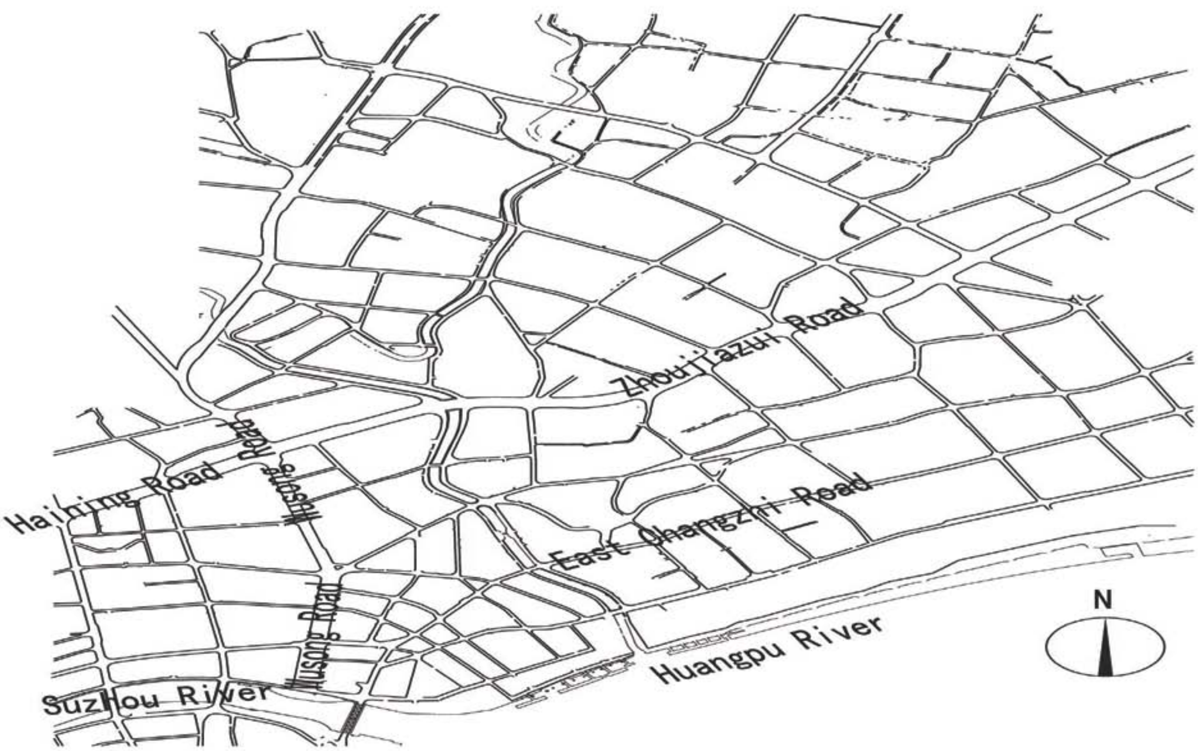

Fig. 5: Map of Shanghai (Partial), China

In the vast sea or prairie, people cannot identify the direction and orientation without the help of the Big Dipper and compass. This type of space can be called non-directional space. In architectural and landscape design, the architect can create some non-directional space, such as: the maze of buildings and the maze of plants in gardens. They are examples of non-directional spaces. Architects can use this principle to design mazes with various fun. In the landscape design, the spatial target directionality can guide visitors to enjoy the rich and colorful art space in accordance with the intention of the designer. The directionality of space is widely used in architectural design, mainly in the art of indoor and outdoor space. The space will be ever-changing and colorful in the role of light, showing the charm of art.

V. Concluding Remarks

To sum up, the directionality of five-dimensional space is based on people, space, visible light and the reference system. The directionality of space can be divided into three categories: one is directional space or identifiable directional space; The second is the space which is difficult to identify the direction; Third is the space without directionality. A proper use on the spatial directionality in architectural design can get a better art space and facilitate the use to identify the direction.

In addition to the directionality of the five-dimensional space discussed above, there are also geometric, topological, and digital spaces, and Einstein's four-dimensional space----time and space theory. The fundamental difference between the above spaces and the five-dimensional space is: The first one is to study the spaces with mathematics, physics methods, while the five-dimensional space we discussed here is a study of the relationship between human being and space based on the feeling of art and experiences. The main points of this new concept are: The object is three-dimensional and the space is five-dimensional. If we can discuss the existence of five-dimensional space from the view of Physics, it will be a larger and new topic.

VI. Acknowledgments

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References Références Referencias

1. Zuxiang Zhu, "Industrial Psychology", Zhejiang Education Press, May 2001 edition, p96. Four college co-edited (Tsinghua University and so on).
2. "Building Physics", China Building Industry Press, July 1980 edition, pp.123.
3. "Einstein's Theory of Relativity" 〈http://blog.sina.com.cn/s/blog_78049e160101209u.html〉.
4. [Italy] Bruno Zevi, "Architectural space theory - how to comment on architecture"(Sizhan Zhang translated), China Building Industry Press, March 1985, first edition, pp.34.
5. [France] Le. Corbusier, "Step to the new building"(Jingxiang Wu translated), China Building Industry Press, 1981, first edition, pp.17.
6. [Poland] M. Devalovsky, "Sunshine and Architecture", China Building Industry Press, 1982 edition;
7. Bo Wang, "Boya Yu and Ziqi Zhong", Jiangxi People's Publishing House, January 1957 first edition.
8. [US] Einstein, (Li Hao translated), "the Significance of the Theory of Relativity," Beijing University Press, February 2014, the first edition, the first chapter, “Space and Time in Physics before Relativity”, pp.4-13.
9. M Born, E Wolff, “Principles of Optics”, Science Press, 1st edition, December 1978, Chapter 3, “Fundamental Geometrical Optics, Fermat Principle”, pp.173.
10. "Collected Works of Einstein" (Supplement) Volume II (Dainian Fan, Lizhong Zhao, Liangying Xu translated), Commercial Press, 2009 December, second edition, “The influence of gravity on light transmission”, pp.231-243.
11. [US] Kyle Kirkland, "Light and Optics"(Qing Wen, Xujin Yuan, Shi Pu translated), China Science and Technology Literature Publishing House, 2008, April, first edition, pp.3.

Appendix 1: Boya Yu And Ziqi Zhong's Story

Boya Yu and Ziqi Zhong's story took place in the Spring and Autumn Period in the ancient China. In the Chu State, there was a man named Boya Yu, who was proficient in music temperament and had superb skill in playing *qin*(A musical instrument), a musical instrument. But he always felt that he could not vividly present his feelings for various things with his performance. When his teacher knew about this, he took Boya to the Penglai Island on the East China Sea, asking him to enjoy the natural scenery and listen to the sound of the ocean. Boya saw the surging waves beating the coast and flying seabirds crying, which filled his ears with harmonious and pleasant music of the nature. He was so impressed that he began to play his *qin*(A musical instrument). The sound of the music followed his feelings and the beauty of nature entered the sound of his musical instrument. But no one could understand his music. He felt very lonely and isolated, and was very unhappy.

One night, Boya took a boat trip. Facing the breeze and seeing the moonlight, he indulged in deep thoughts, and began to play his *qin* (A musical instrument). The melodious sound of music was carried far away, when suddenly he felt someone was listening to his music. He saw a woodman standing on the shore, so he asked the woodman on board, and played music to demonstrate the beauty of the high mountains. The woodman said: "solemn and mighty, just like the Taishan Mountain rising into the sky." When he played music to present the surging waves, the woodman said, “broad and vast, just like the boundless sea!” Boya said excitedly: “I have found an understanding friend.” This woodman was Ziqi Zhong. Later Ziqi Zhong died, and when Boya Yu got the news, he played a last melody in front of Ziqi Zhong’s tomb and then broke all the strings of his *qin*(A musical instrument). He never played again.

(end)

1 Jul 2017

Highlights

1. The relationship between human being and space is a five-dimensional space composed of three-dimensional space, time and visible light.
2. The five-dimensional space owns logic, directional and artistic characteristics.
3. Two key elements to identify the spatial directionality: reference system and visible light.
4. Visible light is necessary condition while reference system is sufficient condition to identify the direction of space.
5. The application of spatial directionality principle in the engineering design can increase the interest and recognizability of the architectural space.

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Comparative Study on Experimental Type 1 & Interval & General Type 2 Mamdani Fis for G^2p^3s

Burak Omer Saracoglu

Abstract- There is only one place, that our species live on today, Earth. Climate change is one of the threats for our planet. Main cause of the climate change is the human activities (excluding orbital variations, Sun's cosmic rays, volcanism, plate tectonics, etc.). One of the human activities, that causes the climate change, is the electricity consumption and generation. These activities has to be performed in a non-polluted way. There are some grid recommendations in this respect based on 100% renewable power generation, instead of as usual grid applications. One of them is the Global Grid. It is a worldwide 100% renewable power grid. Some Global Grid design research studies have been going on for a while. The Global Grid design should be presented very well by some strategic and long term plans. These plans should include annual peak power load (peak demand or load) (GW) forecasting of the Global Grid. This research is probably the first study in this respect.

Keywords: global grid, peak load, fuzzy inference system, mamdani, prediction.

GJRE-J Classification: FOR Code: 091599

COMPARATIVESTUDYONEXPERIMENTALTYPE1INTERVALGENERALTYPE2MAMDANIFISFORG2P3S

Strictly as per the compliance and regulations of:

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Abstract- There is only one place, that our species live on today, Earth. Climate change is one of the threats for our planet. Main cause of the climate change is the human activities (excluding orbital variations, Sun's cosmic rays, volcanism, plate tectonics, etc.). One of the human activities, that causes the climate change, is the electricity consumption and generation. These activities has to be performed in a non-polluted way. There are some grid recommendations in this respect based on 100% renewable power generation, instead of as usual grid applications. One of them is the Global Grid. It is a worldwide 100% renewable power grid. Some Global Grid design research studies have been going on for a while. The Global Grid design should be presented very well by some strategic and long term plans. These plans should include annual peak power load (peak demand or load) (GW) forecasting of the Global Grid. This research is probably the first study in this respect. The forecasting time horizon is taken as 100 years. Experimental type 1 and interval type 2 Mamdani fuzzy inference systems are built on the Juzzy Online V2.0 and compared with each other on historical data. There are two experimental inputs: world population, global annual temperature anomalies. There is one experimental output: annual peak power load demand of the Global Grid. Seven triangular fuzzy input membership functions and forty nine rules are defined in these experimental models. The MAP and MAPE of these core models are calculated as 0,46 and 0,36 (Type 1) and 0,46 and 0,36 (Interval Type 2) respectively. Afterwards, these core models are adjusted by some very simple mathematical and statistical approaches. These adjusted models are able to reach 0,15 and 0,04 MAP and MAPE values. Finally, G^2P^3S (global grid peak power prediction systems) are recommended to be designed and operated in near to mid terms.

Keywords: global grid, peak load, fuzzy inference system, mamdani, prediction.

I. Introduction

There are several grid types in the research, development, demonstration, and deployment (RD3) stages. Some RD3 engineers work on smart grids (see United States and European Union: [1, 2]). Some RD3 engineers work on Super grids and Global Grid (see [3]). In the smart grids, there are two way flow/communication networks. Electricity flows in one direction and information flows in opposite direction [4]. In the Supergrids and the Global Grid, there is only one way flow network. Only electricity flows in one direction like usual grids (business as usual). These conventional like grids work on the principles of bulk generation and storage [5]. This study considers that the Global Grid can be more effective and efficient in climate change actions. Two important main issues during development of the Global Grid are defined as human related issues (politics and its relations with wars, conflicts, ambitions, egos, etc.) and technical issues (electricity transmission, etc.). The first one can be solved by a revolution in human/people minds (no politics, no wars, no conflicts, no ambitions, no egos, etc.). A fair healthy living world can be designed, organized and managed by international organizations (properly modeled united nations: representation capability of each human being well). The most difficult technical issue is seemed power transmission (important RD3 direction) in the technical issues part. Wireless electricity transmission technology will technically and economically be possible for indoor and outdoor applications and usage in mid to long terms (idea supported by correspondence and literature) (see [6, 7, 8, 9]). For instance, in outdoor applications, power transmission will be performed by wireless systems instead of transmission and distributions lines, or electric vehicles will be charged without any cables (any time or stationary charging). In indoor applications, home appliances will work without any cables. Hence, this research study focuses on the Global Grid main topic on way of taking some climate change actions (see [10,11] for crucial signs climate change).

Modeling and designing RD3 works/activities of the Global Grid (worldwide 100% renewable energy power grid) have to be finalized in a detailed manner.

One of the modeling tasks is forecasting/ prediction/projection of peak power load demand. There are several forecasting time horizons. The most common classification has four time horizons: immediate (less than 1 month), short-run (l–3 months), medium-term (3 months–2 years), long-run (2 years or more) [12,13,14]. In power grid documents, three time horizons are mainly observed as short (up to a week a head), medium (up to 10 years ahead) and long (50 years ahead) [15,16]. This research study is an extreme research study, that assumes the long range forecasting time horizon of the Global Grid as 100 years ahead.

Hence, annual peak power load/demand (GW) is taken into account in this 100 years prediction period. Models and predictions of these models on historical data can be used in future research studies and in

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strategic development and expansion plans of the Global Grid.

Section 2 presents literature review. The first experimental core type 1 and interval type 2 Mamdani Global Grid power load forecasting fuzzy inference systems (fuzzy control system, fuzzy rule base system, fuzzy expert system: FIS) on the JuzzyOnline V2.0 (http://ritweb.cloudapp.net:8080/JuzzyOnline/juzzy), and their first experimental comparative analysis are presented in Section 3. Adjusted models based on core models are also presented and compared amongst each other in Section 3. Conclusions and future research are presented in Section 4.

