Online ISSN : 2249-4596
Print ISSN : 0975-5861
DOI : 10.17406/GJRE

Global Journal

of Researches in Engineering: J

General Engineering

Frequency Hopping Signal

Seasonality Smoothing Method

Highlights

Low Probability of Intercept

Spectrogram and the Scalogram

Discovering Thoughts, Inventing Future

VOLUME 16 ISSUE 2 VERSION 1.0

Global Journal of Researches in Engineering: J
General Engineering

Global Journal of Researches in Engineering: J
General Engineering
Volume 16 Issue 2 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

Sponsors: Open Association of Research Society
Open Scientific Standards

Publisher's Headquarters office

Global Journals® Headquarters
945th Concord Streets,
Framingham Massachusetts Pin: 01701,
United States of America
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

Packaging & Continental Dispatching

Global Journals
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:

22 USD (B/W) & 50 USD (Color)

Yearly Subscription (Personal & Institutional):

200 USD (B/W) & 250 USD (Color)

Integrated Editorial Board
(Computer Science, Engineering, Medical, Management, Natural Science, Social Science)

Dr. Bart Lambrecht
Director of Research in Accounting and FinanceProfessor of Finance
Lancaster University Management School
BA (Antwerp); MPhil, MA, PhD (Cambridge)

Dr. Carlos García Pont
Associate Professor of Marketing
IESE Business School, University of Navarra
Doctor of Philosophy (Management), Massachusetts Institute of Technology (MIT)
Master in Business Administration, IESE, University of Navarra
Degree in Industrial Engineering, Universitat Politècnica de Catalunya

Dr. Fotini Labropulu
Mathematics - Luther College
University of ReginaPh.D., M.Sc. in Mathematics
B.A. (Honors) in Mathematics
University of Windso

Dr. Lynn Lim
Reader in Business and Marketing
Roehampton University, London
BCom, PGDip, MBA (Distinction), PhD, FHEA

Dr. Mihaly Mezei
ASSOCIATE PROFESSOR
Department of Structural and Chemical Biology, Mount Sinai School of Medical Center
Ph.D., Etvs Lornd University
Postdoctoral Training,
New York University

Dr. Söhnke M. Bartram
Department of Accounting and FinanceLancaster University Management SchoolPh.D. (WHU Koblenz)
MBA/BBA (University of Saarbrücken)

Dr. Miguel Angel Ariño
Professor of Decision Sciences
IESE Business School
Barcelona, Spain (Universidad de Navarra)
CEIBS (China Europe International Business School).
Beijing, Shanghai and Shenzhen
Ph.D. in Mathematics
University of Barcelona
BA in Mathematics (Licenciatura)
University of Barcelona

Philip G. Moscoso
Technology and Operations Management
IESE Business School, University of Navarra
Ph.D in Industrial Engineering and Management, ETH Zurich
M.Sc. in Chemical Engineering, ETH Zurich

Dr. Sanjay Dixit, M.D.
Director, EP Laboratories, Philadelphia VA Medical Center
Cardiovascular Medicine - Cardiac Arrhythmia
Univ of Penn School of Medicine

Dr. Han-Xiang Deng
MD., Ph.D
Associate Professor and Research Department Division of Neuromuscular Medicine
Davee Department of Neurology and Clinical NeuroscienceNorthwestern University
Feinberg School of Medicine

Contents of the Issue

Global Journal of Researches in Engineering: J
General Engineering
Volume 16 Issue 2 Version 1.0 Year 2016
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 Print ISSN:0975-5861

Hyperbolic Metamaterial Interface: Propagation of Surface Waves

By T. Gric, M. Cada & J. Pistora
Dalhousie University, Canada

Abstract- Herein we study propagation of surface waves at a boundary of an isotropic media and a multilayered hyperbolic metamaterial. The structure dispersion is discussed for various cases of a hyperbolic metamaterial. It is demonstrated that it is possible to tune the frequency range of surface waves by varying the thickness of dielectric sheets. It is also shown that this frequency range can be broadened by decreasing the thickness of the dielectric in the metal-dielectric compound or by replacing the isotropic media with a metal. It is also shown that the mentioned effect can be achieved by increasing the doping concentration of the semiconductor if the metamaterial/semiconductor structure is considered. The effective medium approximation is used and its validity in the long-wavelength limit is justified by investigating the electromagnetic field variations over one period of the proposed structure.