II. Literature Review

Review activity was performed from 11/06/2015 to 01/07/2015 (20 days period). Search terms were found from previous studies, that were read before this research. Some key search terms were "fuzzy logic inference system" and "electricity", "fuzzy logic inference system" and "forecast", "fuzzy logic inference system" and "demand", "fuzzy rule system" and "electricity", "fuzzy rule system" and "forecast", "fuzzy rule system" and "demand". Total search hit number was 38727, that included all websites and documents (duplications etc. included). Journal papers, conference papers, and books were reviewed. Three academic publications' database websites contained majority of documents. These websites were ACM Digital Library [17], Google Scholar [18], and Springer [19]. Other websites didn't help to increase number of documents in research folder in this subject (ASCE Online Research Library [20], American Society of Mechanical Engineers [21], Cambridge Journals Online [22], Directory of Open Access Journals [23], Emerald Insight [24], Hindawi Publishing Corporation [25], Inderscience Publishers [26], Journal of Industrial Engineering and Management [27], Science Direct [28], Taylor & Francis Online/Journals [29], Wiley-Blackwell/Wiley Online Library [30], World Scientific Publishing [31]).

According to this review activity, there were four main time horizon groups found in literature (very short (e.g.[32]), short (e.g.[33]), medium (e.g.[34]), long (e.g.[35])). One of the studies in long term forecasting was by Al-zahra et.al. (2015) [36]. Monthly consumption in Basra, which characterized as nonlinear over time, was modeled by an Auto-Regressive Integrated Moving Average (ARIMA), an artificial neural network (ANN), and an adaptive neuro-fuzzy inference system (ANFIS) models. Mean absolute errors (MAE) were calculated as 0,31604 (Box-Jenkins ARIMA), 0,301 (ANN), and 0,2491 (ANFIS) [36]. Northern-Iraq's power load was studied by Demir (2014) [37]. Mean absolute percentage errors (MAPE) were 5,7% (Winters' additive) and 5,4% (seasonal ARIMA: SARIMA). Taiwanese load predictions were studied with a support vector regression (SVR) by Hong (2009) [38]. Findings showed that MAPE ranged between 1,29% and 2,45%.

During this review period, it was clearly understood that peak power load prediction topic was studied in different parts of the world by several researchers, however long term peak power load forecasting of the Global Grid Concept had not been studied until 01/07/2015. This research study was the first step in this new topic.

III. Experimental Core and Adjusted Type 1 & Interval Type 2 Mamdani Fis Models for G²P³s

Fuzzy inference system's design approach has several important issues as inputs, outputs, membership functions, and rules identifications, inference type and defuzzification method selections [see 39,40,41]. Structure of a fuzzy rule base system is generally presented in literature as shown in "Fig. 1".

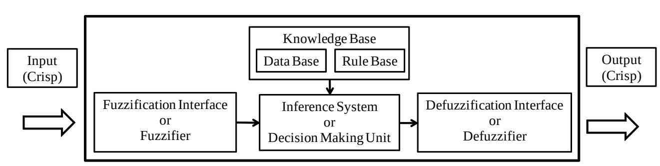
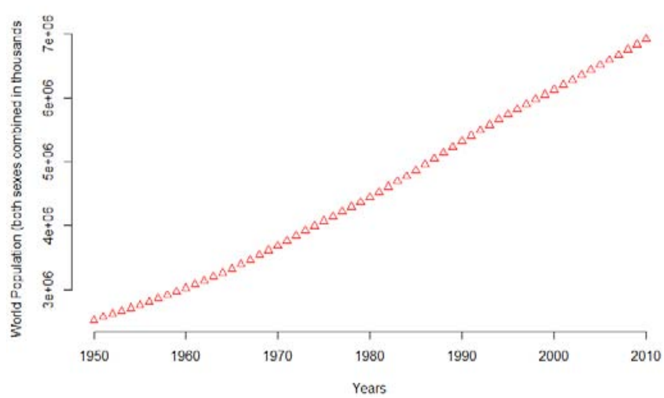


Figure 1: Fuzzy rule base systems (drawn based on [39], [42], [43])

Readers should here visit some important publications for FIS modeling and Juzzy Online for better perception of this research (see a few as [44-54]). Fuzzy inference systems in this research are founded on fuzzy logic principles and Mamdani fuzzy inference. Fuzzy set theory deals with un sharpness of human judgments. It was introduced by Lotfi A. Zadeh in 1965 [44]. Mamdani fuzzy inference was introduced by Ebrahim H. (Abe) Mamdani in 1974 based on Zadeh's fuzzy theory [45]. After 10 years from the first presentation of fuzzy set theory, Dr. Zadeh defined type-2 fuzzy sets in 1975 [46]. Afterwards, several academics and researchers contributed in this field. One of them is Dr. Yaochu Jin. His explanation on design of FIS philosophy is very easy to understand and important: "the most important thing is that the designed fuzzy system is theoretically able to realize the desired functional mapping. Therefore, the approximation capability of the fuzzy systems is of great concern.", "Furthermore, it has also been shown that various types of commonly used membership functions satisfy the conditions for the fuzzy systems to be universal approximators. By universal approximators, we mean that a fuzzy system can approximate any continuous functions on a compact set to an arbitrary degree of accuracy." [47]. This explanation and approach seriously guides this research study. Researchers underline that type-2 fuzzy logic sets and systems are more capable of handling uncertainties, than type-1 fuzzy sets and systems do [48, 49]. According to this judgment, two core models based on type 1 and interval type 2 (second model is related with first model) are built and compared in this study. Furthermore, it is mentioned by several academics that Mamdani's fuzzy rule based systems can handle human judgments better amongst other fuzzy inference systems (see [50,51]). Therefore, Mamdani's fuzzy rule based system is preferred instead of others (e.g. Sugeno). This research study is built on the JuzzyOnline V2.0 under these basic principles. It is a Java based online toolkit developed by Christian Wagner, Mathieu Pierfitte, and Amandine Pailloux [52,53,54].

Comparative analysis is mainly performed on two core experimental models on JuzzyOnline V2.0. These core models are type 1 and interval type 2 Mamdani FIS. Simple and easy experimental models are built in this early RD3 stage. Trial and error approach is followed during this research. There are two experimental inputs (world population, global annual temperature anomalies) and one experimental output (annual peak power demand) as such:

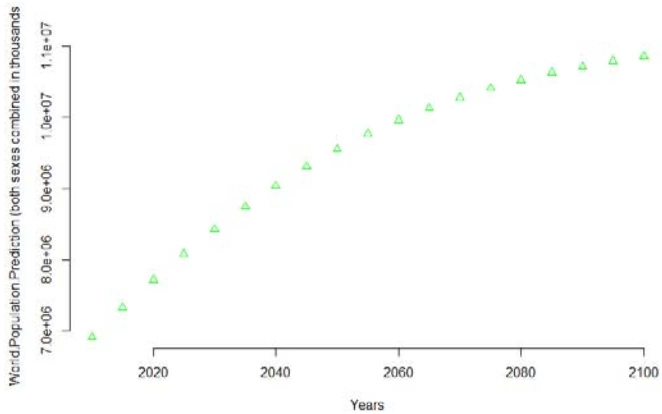
X1 (world population): Historical and prediction data are taken from the Department of Economic and Social Affairs of the Population Division in the United Nations (visit [55]) (see “Fig. 2” top). Predictions are from 2010 to 2100 for each 5 years period (2010, 2015, 2020,......,2100) (see “Fig. 2” bottom). This experimental input variable is preferred in this research because of two main reasons. Firstly, peak power demand is related with population in real life. Secondly, historical and projected data can be gathered easily. This experimental variable is sufficiently accurate in this RD3 stage (see also electronic supplementary material files: ESM).




```
Year=c(1950,1951,1952,1953,1954,1955,1956,1957,1958,1959,1960,1961,1962,1963,1964,1965,1966,1967,1968,1969,1970,1971,1972,1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983,1984,1985,1986,1987,1988,1989,1990,1991,1992,1993,1994,1995,1996,1997,1998,1999,2000,2001,2002,2003,2004,2005,2006,2007,2008,2009,2010)

World.Population=c(2525779,2572851,2619292,2665865,2713172,2761651,2811572,2863043,2916030,2970396,3026003,3082830,3141072,3201178,3263739,3329122,3397475,3468522,3541675,3616109,3691173,3766754,3842874,3919182,3995305,4071020,4146136,4220817,4295665,4371528,4449049,4528235,4608962,4691560,4776393,4863602,4953377,5045316,5138215,5230452,5320817,5408909,5494900,5578865,5661086,5741822,5821017,5898688,5975304,6051478,6127700,6204147,6280854,6357992,6435706,6514095,6593228,6673106,6753649,6834722,6916183)

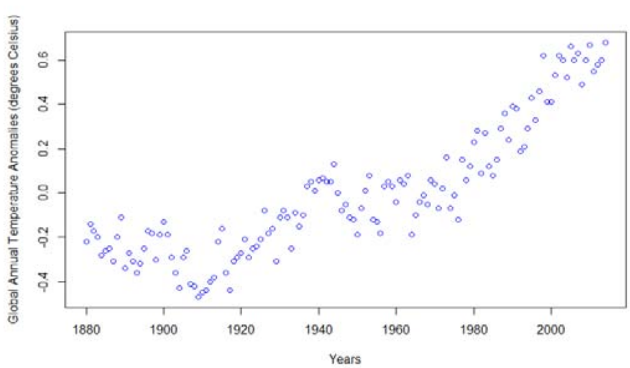
plot(Year, World.Population, xlab = "Years", ylab = "World Population (both sexes combined in thousands", pch=2, cex.main=1.5, frame.plot=FALSE, col="red")
```



Year=c(2010,2015,2020,2025,2030,2035,2040,2045,2050,2055,2060,2065,2070,2075,2080,2085,2090,2095,2100)
World.Population.Prediction=c(6916183,7324782,7716749,8083413,8424937,8743447,9038687,9308438,9550945,9766475,9957399,10127007,10277339,10409149,10524161,10626467,10717401,10794252,10853849)
plot(Year,World.Population.Prediction,xlab="Years",ylab="World.Population.Prediction (both sexes combined in thousands",pch=2,cex.main=1.5,frame.plot=FALSE,col="green")

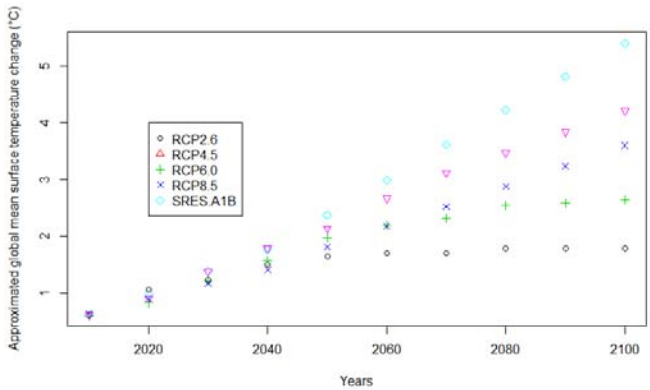
Figure 2: World population historical X1 (top) (country code: 900, year: 1950-2010: 61 data, access date: 05/07/2015), world population projection X1 (bottom) (year: 2011-2100: 18 data, access date: 06/07/2015), visualization generated by scatter graph of R (https://www.r-project.org/) and R Studio (https://www.rstudio.com/) script with data

X2 (global annual temperature anomalies in degrees Celsius: °C): Historical data are taken from the NASA Goddard Institute for Space Studies (GISS) Laboratory in the Earth Sciences Division (ESD) of National Aeronautics and Space Administration's (NASA) Goddard Space Flight Center (GSFC) (visit [56]) (see "Fig. 3" top). Projection data are gathered from the Intergovernmental Panel on Climate Change (IPCC), Annex II: Climate System Scenario Tables, Table AII.7.5. RCP8.5 (see [57]). There are five projections (RCP2.6, RCP4.5, RCP6.0, RCP8.5, SRES.A1B) in the IPCC report. The data are at 10 years period from 2010 to 2090 (see "Fig. 3" bottom). This experimental input variable is preferred in this research, because of three main reasons. Firstly, peak power demand is related with climatic conditions in real life. Secondly, historical and projected data can be taken easily. Finally, there are many academics and researchers, who work in climate change research area. This experimental variable is sufficiently accurate in this RD³ stage (see also ESM).



Year=c(1880,1881,1882,1883,1884,1885,1886,1887,1888,1889,1890,1891,1892,1893,1894,1895,1896,1897,1898,1899,1900,1901,1902,1903,1904,1905,1906,1907,1908,1909,1910,1911,1912,1913,1914,1915,1916,1917,1918,1919,1920,1921,1922,1923,1924,1925,1926,1927,1928,1929,1930,1931,1932,1933,1934,1935,1936,1937,1938,1939,1940,1941,1942,1943,1944,1945,1946,1947,1948,1949,1950,1951,1952,1953,1954,1955,1956,1957,1958,1959,1960,1961,1962,1963,1964,1965,1966,1967,1968,1969,1970,1971,1972,1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983,1984,1985,1986,1987,1988,1989,1990,1991,1992,1993,1994,1995,1996,1997,1998,1999,2000,2001,2002,2003,2004,2005,2006,2007,2008,2009,2010,2011,2012,2013,2014)
Global.Annual.Temperature.Anomalies=c(-0.22,-0.14,-0.17,-0.2,-0.28,-0.26,-0.25,-0.31,-0.2,-0.11,-0.34,-0.27,-0.31,-0.36,-0.32,-0.25,-0.17,-0.18,-0.3,-0.19,-0.13,-0.19,-0.29,-0.36,-0.43,-0.29,-0.26,-0.41,-0.42,-0.47,-0.45,-0.44,-0.4,-0.38,-0.22,-0.16,-0.36,-0.44,-0.31,-0.29,-0.27,-0.21,-0.29,-0.25,-0.24,-0.21,-0.08,-0.18,-0.16,-0.31,-0.11,-0.08,-0.11,-0.25,-0.09,-0.15,-0.1,0.03,0.05,0.01,0.06,0.07,0.05,0.05,0.13,0,-0.08,-0.05,-0.11,-0.12,-0.19,-0.07,0.01,0.08,-0.12,-0.13,-0.18,0.03,0.05,0.03,-0.04,0.06,0.04,0.08,-0.19,-0.1,-0.04,-0.01,-0.05,0.06,0.04,-0.07,0.02,0.16,-0.07,-0.01,-

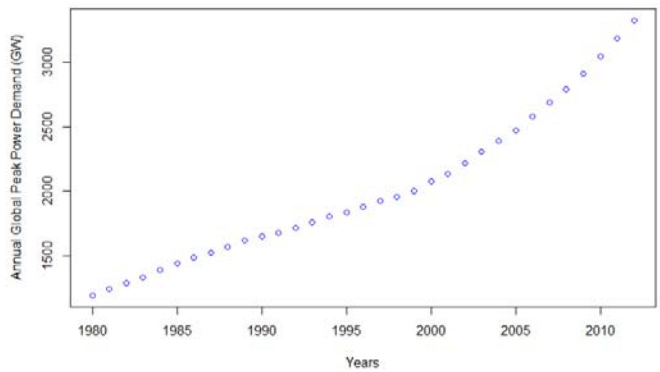
0.12,0.15,0.06,0.12,0.23,0.28,0.09,0.27,0.12,0.08,0.15,0.29,0.36,0.24,0.39,0.38,0.19,0.21,0.29,0.43,0.33,0.46,0.62,0.41,0.41,0.53, 0.62,0.6,0.52,0.66,0.6,0.63,0.49,0.6,0.67,0.55,0.58,0.6,0.68)
plot(Year, Global.Annual.Temperature.Anomalies, xlab = "Years", ylab = "Global Annual Temperature Anomalies (degrees Celsius)", col="blue")



Year=c(2010,2020,2030,2040,2050,2060,2070,2080,2090,2100)
RCP2.6=c(0.62,1.07,1.24,1.50,1.65,1.71,1.71,1.79,1.79,1.79)
RCP4.5=c(0.59,0.83,1.22,1.57,1.97,2.19,2.32,2.54,2.59,2.64)
RCP6.0=c(0.64,0.90,1.17,1.41,1.81,2.18,2.52,2.88,3.24,3.60)
RCP8.5=c(0.62,0.99,1.39,1.77,2.37,2.99,3.61,4.22,4.81,5.40)
SRES.A1B=c(0.62,0.91,1.38,1.79,2.14,2.67,3.12,3.47,3.84,4.21)
Temperature.Change=data.frame(RCP2.6, RCP4.5, RCP6.0, RCP8.5, SRES.A1B)
plot(Year, RCP8.5, xlab="Years", ylab="Approximated global mean surface temperature change (°C)", pch=5, col="5")
points(Year, RCP2.6, pch=1, col="1")
points(Year, RCP4.5, pch=3, col="3")
points(Year, RCP6.0, pch=4, col="4")
points(Year, SRES.A1B, pch=6, col="6")
legend(2020,4,c("RCP2.6","RCP4.5","RCP6.0","RCP8.5","SRES.A1B"),col=c(1,2,3,4,5),pch=c(1,2,3,4,5))

Figure 3: Global annual temperature anomalies in degrees Celsius (°C) historical X2 (top) (year: 1880-2014: 135 data, access date: 05/07/2015), projection X2 (bottom) (year: 2020-2090: 8 data per model, year: 2013), visualization generated by scatter graph of R and R Studio script with data

Y: (annual peak power load demand of the Global Grid: GW) (GW: gigawatt: 109 W: watt): An assumption is made according to some practical life experience (annual peak power load demand conversion coefficient is 60%) in this output variable. Historical data (total electricity installed capacity in million kilowatts) are taken from the U.S. Energy Information Administration (visit [58]) (see “Fig. 4”). This experimental output variable is preferred in this research because historical data can be gathered easily. This experimental variable is sufficiently accurate in this RD3 stage (see ESM).




```
Year=c(1980,1981,1982,1983,1984,1985,1986,1987,1988,1989,1990,1991,1992,1993,1994,1995,1996,1997,1998,1999,2000,2001,2002,2003,2004,2005,2006,2007,2008,2009,2010,2011,2012)
World.Electricity.Installed.Capacity.GW=c(1983,2071,2147,2217,2313,2399,2471,2542,2611,2702,2754,2797,2858,2928,3000,3055,3135,3202,3258,3338,3457,3560,3697,3846,3983,4123,4303,4478,4650,4852,5081,5314,5549)
Conversion=c(0.6)
World.Peak.Power.Demand.GW=World.Electricity.Installed.Capacity.GW*Conversion
plot(Year, World.Peak.Power.Demand.GW, xlab = "Years", ylab = "Annual Global Peak Power Demand (GW)", col="blue")
```

Figure 4: Annual peak power load demand of the Global Grid calculated based on the U.S. Energy Information Administration data, historical Y (year: 1980-2012: 33 data, access date: 21/08/2015), visualization generated by scatter graph of R and R Studio script with data

According to these data and conditions, modeling period is taken as 31 years (from 1980 to 2010). Prediction period is accepted as from 2011 to 2100 (90 years) with time intervals in prediction period of 10 years (2020, 2030,..., 2100). In other words, forecasting interval in this study is taken as 10 years in 100 years prediction period according to time intervals of input variables.

Seven experimental triangular membership functions for experimental core type 1 and interval type 2 Mamdani FIS on JuzzyOnline V2.0 are defined for inputs and output of this study (for details "Fig. 5"). Visual comparison of these membership functions are presented in "Fig. 6". 49 experimental rules are defined in this study (for details "Fig. 7"). Website links of these core models are also given in this section. Details of these core models can be seen in these links. Moreover, these links can be copied and pasted to web browsers and details of these core models can be investigated. Several applications can also be done on these models on web browsers by online internet connection. Centroid defuzzification is used in this study. In computation method, AND connective t-Norm is selected as product and inference t-Norm is selected as product on JuzzyOnline V2.0.

Experimental Core Type 1 Mamdani FIS Membership Functions				
Experimental Inputs				
Input 1: world population lower bound: 4440000, upper bound: 10900000				
membership function name	type	start	peak	stop
very very low	triangular	4440000	4440000	5517000
very low	triangular	4440000	5517000	6594000
low	triangular	5517000	6594000	7670000
moderate	triangular	6594000	7670000	8747000
high	triangular	7670000	8747000	9824000
very high	triangular	8747000	9824000	10900000
very very high	triangular	9824000	10900000	10900000
Input 2: global annual temperature anomalies (degrees Celsius: °C) lower bound: 0, upper bound: 6				
membership function name	type	start	peak	stop
almost the same	triangular	0	0	1
fairly hotter	triangular	0	1	2
rather hotter	triangular	1	2	3
hotter	triangular	2	3	4
very hotter	triangular	3	4	5
very very hotter	triangular	4	5	6
extremely hotter	triangular	5	6	6
Experimental Outputs				
Output 1: annual peak power load demand of Global Grid (GW) lower bound: 1100, upper bound: 5500				
membership function name	type	start	peak	stop
very very low	triangular	1100	1100	1835
very low	triangular	1100	1835	2568
low	triangular	1835	2550	3301
moderate	triangular	2568	3301	4034
high	triangular	3301	4034	4767
very high	triangular	4034	4767	5500
very very high	triangular	4767	5500	5500
Experimental Core Interval Type 2 Mamdani FIS Membership Functions				
Experimental Inputs				
Input 1: world population lower bound: 4440000, upper bound: 10900000				
membership function name	type	start*	peak*	stop*
very very low	triangular	4440000	4440000	5517000
		4440000	4440000	5017000
very low	triangular	4440000	5517000	6594000
		4940000	5517000	6094000
low	triangular	5517000	6594000	7670000
		6017000	6594000	7170000
moderate	triangular	6594000	7670000	8747000
		7094000	7670000	8247000
high	triangular	7670000	8747000	9824000
		8170000	8747000	9324000

Figure 5: Experimental Core Type 1 & Interval Type 2 Mamdani FIS Membership Functions Of JuzzyOnline V2.0 Model

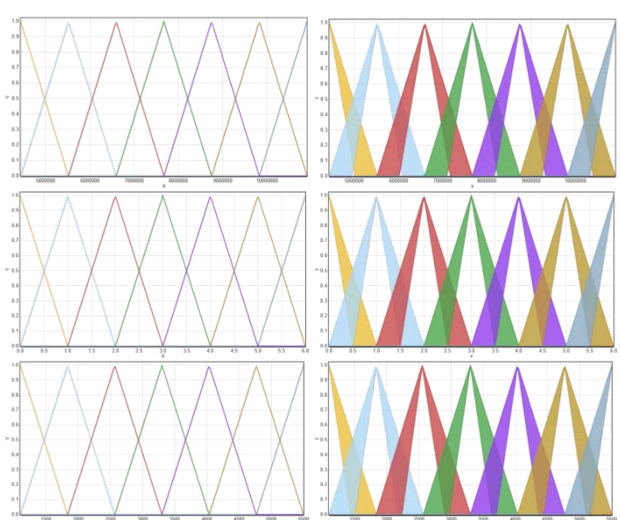


Figure 6: Visual comparisons of inputs and output membership functions, world population: X1 (top), global annual temperature anomalies: X2 (middle), annual peak power load demand of the Global Grid: Y (bottom), visualization generated by JuzzyOnline V2.0

Rule	If	Input 1	and	Input 2	then	Output
1	If	very very low	and	almost the same	then	very very low
2	If	very very low	and	fairly hotter	then	very very low
3	If	very very low	and	rather hotter	then	very low
4	If	very very low	and	hotter	then	very low
5	If	very very low	and	very hotter	then	low
6	If	very very low	and	very very hotter	then	low
7	If	very very low	and	extremely hotter	then	moderate
8	If	very low	and	almost the same	then	very low
9	If	very low	and	fairly hotter	then	very low
10	If	very low	and	rather hotter	then	low
11	If	very low	and	hotter	then	low
12	If	very low	and	very hotter	then	moderate
13	If	very low	and	very very hotter	then	moderate
14	If	very low	and	extremely hotter	then	high
15	If	low	and	almost the same	then	low
16	If	low	and	fairly hotter	then	low
17	If	low	and	rather hotter	then	moderate
18	If	low	and	hotter	then	moderate
19	If	low	and	very hotter	then	high
20	If	low	and	very very hotter	then	high
21	If	low	and	extremely hotter	then	very high
22	If	moderate	and	almost the same	then	moderate
23	If	moderate	and	fairly hotter	then	moderate
24	If	moderate	and	rather hotter	then	high
25	If	moderate	and	hotter	then	moderate
26	If	moderate	and	very hotter	then	high
27	If	moderate	and	very very hotter	then	high
28	If	moderate	and	extremely hotter	then	very high
29	If	high	and	almost the same	then	high
30	If	high	and	fairly hotter	then	high
31	If	high	and	rather hotter	then	high
32	If	high	and	hotter	then	high
33	If	high	and	very hotter	then	high
34	If	high	and	very very hotter	then	high
35	If	high	and	extremely hotter	then	very high
36	If	very high	and	almost the same	then	high
37	If	very high	and	fairly hotter	then	high
38	If	very high	and	rather hotter	then	high
39	If	very high	and	hotter	then	very high
40	If	very high	and	very hotter	then	very high
41	If	very high	and	very very hotter	then	very high
42	If	very high	and	extremely hotter	then	very very high
43	If	very very high	and	almost the same	then	high

Figure 7: Experimental Core Type 1 & Interval Type 2 Mamdani FIS JuzzyOnline V2.0 Rules*

JuzzyOnline V2.0 models are also presented as in the "Tab. 1" and "Tab. 2". Readers can copy and paste to their internet browsers and run the models.