Keywords: *surface wave; metamaterial; drude metal; surface plasmons; terahertz.*

GJRE-J Classification : *FOR Code: 020301*

HYPERBOLICMETAMATERIALINTERFACEPROPAGATIONOFSURFACEWAVES

Strictly as per the compliance and regulations of :

Hyperbolic Metamaterial Interface: Propagation of Surface Waves

T. Gric α, M. Cada σ & J. Pistora ρ

Abstract- Herein we study propagation of surface waves at a boundary of an isotropic media and a multilayered hyperbolic metamaterial. The structure dispersion is discussed for various cases of a hyperbolic metamaterial. It is demonstrated that it is possible to tune the frequency range of surface waves by varying the thickness of dielectric sheets. It is also shown that this frequency range can be broadened by decreasing the thickness of the dielectric in the metal-dielectric compound or by replacing the isotropic media with a metal. It is also shown that the mentioned effect can be achieved by increasing the doping concentration of the semiconductor if the metamaterial/semiconductor structure is considered. The effective medium approximation is used and its validity in the long-wavelength limit is justified by investigating the electromagnetic field variations over one period of the proposed structure.

Keywords: surface wave; metamaterial; drude metal; surface plasmons; terahertz.

I. Introduction

The waves at an interface between an isotropic medium and a uniaxial crystal characterized by its effective permittivities have been first demonstrated in [1]. The existence of these surface waves in some material examples is studied in [2], discussing the challenge posed by their experimental observation. The novelty and potential importance of Dyakonov waves for integrated optics applications were described in a stream of papers [3-5].

In near-infrared and visible wavelengths, the behavior of nanolayered metal-dielectric (MD) compounds is similar to plasmonic crystals. In this case a simplified description of the medium by using the long-wavelength approximation can be justified; the homogenization of the structured metamaterial can also be employed [6-8]. It is interesting to note that the second-rank tensor representing the medium permittivity includes elements of opposite signs, thus yielding extremely anisotropic metamaterials under certain conditions [9, 10]. This category of nanostructured media opens the wide avenues for the practical applications from biosensing to fluorescence engineering [11].

Author α: Dalhousie University, Halifax, Canada, Vilnius Gediminas Technical University, Vilnius, Lithuania.
e-mails: Tatjana.Gric@dal.ca, tatjana.gric@vgtu.lt
Author σ: Dalhousie University, Halifax, Canada Nanotechnology Centre, Technical University of Ostrava, the Czech Republic.
Author ρ: Nanotechnology Centre, Technical University of Ostrava, the Czech Republic.

The existence of surface waves when dealing with anisotropic media possessing the indefinite permittivity was reported for the first time in [12]. This study was dedicated mainly to surface waves enabling sub-diffraction imaging in magnifying superlenses [13], where the surface waves exist at an interface between a metal and an all-dielectric birefringent metamaterial. Dealing with hyperbolic media, however, the authors concluded only with an indefinable analysis of surface waves.

In this paper we retake the task and perform a thorough analysis of surface waves traveling in infinite MD lattices. Our approach is to use the effective-medium approximation.