Table 1: JuzzyOnline V2.0 Experimental Type 1 Mamdani FIS Peak Power Load Fore-casting of Global Grid Website Link

http://ritweb.cloudapp.net:8080/JuzzyOnline2/gensys?type=1&name=Experimen-tal%20Type%201%20Mamdani%20FIS%20Peak%20Power%20Load%20Forecast-ing%20of%20Global%20Grid&input=world%20population&lb=4440000.0&ub=1.09E7&mfnb=7&mf=very%20very%20low&fun=triangular&p=4440000.0_4440000.0_5517000.0&mf=very%20low&fun=triangular&p=4440000.0_5517000.0_6594000.0&mf=low&fun=triangular&p=5517000.0_6594000.0_7670000.0&mf=moderate&fun=triangular&p=6594000.0_7670000.0_8747000.0&mf=high&fun=triangular&p=7670000.0_8747000.0_9824000.0&mf=very%20high&fun=triangular&p=8747000.0_9824000.0_1.09E7&mf=very%20very%20high&fun=triangular&p=9824000.0_1.09E7_1.09E7&input=global%20annual%20temperature%20anomalies&lb=0.0&ub=6.0&mfnb=7&mf=almost%20the%20same&fun=triangular&p=0.0_0.0_1.0&mf=fairly%20hotter&fun=triangular&p=0.0_1.0_2.0&mf=rather%20hot-ter&fun=triangular&p=1.0_2.0_3.0&mf=hotter&fun=triangular&p=2.0_3.0_4.0&mf=very%20hotter&fun=triangular&p=3.0_4.0_5.0&mf=very%20very%20hotter&fun=triangular&p=4.0_5.0_6.0&mf=extremely%20hotter&fun=triangular&p=5.0_6.0_6.0&output=annual%20peak%20power%20d

emand%20of%20Global%20Grid&lb=1100.0&ub=5500.0&mfnb=7&mf=
very%20very%20low&fun=triangular&p=1100.0_1100.0_1835.0&mf=ver
y%20low&fun=triangu-lar&p=1100.0_1835.0_2568.0&mf=low&fun=trian
gu-
lar&p=1835.0_2568.0_3301.0&mf=moderate&fun=triangular&p=2568.0_
3301.0_4034.0&mf=high&fun=triangular&p=3301.0_4034.0_4767.0&mf
=very%20high&fun=triangular&p=4034.0_4767.0_5500.0&mf=very%20v
ery%20high&fun=triangular&p=4767.0_5500.0_5500.0&if=0_0_1_0&the
n=0_0&if=0_0_1_1&then=0_0&if=0_0_1_2&then=0_1&if=0_0_1_3&the
n=0_1&if=0_0_1_4&then=0_2&if=0_0_1_5&then=0_2&if=0_0_1_6&the
n=0_3&if=0_1_1_0&then=0_1&if=0_1_1_1&then=0_1&if=0_1_1_2&the
n=0_2&if=0_1_1_3&then=0_2&if=0_1_1_4&then=0_3&if=0_1_1_5&the
n=0_3&if=0_1_1_6&then=0_4&if=0_2_1_0&then=0_2&if=0_2_1_1&the
n=0_2&if=0_2_1_2&then=0_3&if=0_2_1_3&then=0_3&if=0_2_1_4&the
n=0_4&if=0_2_1_5&then=0_4&if=0_2_1_6&then=0_5&if=0_3_1_0&the
n=0_3&if=0_3_1_1&then=0_3&if=0_3_1_2&then=0_4&if=0_3_1_3&the
n=0_3&if=0_3_1_4&then=0_4&if=0_3_1_5&then=0_4&if=0_3_1_6&the
n=0_5&if=0_4_1_0&then=0_4&if=0_4_1_1&then=0_4&if=0_4_1_2&the
n=0_4&if=0_4_1_3&then=0_4&if=0_4_1_4&then=0_4&if=0_4_1_5&the
n=0_4&if=0_4_1_6&then=0_5&if=0_5_1_0&then=0_4&if=0_5_1_1&the
n=0_4&if=0_5_1_1&then=0_4&if=0_5_1_3&then=0_5&if=0_5_1_4&the
n=0_5&if=0_5_1_5&then=0_5&if=0_5_1_6&then=0_6&if=0_6_1_0&the
n=0_4&if=0_6_1_1&then=0_5&if=0_6_1_2&then=0_5&if=0_6_1_3&the
n=0_6&if=0_6_1_4&then=0_6&if=0_6_1_5&then=0_6&if=0_6_1_6&the
n=0_6&actn=p&itn=p

Experimental core type 1 and interval type 2 Mamdani FIS models on the JuzzyOnline V2.0 are run for each annual data and results are found, copied and recorded on a Microsoft Excel 2007 ∗.xls file (http://www.microsoft.com). An Apache OpenOffice Calc ∗.ods file (http://www.openoffice.org/) is also generated from this file (see ESM). Historical annual peak power load demand of the Global Grid, experimental core type 1 Mamdani FIS based Global Grid peak power load forecasting model (ECT1MFISGGPP) findings on historical data and predictions of experimental core interval type 2 Mamdani FIS based Global Grid peak power load forecasting model (ECIT2MFISGGPP) on historical data are presented in "Fig. 8" (see ESM).

A few prediction performance assessment measures are tested in this study. These measures (absolute percentage error, maximum absolute percentage error, mean absolute percentage error) are mostly seen in literature and calculated according to equation 1 to 3.

Absolute percentage error (APE):

$$APE_t = \frac{(|Actual_t - Predicted_t|)}{(Actual_t)} \quad (1)$$

Maximum absolute percentage error (MAP):

$$MAP = max(APE_t) \quad (2)$$

Mean absolute percentage error (MAPE):

$$MAPE = \frac{1}{n}\sum_1^n (APE_t) \quad (3)$$

Where actual shows historical annual electricity demand of the Global Grid, predicted shows forecasted annual electricity demand of the Global Grid, t stands for year, and n stands for total number of years. Values of these prediction performance assessment measures are presented very clearly in ESM and showed by "Fig. 9". APE of core type 1 models ranges between 0,32 and 0,46, so that MAP of this model is found as 0,46. MAPE of this model is calculated as 0, 36 (see ESM). APE of core interval type 2 models ranges between 0,29 and 0,46, so that MAP of this model is found as 0,46. MAPE of this model is calculated as 0,36 (see ESM). These measures shows that both of these models need serious improvement efforts. Before spending time and efforts on these FIS model enhancements, some simple adjustments are made according to following approaches and adjusted models are also compared. It is hoped that these adjusted models will help improvements of these core FIS models in future studies.

Adjusted model approach 1: First, differences between actual values and predicted values are calculated in this approach. Second, arithmetic average of these values is calculated in this data series. Core type 1 and interval type 2 model predictions are adjusted by summation of this value. New models based on this procedure is called experimental adjusted 1 type 1 Mamdani FIS based Global Grid peak power load forecasting model (EA1T1MFISGGPP) and experimental adjusted 1 interval type 2 Mamdani FIS based Global Grid peak power load forecasting model (EA1IT2MFISGGPP). Predictions of these adjusted 1 models are presented in Figure 6. APE of adjusted 1 type 1 model ranges between 0,00 and 0,27, so that MAP of this model is found as 0,27. MAPE of this model is calculated as 0,11 (see ESM). APE of adjusted 1 interval type 2 model ranges between 0,00 and 0,25, so that MAP of this model is found as 0,25. MAPE of this model is calculated as 0,11 (see ESM and “Fig. 9”).

Adjusted model approach 2: Minimum value amongst values of first step of adjusted model approach 1 procedure is found in this approach. Core type 1 and interval type 2 model predictions are adjusted by summation of this value. New models based on this procedure is called EA2T1MFISGGPP & EA2IT2MFISGGPP. Predictions of these adjusted 2 models are presented in “Fig. 8”. APE of adjusted 2 type 1 model ranges between 0,00 and 0,33, so that MAP of this model is found as 0,33. MAPE of this model is calculated as 0,14 (see ESM). APE of adjusted 2 interval type 2 model ranges between 0,00 and 0,32, so that MAP of this model is found as 0,32. MAPE of this model is calculated as 0,13 (see ESM and “Fig. 9”).

Adjusted model approach 3: Maximum value amongst values of first step of adjusted model approach 1 procedure is found in this approach. Core type 1 and interval type 2 model predictions are adjusted by summation of this value. New models based on this procedure is called EA3T1MFISGGPP & EA3IT2MFISGGPP. Predictions of these adjusted 3 models are presented in “Fig. 8”. APE of adjusted 3 type 1 model ranges between 0,00 and 0,84, so that MAP of this model is found as 0,84. MAPE of this model is calculated as 0,41 (see ESM). APE of adjusted 3 interval type 2 model ranges between 0,00 and 0,83, so that MAP of this model is found as 0,83. MAPE of this model is calculated as 0,41 (see ESM and “Fig. 9”).

Adjusted model approach 4: First, ratio values between actual values and predicted values are calculated in this approach. Second, arithmetic average of these values is calculated in this data series. Core type 1 and interval type 2 model predictions are adjusted by multiplication of this value. New models based on this procedure is called EA4T1MFISGGPP & EA4IT2MFISGGPP. Predictions of these adjusted 4 models are presented in “Fig. 8”. APE of adjusted 4 type 1 model ranges between 0,00 and 0,15, so that MAP of this model is found as 0,15. MAPE of this model is calculated as 0,04 (see ESM). APE of adjusted 4 interval type 2 model ranges between 0,00 and 0,15, so that MAP of this model is found as 0,15. MAPE of this model is calculated as 0,01 (see ESM and “Fig. 9”).

Adjusted model approach 5: Minimum value amongst values of first step of adjusted model approach 4 procedure is found in this approach. Core type 1 and interval type 2 model predictions are adjusted by multiplication of this value. New models based on this procedure are called EA5T1MFISGGPP & EA5IT2MFISGGPP. Predictions of these adjusted 5 models are presented in “Fig. 8”. APE of adjusted 5 type 1 model ranges between 0,00 and 0,20, so that MAP of this model is found as 0,20. MAPE of this model is calculated as 0,06 (see ESM). APE of adjusted 5 interval type 2 model ranges between 0,00 and 0,23, so that MAP of this model is found as 0,23. MAPE of this model is calculated as 0,09 (see ESM and “Fig. 9”).

Adjusted model approach 6: Maximum value amongst values of first step of adjusted model approach 4 procedure is found in this approach. Core type 1 and interval type 2 model predictions are adjusted by multiplication of this value. New models based on this procedure are called EA6T1MFISGGPP & EA6IT2MFISGGPP. Predictions of these adjusted 6 models are presented in “Fig. 8”. APE of adjusted 6 type 1 model ranges between 0,00 and 0,25, so that MAP of this model is found as 0,25. MAPE of this model is calculated as 0,18 (see ESM). APE of adjusted 6 interval type 2 model ranges between 0,00 and 0,31, so that MAP of this model is found as 0,31. MAPE of this model is calculated as 0,18 (see ESM and “Fig. 9”).

Adjusted model approach 7: Most repeated or observed or frequent value (mode) amongst values of first step of adjusted model approach 4 procedure is found in this approach (mode of a data series). Core type 1 and interval type 2 model predictions are adjusted by multiplication of this value. New models based on this procedure are called EA7T1MFISGGPP & EA7IT2MFISGGPP. Predictions of these adjusted 7 models are presented in “Fig. 8”. APE of adjusted 7 type 1 model ranges between 0,00 and 0,20, so that MAP of this model is found as 0,20. MAPE of this model is calculated as 0,06 (see ESM). APE of adjusted 7 interval type 2 model ranges between 0,00 and 0,18, so that MAP of this model is found as 0,18. MAPE of this model is calculated as 0,04 (see ESM and "Fig. 9").

Adjusted model approach 8: Mid value (median) amongst values of first step of adjusted model approach 4 procedure is found in this approach (median of a data series). Core type 1 and interval type 2 model predictions are adjusted by multiplication of this value. New models based on this procedure are called EA8T1MFISGGPP & EA8IT2MFISGGPP. Predictions of these adjusted 8 models are presented in "Fig. 8". APE of the adjusted 8 type 1 model ranges between 0,00 and 0,17, so that MAP of this model is found as 0,17. MAPE of this model is calculated as 0,04 (see ESM). APE of adjusted 8 interval type 2 model ranges between 0,00 and 0,17, so that MAP of this model is found as 0,17. MAPE of this model is calculated as 0,04 (see ESM and "Fig. 9").

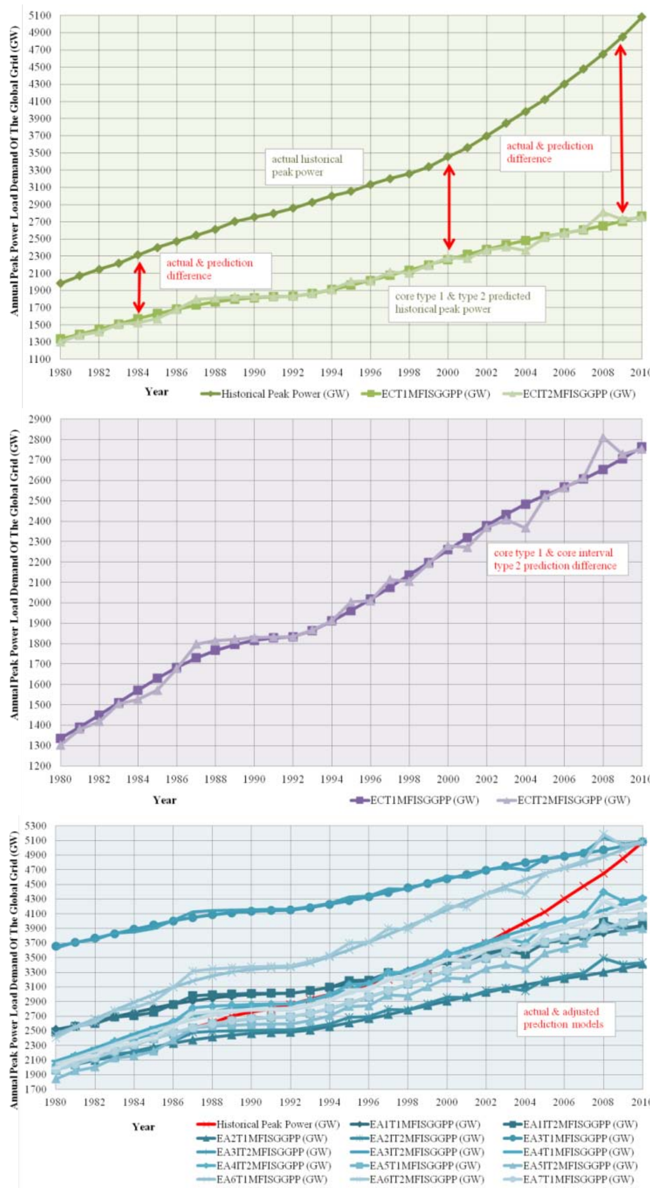


Figure 8: Historical annual peak power load demand of the Global Grid & predictions on historical data by experimental core type 1 and interval type 2 Mamdani FIS based Global Grid peak power load forecasting models (top), predictions on historical data by experimental core type 1 and interval type 2 Mamdani FIS based Global Grid peak power load forecasting models (middle), historical actual annual peak power load demand of the Global Grid & all adjusted models (bottom), visualization generated by the scatter with straight lines chart of the Microsoft Office Excel 2007 (http://www.microsoft.com)

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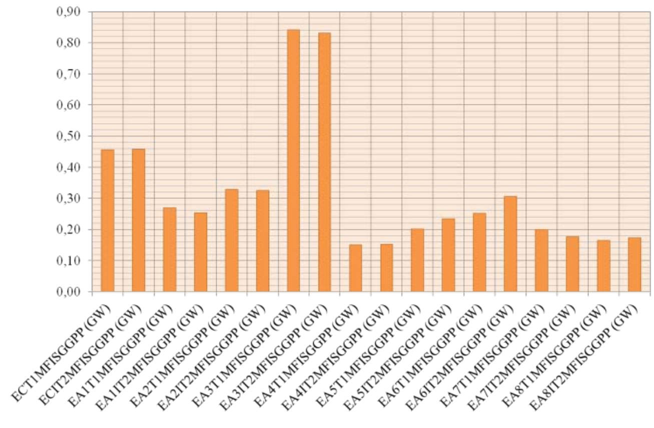
Prediction performance assessment shows that best fit model for annual peak power load demand projection of the Global Grid is the fourth adjusted models (ratio based adjustment) (EA4T1MFISGGPP & EA4IT2MFIS-GGPP) with their 0,15 MAP and 0,04 MAPE performance values.



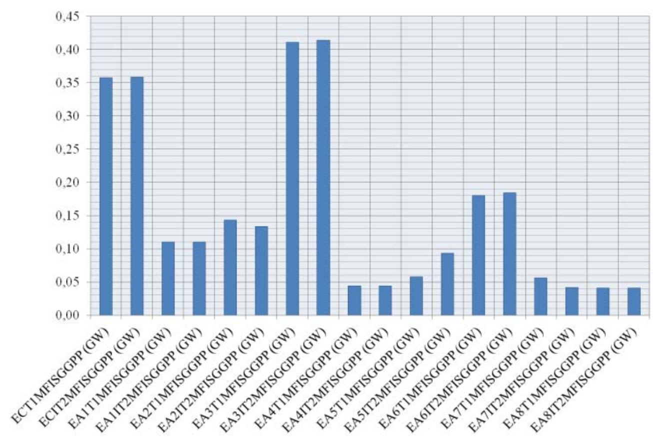


Figure 7: Core and adjusted models MAP (top) & MAPE (bottom), visualization generated by the 2-D clustered column chart of the Microsoft Office Excel 2007

This comparison study proves that core type 1 and interval type 2 Mamdani FIS models have to be improved for getting better predictions. However, long term forecasts (100 years) can be calculated with all of these models by their current capabilities. It is recommended that predictions should be made with core and best performed adjusted models.

IV. Conclusions and Future Work

This research paper defines an important real world problem and its research study. Afterwards, the first comparable experimental FIS models (type 1 and interval type 2) are constructed by JuzzyOnline V2.0. Prediction performances of these experimental core models are presented and compared with each other. Two mostly used prediction performances (maximum absolute percentage error: MAP, mean absolute percentage error: MAPE) are preferred for comparison purposes. Historical annual peak power load demand of the Global Grid (GW) data, predicted/forecasted historical annual peak power load demand of the Global Grid (GW) values, and absolute percentage errors (APE) are clearly given for future research studies and other researchers. Core models are improved by help of some very simple and primitive mathematical approaches. Some of these adjusted models perform well. Author plans to continue working in this research topic. All possible variables will be investigated and all data for these variables will be found and analyzed in few years. All Mamdani FIS rules will be studied and found in near future. All membership functions will be defined and investigated during this period. All verbal definitions will be studied and defined by a worldwide research study. An automatic data gathering and predicting tool (acronym: G2P3S: global grid peak power prediction systems) will be designed and developed under a Global Grid Prediction Systems (G2PSs) (see [59]). G2P3S will not work only one model, but it is aimed to be working on several models at the same time. For instance, core type 1 and type 2 models and adjusted models are all used and presented concurrently on it.

This proposed tool will be presented on annual basis to the world on a website.

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References Références Referencias

1. U.S. Department Of Energy, The Department of Energy's Office of Electricity Delivery and Energy Reliability: SmartGrid.gov, https://www.smartgrid.gov/ (accessed in 18/10/2015)
2. European Technology Platform: European technology platform for the electricity networks of the future: Smart Grids European Technology Platform, http://www.smartgrids.eu/ (accessed in 18/10/2015)
3. Global Energy Network Institute (GENI): Linking Renewable Energy Resources Around the World, http://www.geni.org/index.html (accessed in 18/10/2015)
4. The National Institute of Standards and Technology (NIST): Smart Grid, http://www.nist.gov/smartgrid/ (accessed in 18/10/2015)
5. Chatzivasileiadis, S., Ernst, D., Andersson, G.: The Global Grid press 2013, https://orbi.ulg.ac.be/bitstream/2268/144423/3/GlobalGrid_pres_2013.pdf (accessed in 18/10/2015)
6. Tripathi, P.R.: E-mail correspondence of Burak Omer Saracoglu and Prabhat Ranjan Tripathi on 18/10/2015
7. Maqsood, M., Nasir, M.N.: Wireless electricity (Power) transmission using solar based power satellite technology. 6th Vacuum and Surface Sciences Conference of Asia and Australia (VASSCAA-6), In Journal of Physics: Conference Series, Vol. 439, No. 1, p. 012046), doi:10.1088/1742-6596/439/1/012046, IOP Publishing. (2013)
8. Sharma, S.: Advanced Trends in Wireless Electricity Transmission using Semiconductor Devices. International Journal of Scientific & Engineering Research, Vol. 4, No: 12, pp.188–194. (2013)
9. Kumar, P., Pant, P., Dimri, U.: Wireless Electricity Transmission Fuel for Future Devel-opment. International Journal of Science and Research, Vol. 3, No: 12, pp.1991–1994. (2014)
10. National Aeronautics and Space Administration (NASA): Global Climate Change Vital Signs of the Planet http://climate.nasa.gov/ (accessed in 18/10/2015)
11. National Aeronautics and Space Administration (NASA): Global Ice Viewer http://climate.nasa.gov/interactives/global-ice-viewer/#/1/4 (accessed in 18/10/2015)
12. Makridakis, S., Wheelwright, S.: Integrating forecasting and planning. Long Range Plan-ning, Vol:6, No:3, pp.53–63. (1973)
13. Das, J.K.: Statistics for Business Decisions, Academic Publishers, Bhawani Dutta Lane, Kolkata. (2012)
14. Jain, C.L., Malehorn, J. eds.: Practical guide to business forecasting. Institute of Business Forec. (2005)
15. Soliman, S.A., Al-Kandari, A.M.: Electrical load forecasting: modeling and model con-struction. Elsevier. (2010)
16. Chaturvedi, D.K.: Soft computing: techniques and its applications in electrical engineer-ing. Vol. 103. Springer. (2008)
17. ACM Digital Library, http://dl.acm.org/
18. Google Scholar, http://scholar.google.com.tr/
19. Springer, http://www.springer.com/gp/
20. ASCE Online Research Library, http://ascelibrary.org/
21. American Society of Mechanical Engineers, http://asmedigitalcollection.asme.org/
22. Cambridge Journals Online, http://journals.cambridge.org
23. Directory of Open Access Journals, http://doaj.org
24. Emerald Insight, http://www.emeraldinsight.com/
25. Hindawi Publishing Corporation, http://www.hindawi.com/
26. Inderscience Publishers, http://www.inderscience.com/
27. Journal of Industrial Engineering and Management, http://www.jiem.org/index.php/jiem
28. Science Direct, http://www.sciencedirect.com
29. Taylor & Francis Online/Journals, http://www.tandfonline.com/
30. Wiley-Blackwell/Wiley Online Library, http://online library. wiley.com/
31. World Scientific Publishing, http://www.world scientific.com/
32. Sachdeva, S., Singh, M., Singh, U.P., Arora, A.S.: Efficient Load Forecasting Optimized by Fuzzy Programming and OFDM Transmission. Advances in Fuzzy Systems, Vol:2011, Article ID 326763, doi:10.1155/2011/326763 (2011)
33. Aggarwal, S.K., Kumar, M., Saini, L.M., Kumar, A.: Short-Term Load Forecasting in Deregulated Electricity Markets using Fuzzy Approach. Journal of Engineering and Technology, Vol:1, No:1, pp.24–30. (2015)
34. Moreno-Chaparro, C., Salcedo-Lagos, J., Rivas, E. yOrjuela Canon, A.: A method for the monthly electricity demand forecasting in Colombia based on wavelet analysis and a nonlinear autoregressive model. Ingeniería, Vol.16, No.2, pp.94–106. (2011)

35. Arfoa, A.A.: Long-Term Load Forecasting of Southern Governorates of Jordan Distribution Electric System. Energy and Power Engineering, Vol.7, 242–253. (2015)
36. Al-zahra, K.A., Moosa, K., Jasim, B.H.: A comparative Study of Forecasting the Electrical Demand in Basra city using Box-Jenkins and Modern Intelligent Techniques. Iraq Journal Electrical and Electronic Engineering, Vol.11, No.1, pp.97–110. (2015)
37. Demir, A.: Elaboration of Electricity Energy for Production-Consumption Relation of Northern-Iraq for the Future Expectations. International Journal of Academic Research in Economics and Management Sciences, Vol.3, No:5, pp.101–106. (2014)
38. Hong, W.C.: Electric load forecasting by support vector model. Applied Mathematical Modelling, Vol.33, No:5, pp.2444–2454. (2009)
39. Kumar, S., Narula, P., Ahmed, T., Knowledge extraction from numerical data for the Mamdani type fuzzy systems: a BBO approach. In: Innovative Practices in Management and Information Technology for Excellence, Jagadhri, India. (2010). (http://embeddedlab.csuohio.edu/BBO/BBO_Papers/Knowledge%20Extraction.pdf)
40. Noor, N.M.M., Retnowardhani, A.: An Integrated Framework Of Decision Support System In Crime Prevention, In: DSS 2.0 – Supporting Decision Making with New Technologies, 17th conference for IFIP WG8.3 DSS, 2-5 June 2014, Paris, France (2014). (http://dss20conference.files.wordpress.com /2014/05/noor.pdf)
41. Keshwani, D.R., Jones, D.D., Meyer, G.E., Brand, R.M.: Rule-based Mamdani-type fuzzy modeling of skin permeability, Biological Systems Engineering: Papers and Publications. Paper 80. (2008). http://digitalcommons.unl.edu/biosysengfacpub/80
42. Cordón, O.: A historical review of evolutionary learning methods for Mamdani-type fuzzy rule-based systems: Designing interpretable genetic fuzzy systems. International Journal of Approximate Reasoning, Vol.52, pp. 894–913 (2011).
43. Garg, S., Sharma, B.R., Cohen, K., Kumar, M.: A Fuzzy Logic Based Image Processing Method for Automated Fire and Smoke Detection, In: 51st AIAA (American Institute of Aeronautics and Astronautics) Aerospace Sciences Meeting including the New Horizons Forum and Aerospace Exposition, 07-10 January 2013, Grapevine (Dallas/FL Worth Region), Texas, (2013) http://arc.aiaa.org/doi/pdf/10.2514/6.2013-879
44. Zadeh, L.A.: Fuzzy sets. Information and Control, 8, 338–353 (1965)
45. Mamdani, E.H.: Application of fuzzy algorithms for control of simple dynamic plant. Proceedings of the Institution of Electrical Engineers, 121, 12, 1585–1588 (1974)
46. Zadeh, L.A.: The Concept of a Linguistic Variable and its Application to Approximate Reasoning-I. Information Sciences, 8, 3, 199–249 (1975)
47. Jin, Y.: Advanced Fuzzy Systems Design and Applications. Studies In Fuzziness And Soft Computing, Physica-Verlag Heidelberg New York (2003)
48. Mendel, J.M.: Type-2 Fuzzy Sets and Systems: An Overview. IEEE Computational Intelligence Magazine, 2, 1, 20–29 (2007)
49. Gera, Z., Dombi, J.: Type-2 implications on non-interactive fuzzy truth values. Fuzzy Sets and Systems, 159, 3014–3032 (2008)
50. Cordon, O.: A historical review of evolutionary learning methods for Mamdani-type fuzzy rule-based systems: Designing interpretable genetic fuzzy systems. International Journal of Approximate Reasoning, 52, 894–913 (2011)
51. Alcala, R., Casillas, J., Cordon, O., Herrera, F., Zwir, S.J.I.: Techniques for Learning and Tuning Fuzzy Rule-Based Systems for Linguistic Modeling and their Application. Knowledge Engineering Systems, Techniques and Applications, 3, 889–941 (1999)
52. Wagner, C.: Juzzy - A Java based toolkit for Type-2 Fuzzy Logic. In: Advances in Type-2 Fuzzy Logic Systems (T2FUZZ) 2013 IEEE Symposium, pp.45–52. IEEE Press (2013)
53. Wagner, C.: JuzzyOnline: An Online Toolkit for the Design, Implementation, Execution and Sharing of Type-1 and Type-2 Fuzzy Logic Systems, 2014 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), pp.2321–2328. IEEE Press (2014)
54. Wagner, C., Pierfitt, M., McCulloch, J.: Juzzy online: An online toolkit for the design, implementation, execution and sharing of Type-1 and Type-2 fuzzy logic systems. In 2014 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), pp. 2321-2328. IEEE Press. (2014)
55. United Nations, Department of Economic and Social Affairs, Population Division, Population Estimates and Projections Section, World Population Prospects: The 2012 Revision, Excel Tables - Population Data, http://esa.un.org/unpd/wpp/Excel-Data/population.htm
56. NASA Goddard Institute for Space Studies (GISS) Laboratory, Earth Sciences Division (ESD), National Aeronautics and Space Administration (NASA), Goddard Space Flight Center (GSFC) http://www.giss.nasa.gov/
57. IPCC, 2013: Annex II: Climate System Scenario Tables [Prather, M., G. Flato, P. Friedlingstein, C. Jones, J.-F. Lamarque, H. Liao and P. Rasch (eds.)]. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the

Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. (2013)
58. The U.S. Energy Information Administration, International Energy Statistics, Total Elec-tricity Installed Capacity (Million Kilowatts), http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=2&pid=2&aid=7 (accessed in 20/08/2015)
59. Saracoglu, B.O.: Global Grid Electricity Demand Prediction System (G2EDPS), Global Grid Prediction Systems (G2PSs). https://www.researchgate.net/publication/289813050_Global_Grid_Prediction_Systems (2015)

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Effect of Signal to Noise Ratio on Adaptive Beamforming Techniques

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Abstract- The capability of adaptive antenna array lies in forming higher gain in the user directions and lower gain in the interferer directions. The technique used to produce such radiation pattern by calculating the excitation weights are called the adaptive beamforming techniques. It tries to minimize the error between the desired and actual signal and maximize the signal to noise ratio (SNR). But in severe interference environment when the actual signal is weak, the effect of SNR on the radiation pattern needs to be considered. This paper describes the effect of SNR on different adaptive beamforming techniques such as non- blind Least mean Square (LMS), blind Constant Modulus Algorithm (CMA) and evolutionary Particle Swarm Optimization (PSO). The performance and validation of beamforming algorithms are studied through MATLAB simulation by varying SNR parameter for different desired and interference direction. Different weights are obtained using this beamforming algorithm to optimize the radiation pattern. The parameters for comparison are the main beam and null placement for different angles of user and interferer. The mean SLL and directivity are also studied.

Keywords: adaptive antenna, beamforming, particle swarm optimization, least mean square, constant modulus algorithm, signal to noise ratio.

GJRE-J Classification: FOR Code: 091599

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Smita Banerjee [α] & Ved Vyas Dwivedi [σ]

Abstract- The capability of adaptive antenna array lies in forming higher gain in the user directions and lower gain in the interferer directions. The technique used to produce such radiation pattern by calculating the excitation weights are called the adaptive beamforming techniques. It tries to minimize the error between the desired and actual signal and maximize the signal to noise ratio (SNR). But in severe interference environment when the actual signal is weak, the effect of SNR on the radiation pattern needs to be considered. This paper describes the effect of SNR on different adaptive beamforming techniques such as non- blind Least mean Square (LMS), blind Constant Modulus Algorithm (CMA) and evolutionary Particle Swarm Optimization (PSO). The performance and validation of beamforming algorithms are studied through MATLAB simulation by varying SNR parameter for different desired and interference direction. Different weights are obtained using this beamforming algorithm to optimize the radiation pattern. The parameters for comparison are the main beam and null placement for different angles of user and interferer. The mean SLL and directivity are also studied.

Keywords: adaptive antenna, beamforming, particle swarm optimization, least mean square, constant modulus algorithm, signal to noise ratio.

I. Introduction

In satellite communication systems, the receiver receives extremely weak signals from the satellite. To enhance reception and radiation patterns dynamically in response to the signal environment, such technologies depend on adaptive array signal processing. An adaptive antenna is an array of antenna elements followed by a sophisticated signal processor that can adjust or adapt its own radiation pattern in order to focus the reception of the antenna array in a certain direction and rejects the signal from other direction. The necessity to remove the effect of the undesired signal to the desired one motivates advances in communication receiver antenna and hence synthesizing methods [1-4].

An adaptive antenna array combines the outputs of antenna elements. The directional gain of the antenna is controlled by adjusting phase or amplitude or both at each individual element. The weighted signals are summed and the output is fed to a controller. These weights are computed adaptively to adapt to the changes in the signal environment. Different adaptive beamforming algorithms are employed to minimize the error between the desired signal and the array output that adjusts the weights to satisfy an optimization criterion [5-11].

The capability of adaptive antenna array lies in forming higher gain in the user directions and lower gain in the interferer directions. There are different adaptive beamforming algorithms studied in literature which are used in the adaptive antenna array [12-24]. Beamformers based upon statistically optimum blind and non-blind adaptive beamforming are analyzed and compared on the basis of beamforming capability and rate of convergence. It is observed that the convergence rate of Least Mean Square (LMS) is slowest where as Constant CGM is the fastest among all. SMI is found to have more computational complexity. Recursive Least Square (RLS) is found to have higher side lobe level (SLL) and null depths as compared to CGM [16]. It was observed that the conventional Adaptive Beamforming (ABF) technique like Minimum Variance Distortionless Response (MVDR) improves the signal-to-interference-plus-noise ratio (SINR) but unable to reduce the SLL [17]. Hence to improve the SINR with reduced SLL, many optimization techniques have been used in ABF application. Adaptive Mutated Boolean Particle Swarm Optimization (AMBPSO) technique takes the uncorrelated desired and interferer signal directions and succeed in providing good SINR value with lower SLL as compared to conventional MVDR [18]. Adaptive Dispersion Invasive Weed Optimization (ADIWO) shows improvement in steering ability regarding the main lobe and the nulls, faster as compared to PSO and achieves better SLL than the PSO and MVDR [19]. Hybrid Particle Swarm Optimization with Gravitational Search Algorithm (Hybrid PSOGSA) shows its ability for optimization in beam-forming for a larger number of user signals and speedy computation using parallel GSA as compared to sequential stand alone algorithms but cannot maximise the gain along the user direction [20-21]. Mementic algorithm shows optimal radiation pattern design to maximise the signal to interference ratio (SIR) by perturbing the phase-position [22]. But, for the case of adaptive antennas, the position of the antenna elements cannot be changed so it should be kept fixed. As the required phase controls are available at no extra cost. Hence only phase weights are considered for optimal

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radiation pattern which shows good null depth along the undesired direction but the array factor (AF) gain along the main lobe is not satisfactory [23-24] .

In all of the above adaptive beamforming techniques proposed so far try to minimize the error between the desired and actual signal and maximize the signal to interference ratio (SIR). But in severe interference environment when the actual signal is weak, the effect of SNR on the radiation pattern needs to be considered.

The present study analyses different adaptive techniques such as non- blind LMS, blind CMA and evolutionary PSO. The performance of beamforming algorithms are studied through MATLAB simulation by varying SNR parameter for different desired and interference direction. Different weights are obtained using this beamforming algorithm to optimize the radiation pattern. The parameters for comparison are the main beam and null placement for different angles of user and interferer. The mean SLL and directivity are also studied.

The rest of the paper is arranged as follows: Section II describes the mathematical model of signal, Section III formulates the adaptive beamforming problem, Section IV, V and VI describes adaptive beamforming using PSO, LMS and CMA, Section VII compares the results and Section V concludes the whole study.

II. Signal Model

Consider a Uniform Linear Array (ULA) with N elements as shown in Figure 1.

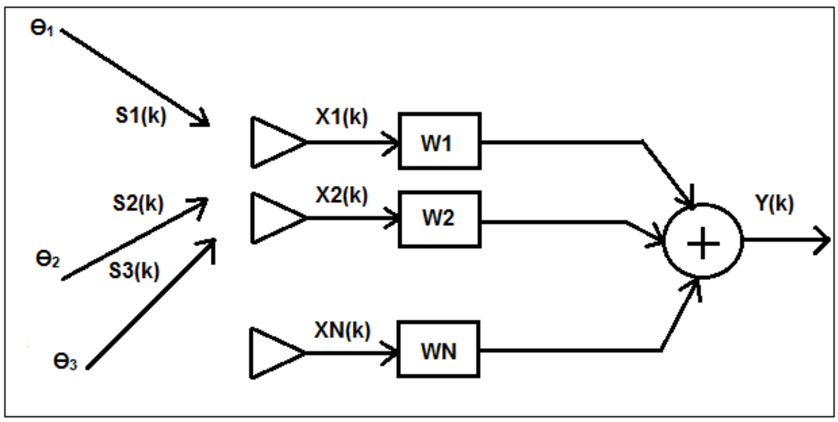

Figure 1: Uniform Linear Array

Let S narrowband signals are received at ULA with different direction of arrivals (DOAs) Θ_1, Θ_2,…..,Θ_S.

Let S(k) is the S X1 signal vector from the S[th] source with DOA equal to Θ_S.

$$S(k) = [S_1(k) \quad S_2(k) \quad \ldots \quad \ldots \quad S_S(k)] \qquad (1)$$

We define the input signals as X_1 (k), X_2(k),.........X_N(k). As they reach the antenna elements, the N X 1 signal vector X(k) can be written as

$$X(k) = \sum_{s=1}^{S} S_s(k) * SV(\theta_s) \qquad (2)$$

Where SV (θ) is the steering vector or array response vector of N X 1 which controls the direction of antenna beam.

$$SV(\theta) = [1 \quad \exp(-j\pi\sin(\theta)) \quad \exp(-2j\pi\sin(\theta)) \quad .... \quad .... \quad \exp(-j(N-1)\sin(\theta))]^T \qquad (3)$$

Now if the signal 1,2……S consist of U number of desired user arriving from Θ_1,Θ_2,Θ_3,……Θ_U , I number of interferences arriving from Θ_1,Θ_2,Θ_3,……Θ_I with variance σ_i^2 and noise with variance σ_n^2, then the input signal consist of user signal S_u, interferer signal S_i and noise N. The received signal can be written as

$$X(k) = \sum_{s=1}^{U} S_u(k) * SV(\theta_u) + \sum_{i=1}^{I} S_i(k) * SV(\theta_i) + N(k) \qquad (4)$$

Where $SV(\theta_u) = [1 \quad \exp(-j\pi\sin(\theta_u)) \quad ..... \quad \exp(-j\pi(N-1)\sin(\theta_u))]$ is the steering vector of the desired signal along the user and $SV(\theta_i) = [1 \quad \exp(-j\pi\sin(\theta_i)) \quad ..... \quad \exp(-j\pi(N-1)\sin(\theta_i))]$ is the steering vector along the interferer direction.

III. Adaptive Beamforming Problem Formulations

An ULA will receive the incoming signals which will be multiplied by the weights of antenna elements which are then summed to get the output in the form of received signal. The received signal will be graphical represented in the form of the radiation properties as a function of space coordinates known as radiation pattern. The radiation pattern of the linear array for far field is represented in terms of array factor (AF) by [15],

$$AF = \sum_{n=1}^{N} X(k) * w_n \qquad (5)$$

where N= number of elements, $w_n = a_n * \exp(jb_n)$ = complex array weights at element n, a_n = amplitude weight at element n, b_n =phase shift weight at element n.

In adaptive antenna beamforming, the radiation pattern of ULA is controlled through various adaptive algorithms. Adaptive algorithm dynamically optimizes the radiation pattern according to the changing electromagnetic environment. The output or received signal is given to the adaptive algorithm where it checks the output radiation pattern with the desired radiation pattern. If the received actual radiation pattern does not meet the user demands, then adaptive algorithm will try to adjust the weights of the antenna array such that the actual and desired radiation pattern remains same. The antenna array pattern is optimized to have maximum possible gain in the direction of the desired signal and nulls in the direction of the interferers.

Figure 2 shows the block diagram of an adaptive antenna array.

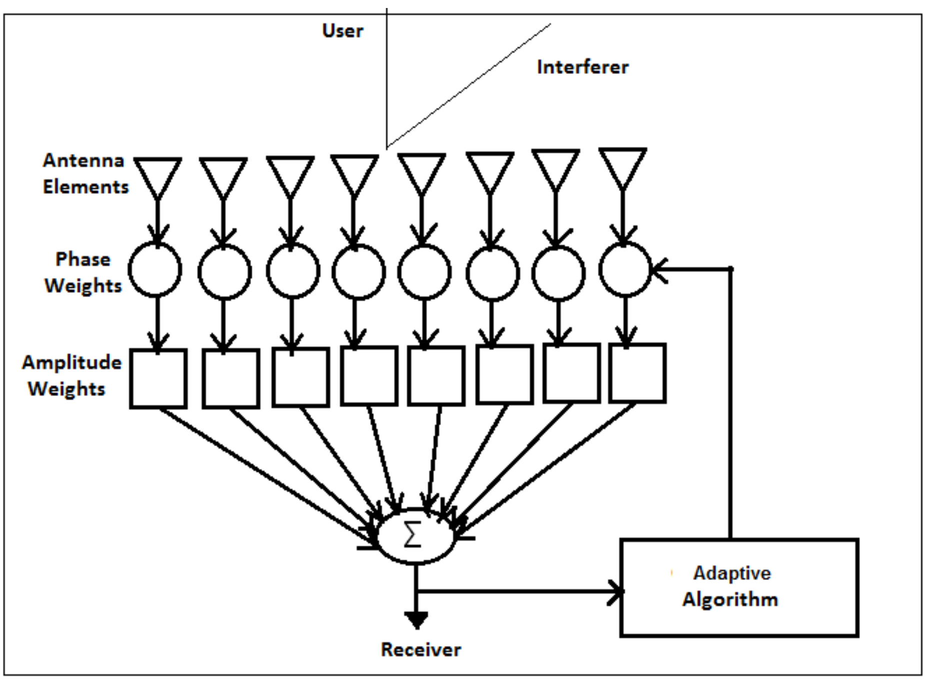

Figure 2: Block Diagram of Adaptive Antenna Array

IV. Adaptive Beamforming Using Particle Swarm Optimization

Particle Swarm Optimization (PSO) was developed by Eberhart and Shi [25]. It is used as adaptive algorithm to search the optimized adaptive antenna radiation pattern. This is done using the algorithm summarized in the Table 1 [26]. In every iteration, PSO algorithm will try to increase the AF gain of the desired user and decrease the AF gain of the interfering user as compared of the previous iteration. The converged value of weights produces an optimized adaptive antenna radiation pattern.