II. Geometry of the Problem

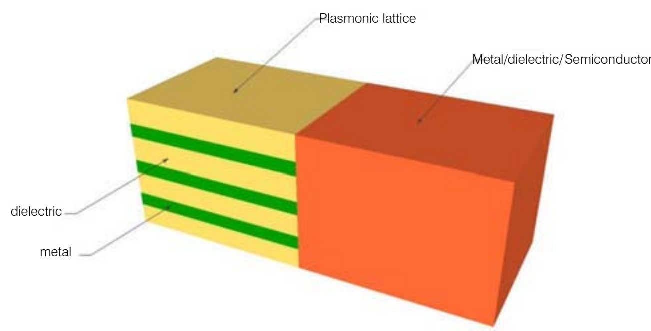


Fig. 1 : The model under study consisting of an infinite MD lattice ($x<0$) and an isotropic material ($x>0$). The periodic structure contains a Drude metal and a dielectric.

The investigated structure is shown in Fig. 1. It should be mentioned that an infinite periodic model consisting of alternating layers of a metal and a conventional dielectric is placed on the left of the homogeneous dielectric. The effective dielectric tensor components parallel ($\varepsilon_{\parallel}$) and perpendicular ($\varepsilon_{\perp}$) to the anisotropy axis are described in [14] as:

$$\varepsilon_{\perp} = \frac{\varepsilon_m d_m + \varepsilon_d d_d}{d_m + d_d} \qquad (1)$$

$$\frac{1}{\varepsilon_{\parallel}} = \frac{d_m/\varepsilon_m + d_d/\varepsilon_d}{d_m + d_d} \qquad (2)$$

where d_m (d_d) is the thickness and ε_m (ε_d) is the dielectric constant of the metallic (dielectric) component. The effective medium approximation in Eqs. (1) and (2) is valid in the long-wavelength limit. However, the field varies significantly on the scale of one period due the excitation of surface plasmon (SP) polaritons at metal/dielectric interfaces. Therefore, the approximation in Eqs. (1) and (2) may not be applicable in some spectral ranges.

III. Numerical Analysis of Dispersion Characteristics

Herein we discuss the numerical solution to the dispersion relation [15], either obtained for metamaterial/air interface or for metamaterial/metal and metamaterial/semiconductor interfaces.

a) Metamaterial/Air interface

The dispersion relation [15] is graphically represented in Fig. 2 for the MD crystal displayed in Fig. 1 at $x < 0$, considering different widths of the dielectric d_d and assuming, that we are dealing with metamaterial/air interface.

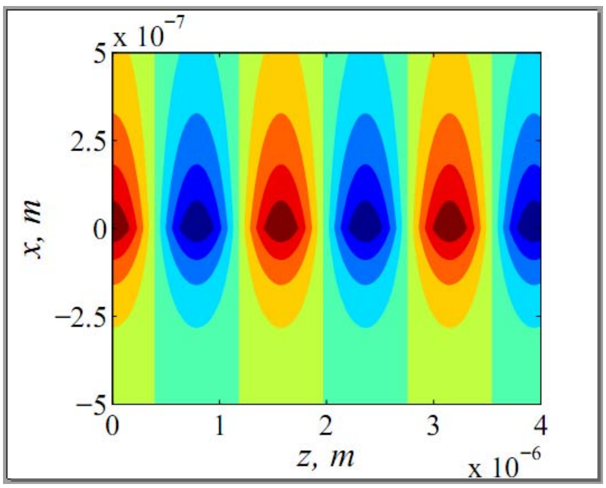


Fig. 2 : Dispersion curves of TM modes at a metamaterial/air interface for different widths of the dielectric layer $d_d > 0$ (red dots) in a Drude metal/dielectric compound. The light line is shown (dashed line), and $d_m = 35$ nm.

Fig. 2 shows the dispersion of surface waves at a metamaterial/air interface. The case ($d_d > 0$) corresponds to classic surface waves well known for conductive interfaces [16]. Thus, this example illustrates the verification of our methodology [15]. In addition, the light line in vacuum is plotted in Fig. 2 as dashed line. Our calculated data corresponds to the data of [17] where also a complete discussion of the surface wave characteristics in this case can be found.