The amplitudes excitations are kept constant whereas the phase excitations are selected as the optimization parameters. Hence the AF can be written as

$$AF = \sum_{n=1}^{N} X(k) * \exp^{jb_n} \qquad (6)$$

The objective function is formulated to find the values of phase of the element of antenna array in order to focus the main lobe towards desired user while low gain towards interfering user. It is formulated using the AF equation for $\beta = 0$. For 1 user and 2 interferer, there are three cost functions: $AF(\theta_{s1})$: the first cost function is the magnitude of the radiation pattern in the user direction θ_{s1} and $AF(\theta_{i1})$, $AF(\theta_{i2})$: the other two cost function are the magnitude of the radiation pattern in the interferer directions θ_{i1} and θ_{i2}. The aims are to maximize the AF gain of the desired user and minimize the AF gain of the interfering user. This is multi-objective optimization.

$$\text{Fitness function for Beamforming} = \mathrm{AF}(\theta_{s1}) - [AF(\theta_{i1}) + AF(\theta_{i2})] \tag{7}$$

where

$$AF(\theta_{s1}) = \sum_{n=1}^{N} \exp^{-j\pi(n-1)(\sin\theta_{s1})} * \exp^{jb_n} \tag{8}$$

and

$$AF(\theta_{i1}) = \sum_{n=1}^{N} \exp^{-j\pi(n-1)(\sin\theta_{i1})} * \exp^{jb_n} \tag{9}$$

$$AF(\theta_{i2}) = \sum_{n=1}^{N} \exp^{-j\pi(n-1)(\sin\theta_{i2})} * \exp^{jb_n} \tag{10}$$

Table 1: Algorithm for Adaptive Beamforming using PSO

Step-1: *Initialize population, number of iterations, tuning parameters* $(\phi_1 and \phi_2)$ *and weights (w). The particle corresponds to phase* b_n *in the interval [-2π, 2π].*
Step-2: *Initialize starting position for the* k^{th} *variable in the population by* $b_n(i,k) = b_n(i,\min) + (b_n(i,\max) - b_n(i,\min))u(i)$ *where* $k = 1,2,---npop$ *and* $u(i)$ *is the random number generated between 0 and 1. Initialize the velocities of the* k^{th} *variable as* $v(i,k) = 0.$
Step-3: *Evaluate the fitness function for each particle* $b_n(i)$*. Compute FF (i, k) as per the equation (7).*
Step-4: *Compute pbest(i, k) = FF(i, k) and gbest(i) = max (pbest (i, k)) with its location pbest (k) and gbest.*
Step-5: *Update velocity v (i+1, k) and position* b_n *(i+1, k) using* $v(i+1,k) = w * v(i,k) + \phi 1(p(b_n ik) - b_n(i,k))u(i) + \phi 2(g(ib_n) - b_n(i,k))u(i)$ $b_n(i+1,k) = b_n(i,k) + v(i+1,k)$
Step-6: *Update fitness function FF(i+1, k).*
Step-7: *If FF(i+1, k) > FF(i, k), then pbest(i+1, k)=FF(i+1, k).*
Step-8: *Update gbest (i+1, k) = max (pbest(i+1,k)).*
Step-9: *If i<*i_{max} *then increment i and go to step-5, else stop.*

V. Adaptive Beamforming Using Least Mean Square Algorithm

Least Mean Square (LMS) algorithm was first developed by Widrow and Hoff in 1960. The optimum weights can be estimated with LMS algorithm. The algorithm recursively computes and updates the weight vector. Successive corrections to the weight vector in the direction of the negative of the gradient vector eventually lead to the MMSE between the beamformer output and the reference signal. At this point the weight vector assumes to be its optimum value. The algorithm contains three steps in each recursion: the computation of the processed signal with the current set of weights, the generation of the error between the processed signal and the desired signal, and the adjustment of the weights with the new error information. The following Table 2 summarize the above three steps [13].

Table 2: Algorithm for Adaptive Beamforming using LMS

Step-(1): *Initialize number of iteration i_{max} and the value of μ.*
Step-(2): *Initialize weight W_{LMS}, error E_{LMS} and output y_{LMS} as 0.*
Step-(3): *Compute Output, $y_{LMS}(i, k) = W_{LMS}(i, k)^H x(k)$*
Step-(4): *Compute Error, $E_{LMS}(i, k) = S_u(k) - y_{LMS}(i, k)$*
Step-(5): *Compute Weight, $W_{LMS}(i+1, k) = W_{LMS}(i, k) + \mu x(k) E_{LMS}^*(i, k)$*
Step-(6): *If $i > i_{max}$, then stop, otherwise go to step (3) to update output, error and weight.*

VI. Adaptive Beamforming Using Constant Modulus Algorithm

The constant modulus algorithm (CMA) was first proposed by Godward. It is used for blind equalization of signals that have a constant modulus where reference signals are not available. The algorithm contains three major steps in each recursion: the computation of the output signal with the current set of weights, the generation of the error, and the adjustment of the weights with the new error information. The following Table 3 summarize the above three steps [16].

Table 3: Algorithm for Adaptive Beamforming using CMA

Step-(1): *Initialize number of iteration i_{max} and the value of μ.*
Step-(2): *Initialize weight W_{CMA}, error E_{CMA} and output y_{CMA} as 0.*
Step-(3): *Compute Output, $y_{CMA}(i, k) = W_{CMA}(i, k)^H x(k)$.*
Step-(4): *Compute Error, $E_{CMA}(i, k) = y_{CMA}(i, k) / \lvert y_{CMA}(i, k) \rvert - y_{CMA}(i, k)$.*
Step-(5): *Compute Weight, $W_{CMA}(i+1, k) = W_{CMA}(i, k) + \mu x(k) E_{CMA}^*(i, k)$*
Step-(6): *If $i > i_{max}$, then stop, otherwise go to step (3) to update output, error and weight.*

VII. Numerical Simulation Results

A 16 element ULA with $\lambda/2$ interelement spacing is taken. PSO, LMS and CMA were applied on a 16-element ULA. Three algorithms were compared on the basis of the SNR. In order to compare the performance, the simulations are done using MATLAB. All the algorithms were executed for 200 iterations and the termination criterion is set for the number of iterations. For PSO, the population size is assumed as 100 and tuning parameter ϕ_1 and ϕ_2 are set to 2.0. Phase excitation b_n is chosen as the design variable in the PSO with lower and upper limit taken in the range of $[-2\pi, 2\pi]$ with initial values of position and velocities are taken as random. For LMS and CMA, μ is taken as 0.001 and the initial weight and error are set to 0.

Based upon the aims to maximize the AF gain of the desired user and minimize the AF gain of the interfering user. PSO will try to maximize the value of the AF gain along User1 while minimize the AF gain along interferer1 and interferer2. LMS will recursively computes and updates the weight vector between the output signal and the desired signal. CMA will update the information based upon the new error information.

To validate the study, two different scenarios are studied with different position of interferer. In scenario#1, the ULA receives a desired signal arriving from angle θ_{s1} = 0 and 2 interference signals arriving from angles θ_{i1} = -15 and θ_{i2} = 30. In scenario#2, the ULA receives a desired signal in the same direction with 2 interference signals arriving from angles θ_{i1} = -40 and θ_{i2} = 20. Seven cases are studied for each scenario for different SNR values.

For each case, it was observed that PSO algorithm produce main lobe along θ_{s1} and nulls towards θ_{i1} and θ_{i2}. The AF gain along the main lobe is 0 dB whereas the AF gain towards the null is -20 dB to -50 dB as shown in Table 4. The maximum SLL is -15dB to -17dB with directivity of 7 dB as shown in Figure 3 and Figure 4.

LMS algorithm also produces main lobe gain of 0 dB along the θ_{s1} direction and null gain of -33 dB to -66dB for SNR=30dB to SNR=-10dB as shown in Table 4. As SNR reduces more than -10 dB, LMS fail to point the main beam and null along the user and the interferer direction in both the scenarios.

CMA algorithm works well for SNR=30 dB to SNR=10dB. As SNR starts deteriorating CMA does not produce main beam along the user and fails to point lower gain along the interferer as shown in Table 4. In both the scenarios, LMS and CMA gives reduced SLL.

The comparative Table 5 for both the scenario shows that PSO is better as compared to LMS and CMA for every value of SNR. LMS and CMA fail to adapt for lower value of SNR. However LMS and CMA shows better SLL as compared to PSO. Table 6 gives the optimized excitation weights for PSO, LMS and CMA for SNR=30dB.

Table 4: AF gain along main lobe and null for PSO, LMS and CMA for different values of SNR for scenario#1and scenario#2 (*MB-Main Beam, * NP-Null Position)

SNR (dB)	Scenario	PSO			LMS			CMA		
		G_S1	G_I1	G_I2	G_S1	G_I1	G_I2	G_S1	G_I1	G_I2
30	#1	0	-30	-23	0	-33	-38	0	-32	-37
	#2	0	-32	-42	0	-48	-40	0	-40	-47
20	#1	0	-25	-53	0	-32	-50	0	-37	-43
	#2	0	-22	-21	0	-43	-36	0	-37	-34
10	#1	0	-34	-45	0	-48	-36	0	-30	-28
	#2	0	-44	-30	0	-35	-36	0	-39	-26
0	#1	0	-32	-37	0	-34	-40	*MB and *NP are not exact		
	#2	0	-38	-45	0	-39	-44	*NP are not exact		
-10	#1	0	-34	-35	0	-37	-39	*MB and *NP are not exact		
	#2	0	-51	-48	0	-66	-38	*MB and *NP are not exact		
-20	#1	0	-41	-42	*MB and *NP are not exact			*MB and *NP are not exact		
	#2	0	-50	-34	*MB and *NP are not exact			*MB and *NP are not exact		
-30	#1	0	-35	-35	*MB and *NP are not exact			*MB and *NP are not exact		
	#2	0	-36	-28	*MB and *NP are not exact			*MB and *NP are not exact		

Table 5: Comparison of PSO, LMS and CMA for different values of SNR for scenario#1 and scenario#2 (*C-Main beam and null are converging at exact position, *NC- Main beam and null are not converging at exact position)

SNR	Scenario#1			Scenario#2		
	PSO	LMS	CMA	PSO	LMS	CMA
30	*C	*C	*C	*C	*C	*C
20	*C	*C	*C	*C	*C	*C
10	*C	*C	*C	*C	*C	*C
0	*C	*C	*NC	*C	*C	*NC
-10	*C	*C	*NC	*C	*C	*NC
-20	*C	NC	*NC	*C	*NC	*NC
-30	*C	NC	*NC	*C	*NC	*NC

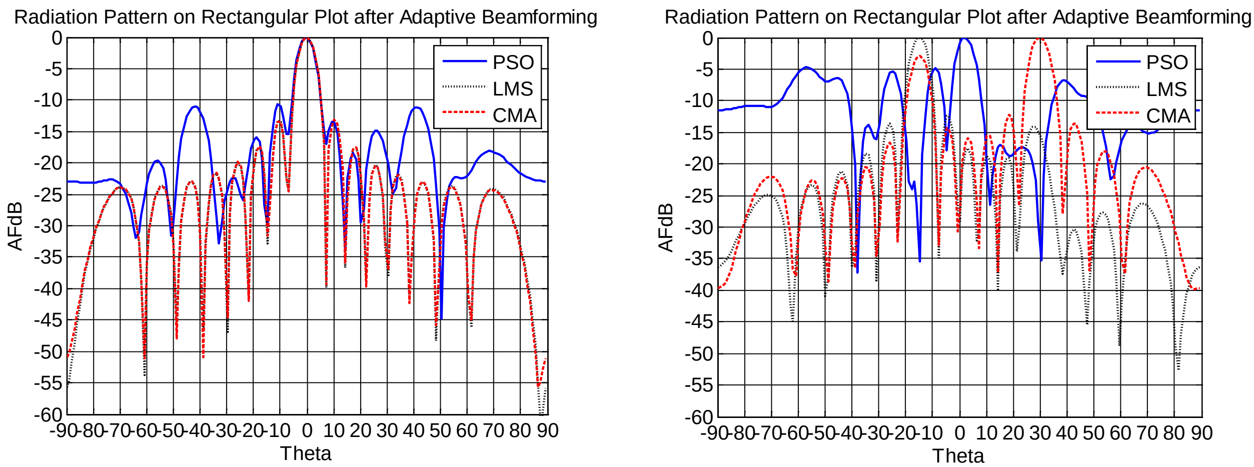

Figure 3: Best radiation pattern found by PSO, LMS and CMA for 16 element antenna array with user at 0^0 and interferers at -15^0 & 30^0 with SNR=30 dB (a) Rectangular Plot for SNR=30dB (SLLPSO=-15.41dB, SLLLMS=-19.12dB, SLLCMA=-19.14dB) (b) Rectangular Plot for SNR=-30dB (SLLPSO=-10.35dB)

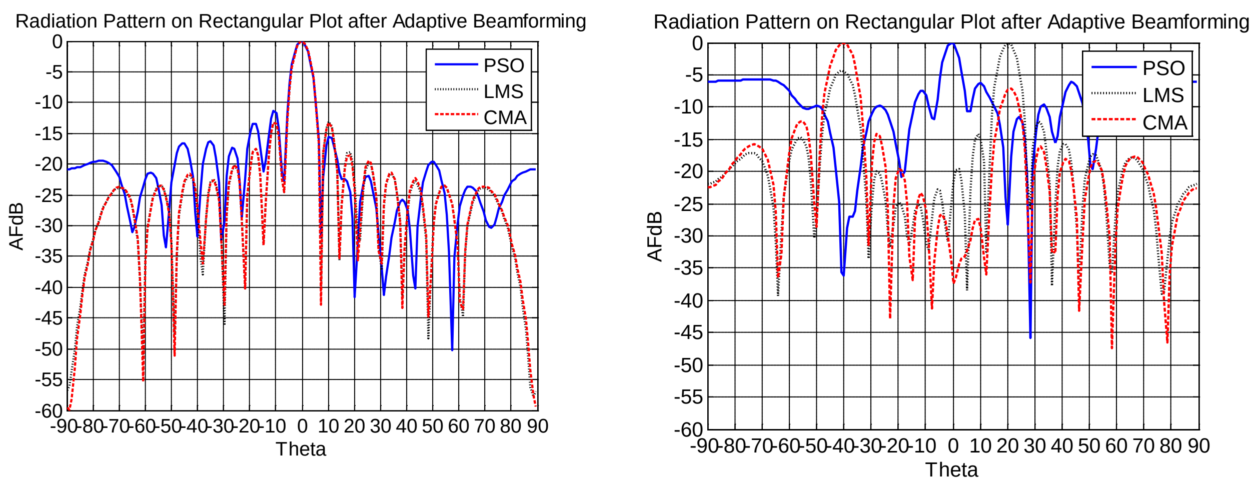

Figure 4: Best radiation pattern found by PSO, LMS and CMA for 16 element antenna array with user at 0^0 and interferers at -40^0 & 20^0 with SNR=30 dB (a) Rectangular Plot for SNR=30dB (SLLPSO=-17.46dB, SLLLMS=-19.15dB, SLLCMA=-19.32dB) (b) Rectangular Plot for SNR=-30dB (SLLPSO=-7.63dB)

Table 6: Optimized excitation weights for SNR=30 dB for scenario #1 and scenario#2

N	(W_{PSO})#1	(W_{PSO})#2	(W_{LMS})#1	(W_{LMS})#2	(W_{CMA})#1	(W_{CMA})#2
1	1.00 + 0.00i	1.00 + 0.00i	1.00 + 0.00i	1.00 + 0.00i	1.00 + 0.00i	1.00 + 0.00i
2	0.84 - 0.54i	-0.28 + 0.95i	0.99 + 0.00i	0.99 + 0.00i	1.00 - 0.02i	0.99 + 0.00i
3	0.59 + 0.80i	0.88 - 0.46i	0.99 + 0.00i	0.98 + 0.00i	0.98 - 0.00i	0.98 + 0.01i
4	0.99 + 0.02i	-0.09 + 0.995i	0.99 + 0.00i	0.99 + 0.00i	0.97 + 0.00i	0.99 + 0.01i
5	0.53 - 0.84	0.66 + 0.750i	0.99 + 0.00i	0.99 + 0.01i	0.99 + 0.02i	0.99 + 0.01i
6	-0.04 - 0.99i	-0.72 + 0.688i	0.99 + 0.00i	0.98 + 0.00i	0.99 - 0.00i	0.99 + 0.01i
7	0.66 - 0.74i	0.63 + 0.770i	1.00 + 0.00i	0.99 + 0.00i	0.97 - 0.00i	0.99 - 0.00i
8	0.54 + 0.83i	-0.99 + 0.032i	1.00 + 0.00i	0.99 + 0.00i	0.98 - 0.00i	0.98 + 0.01i
9	-0.29 - 0.95i	0.29 - 0.954i	0.99 + 0.00i	0.98 + 0.00i	0.98 + 0.00i	0.98 + 0.01i
10	-0.92 - 0.37i	-0.40 + 0.912i	0.99+ 0.00i	0.99 + 0.00i	0.98 - 0.01i	1.00 + 0.00i
11	-0.14 + 0.98i	0.82 - 0.571i	0.99 + 0.00i	0.99 + 0.00i	0.99 - 0.01i	1.00 + 0.00i
12	-0.79 + 0.60i	0.03 - 0.999i	0.99 + 0.00i	0.99 + 0.00i	0.98 + 0.00i	0.99 + 0.00i
13	0.17 + 0.98i	-0.34 + 0.939i	0.99 - 0.00i	0.99 - 0.00i	0.99 + 0.01i	0.99- 0.00i
14	-0.62 - 0.78i	0.44 - 0.896i	0.99 + 0.00i	0.99 + 0.00i	0.99 - 0.00i	0.98 + 0.00i
15	0.82 - 0.56i	-0.44 + 0.896i -	0.99 + 0.00i	0.99 + 0.00i	0.97 - 0.01i	0.99 + 0.00i
16	0.21 - 0.97i	0.90 - 0.431i	1.00 + 0.00i	0.98 + 0.00i	0.97 + 0.00i	0.99 + 0.00i

VIII. Conclusions

In this paper, ABF based on PSO, LMS and CMA method have been simulated for 16 elements ULA. A performance analysis and validation is done by changing the values of SNR for two different positions of interferers. The main lobe gain and null depth are calculated to validity this approach. It is shown that the PSO-based beamformer provides accurate 0dB main beam gain and null depth of -20dB to -50dB with better SLL for each case of SNR. However, CMA fail to provide main beam and null placement for SNR< 0dB and LMS for SNR< -20dB. Therefore, the PSO method seems to be simple and appropriate in ABF applications based on the fitness function. ABF using PSO shows mean side lobe level (SLL) of -15 dB to -17 dB with a directivity of 7dB for each case of SNR. LMS and CMA show better SLL than PSO. It can be further studied with complex fitness functions in order to improve the value of SLL.

References Références Referencias

1. Balanis. C.A.: Antenna Theory: Analysis and Design. 3rd Edition, John Willy & Sons Inc., New York (2005).
2. Das, S., "Smart antenna design for wireless communication using adaptive beam-forming approach," TENCON 2008 - 2008 IEEE Region 10 Conference , vol., no., pp.1,5, 19-21 Nov. 2008
3. Keng Jin Lian, "Adaptive antenna arrays for satellite personal communication systems", Master of science thesis, January 27, 1997, Virginia polytechnic institute and state university, Blacksburg.
4. A.Canabal, R.P.Jedicka and A.G.Pino, "Multifunctional phased array antenna design for satellite tracking", Elsveier Journal, Volume 57, Issue 12, December 2005, Pages 887–900.
5. W. Jiancheng, Q.Hui and c. Jianming, "Optimizing adaptive linear array antenna pattern under intensive interference environment using Genetic Algorithm," fourth International Conference on Intelligent Computation Technology and Automation, pp.185-187, 2011.
6. S. Banerjee, V. V. Dwivedi, "Linear Antenna Array Synthesis to Reduce the Interference in the Side Lobe using Continuous Genetic Algorithm"IEEE Fifth International Conference on Advances in Computing and Communications, pp.291-296 (2015)
7. Shahera Hossain, Mohammad Tariqul Islam and Seiichi Serikawa, "Adaptive Beamforming Algorithms for Smart Antenna Systems" International Conference on Control, Automation and Systems 2008, Oct. 14-17, 2008 in Coex, Seoul, Korea
8. Zhao hongwei, Lian Baowang and Feng Juan, "Adaptive Beamforming Algorithm for Interference Suppression in GNSS Receivers", International Journal of Computer Science & Information Technology (IJCSIT),Vol 3, No 5, Oct 2011, pp. no.17-28.
9. B. Widrow et. al. "Adaptive antenna systems," Proc. IEEE, Vol. 55, No.12 Dec., 1967.
10. S.P. Applebaum, Adaptive Arrays, tech. rep., Syracuse University Research Corporation, 1965. Reprinted in IEEE Transactions on Antennas and Propagation, 1976.
11. Y. J. Gu, Z. G. Shi, K. S. Chen and Y. Li, "Robust Adaptive Beamforming for Steering Vector Uncertainties Based on Equivalent DOAs Method", Progress In Electromagnetics Research, PIER 79, pp. no. 277–290, 2008.
12. Sangeeta Kamboj and Dr. Ratna Dahiya, "Adaptive antenna array for Satellite Communication Systems", Proceedings of the International Multi Conference of Engineers and Computer Scientists 2008, IMECS 2008, 19-21 March 2008, Hong Kong.
13. S. Banerjee and V. V. Dwivedi, "An LMS Adaptive Antenna Array", International Journal of Advanced Research in Engineering and Technology, vol. 4, no. 6, Sep-Oct. 2013, pp. 166-174.
14. S. Banerjee and V. V. Dwivedi, " Review of adaptive linear antenna array pattern optimization", International Journal of Electronics and Communication Engineering (IJECE), vol. 2, issue 1, pp. 25--42 (2013).
15. S. Banerjee and V. V. Dwivedi.: Linear array synthesis using Schelkunoff polynomial method and particle swarm optimization, IEEE International Conference on Advances in Computer Engineering and Applications ICACEA, pp.727--730 (2015).
16. Prerna Saxena and A.G. Kothari, "Performance Analysis of Adaptive Beamforming Algorithms for Smart Antennas", International Conference on Future Information Engineering, IERI Procedia 10, 2014, pp. no.131 – 137.
17. Liu, F., J. Wang, C. Y. Sun, and R. Du, "Robust MVDR beamformer for nulling level control via multi-parametric quadratic programming," Progress In Electromagnetics Research C, Vol. 20, 239-254, 2011.
18. Z. D. Zaharis and T. V. Yioultsis, "A Novel Adaptive Beamforming Technique Applied on Linear Antenna Arrays using Adaptive Mutated Boolean PSO", Progress In Electromagnetics Research, Vol. 117, pp.no. 165-179, 2011.
19. Z. D. Zaharis, C. Skeberis and T. D. Xenos, "Improved Antenna Array Adaptive Beam-Forming with Low Side Lobe Level using A Novel Adaptive Invasive Weed Optimization Method", Progress In Electromagnetics Research, Vol. 124, pp. no.137-150, 2012.
20. Magdy, A., EL-Ghandour, O.M. and Hamed, H.F.A. (2015) Performance Enhancement for Adaptive Beam-Forming Application Based Hybrid PSOGSA Algorithm. Journal of Electromagnetic Analysis and

Applications, 7, 126-133. http://dx.doi.org/10.4236/jemaa.2015.74014.

21. Ahmed Magdy, Osama M. El-Ghandour, and Hesham F. A. Hamed, "Adaptive Beam-forming Optimization Based Hybrid PSOGSA Algorithm for Smart Antennas Systems, Progress In Electromagnetics Research Symposium Proceedings, Prague, Czech Republic, July 6-9, 2015, pp. no. 973-977.
22. Chao-Hsing Hsu and Wen-Jye Shyr, "Memetic Algorithms for Optimizing Adaptive Linear Array Patterns By Phase-Position Perturbations", Circuits Systems Signal Processing, Vol.24, no.4, pp. no. 327-341 , 2005.
23. Virgilio Zuniga, Ahmet T. Erdogan and Tughrul Arslan, "Adaptive radiation pattern optimization for antenna arrays by phase perturbations using particle swarm optimization," IEEE NASA/ESA Conference on Adaptive Hardware and Systems (AHS), pp.209-214, 15-18 June 2010.
24. A.Prakasa Rao and N.V.S.N. Sarma, "Interference Suppression in Multiple Beams Adaptive Linear Array using Genetic Algorithm, " Antenna Test and Measurement Society, India,2011.
25. R. C. Eberhart and Y. Lu, "Particle swarm optimization: developments, applications and resources, evolutionary computation," Proceedings of the 2001 Congress on Evolutionary Computation, vol. 1, pp. 81-86, 2001.
26. Arora. R. K.: Optimization: Algorithms and Applications, 1st Edition, CRC Press, New York (2015).

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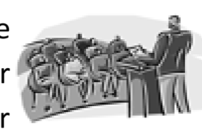

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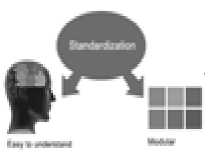
The FARSE can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSE, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.



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The FARSE member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A. Once you are designated as FARSE, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

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The MARSE member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSE, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

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Auxiliary Memberships

Institutional Fellow of Open Association of Research Society (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

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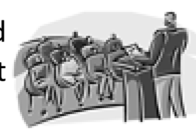

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

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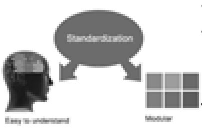
We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.



After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.

The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

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We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

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- The Fellow can become member of Editorial Board Member after completing 3yrs.
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- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone. "

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The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

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1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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Complete support for both authors and co-author is provided.

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Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

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(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

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It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

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Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

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Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

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Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

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A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

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1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

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8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.
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- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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