As can be seen from Fig. 2, the frequency range for surface waves can be controlled by the fill factors of the air and metal sheets in the MD compound.

If we decrease the thickness of the dielectric d_d, the dispersion curve moves to a lower frequency. The dependence of the frequency range for the surface wave existence on the thickness of the dielectric layer provides additional degree of freedom to control surface waves.

Fig. 3 shows the profiles of the magnetic field along the x axis for the investigated case, i. e. metamaterial/air. The magnetic field has been obtained when $\beta = 4 \cdot 10^6$ 1/m. The wave field is tightly confined near $x = 0$ for all the thicknesses of the dielectric d_d.

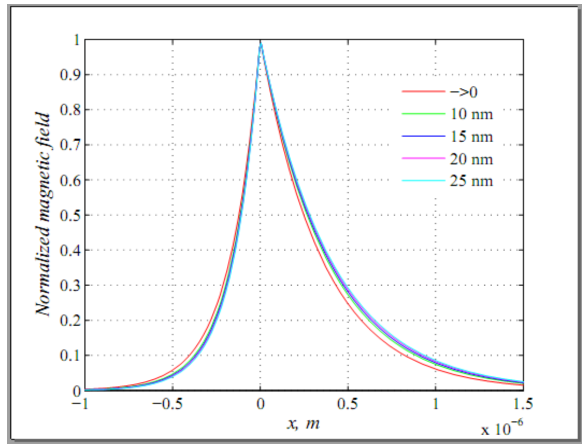


Fig. 3 : Magnetic field (normalized) for different values of parameter d_d for SP modes at metamaterial/air inter face.

The conducted analysis shows, that the frequency range for the surface wave existence seems to be narrow. Thus, we shall leave the geometry unchanged but assume that instead of an interface between a metamaterial and air we will be dealing with an interface between a metamaterial and a metal. Doing so, we can extend the frequency range for the surface wave existence. It should be noticed, that each medium is capable of supporting propagating surface waves separately.

b) Metamaterial/Metal interface

The dispersion curves for the matamterial/metal structure are presented in Fig. 4. The calculations were performed using the following parameters for bulk silver: $\omega_p = 2297.09$ THz, $\varepsilon_\infty = 5.2$ [18]. As in previous cases we discuss the effects of the thickness of the dielectric d_d on the dispersion curve. It should be noticed that the upper and the lower limits move to lower frequencies when d_d is decreased. However the lower limit moves faster than the upper one. The mentioned issue leads to a broader frequency range for the surface wave existence.

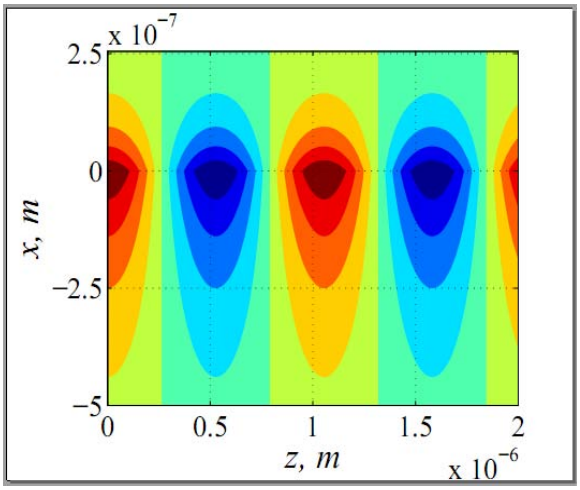


Fig. 4 : Dispersion curves of TM modes at a metamaterial/metal interface for different widths of the dielectric layer $d_d > 0$ (red dots) in a Drude metal/dielectric compound. The light line is shown (dashed line), and $d_m = 35$ nm.

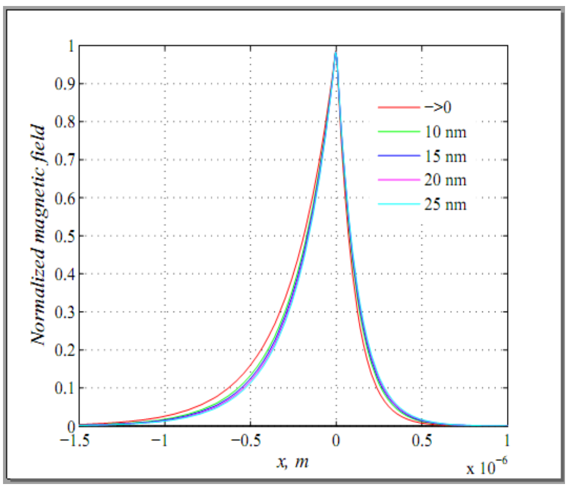


Fig. 5 : Magnetic field (normalized) for different values of parameter d_d for SP modes at metamaterial/air interface.

Fig. 5 shows the profile of the magnetic field along the x axis for the case under the study. It is interesting to point out, that $\beta = 6{\cdot}10^6$ 1/m.

It should be mentioned, that the wave field is tightly confined near $x = 0$ for all the thicknesses of the dielectric d_d. It is interesting to note that in the case of a metamaterial/air interface (Fig. 3) the tighter confinement near the boundary $x = 0$ is exhibited in the metamaterial while in the case of a metamaterial/metal interface the tighter confinement is in the metal.

c) Metamaterial/Semiconductor interface

It is interesting to notice, that he case of heavy doped Si is considered, assuming that the doping level is $N_1 = 5{\cdot}10^{19}$ cm^{-3} [19]. An average effective mass m_1 for electrons is $0.26m_0$ with m_0 being the free-electron mass, and $\varepsilon_{\infty 1} = 11.68$.

Figure 6 shows the longitudinal propagation constant β as a function of the propagation frequency, for different values of dielectric layers d_d, employed in the MD lattice.

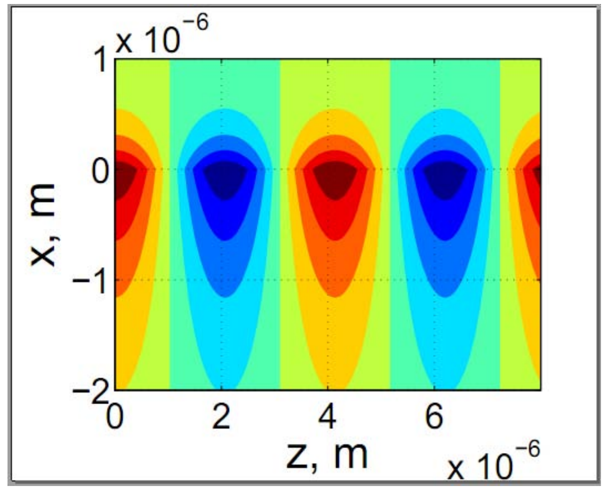


Fig. 6 : Dispersion curves of TM modes at a metamaterial/semiconductor interface for different widths of the dielectric layer $d_d > 0$ (red dots) in a Drude metal/dielectric compound. The light line is shown (dashed line), and $d_m = 35$ nm. Points *A, B, C, D, E* are used in Fig. 8.

It is interesting to notice, that the behavior of the dispersion curves in the investigated case is consistent with the effect of d_d on the frequency range of the negative $\varepsilon_{||}$ [20].

To date it is well known, that the presence of semiconductor in the structure can tune the properties of the investigated system in the easy way. Thus in Fig. 7 we present the dispersion curves of the surface wave dealing with the different concentrations of the Si.

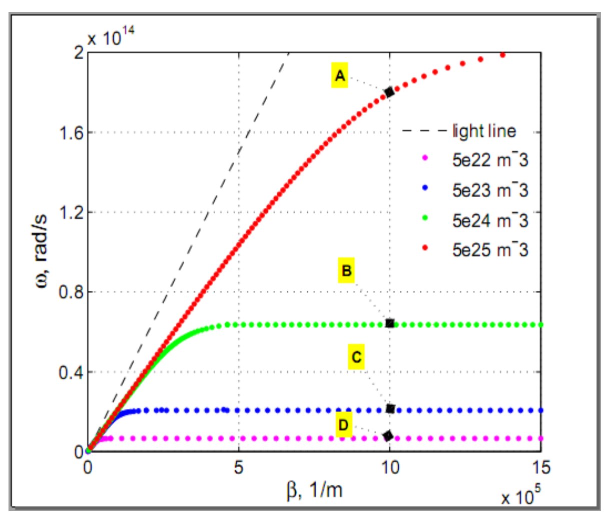


Fig. 7 : Dispersion curves of TM modes at a metamaterial/semiconductor interface for different concentration N_1 of Si. The light line is shown (dashed line), and $d_d = d_m = 35$ nm. Points A, B, C, D are used in Fig. 9.

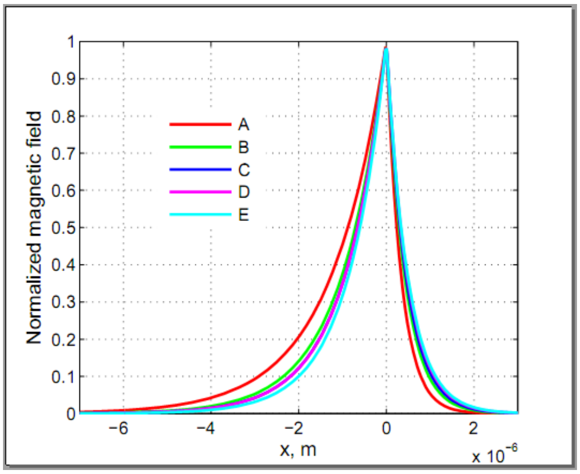


Fig. 8 : Magnetic field (normalized) of SP modes at metamaterial/semiconductor

Interface for the points *A, B, C, D* and *E* highlighted in Fig. 2, when that the doping level is $N_1=5\cdot10^{19}$ cm-3.

Fig. 8 shows the profile of the magnetic field along the *x* axis for the investigated case, i. e. metamaterial/semiconductor. Fig. 8 shows the magnetic field for the points when $\beta = 1.5\cdot10^6$ 1/m. The tight confinement of the wave field is observable near $x = 0$ for all the thicknesses of the dielectric d_d. It is interesting to note that the tighter confinement near the boundary $x = 0$ is exhibited in the semiconductor.

Moreover, it is of particular interest to plot the profile of the magnetic field along the *x* axis, when the doping level of the silicon changes. The results are depicted in Fig. 9 being $d_d = d_m = 35$ nm.

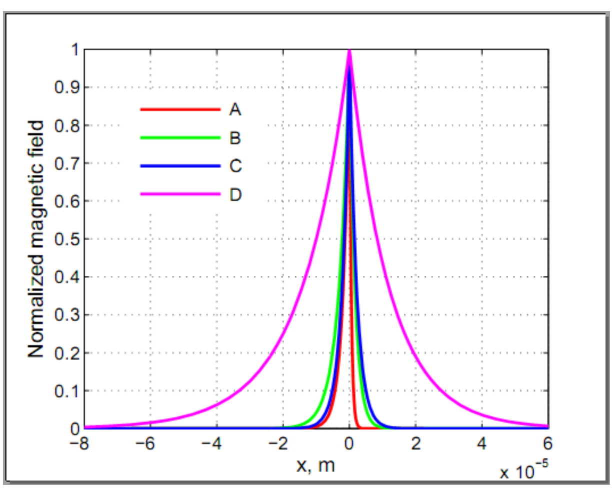


Fig. 9 : Magnetic field (normalized) of SP modes at metamaterial/semiconductor interface for the points *A, B, C* and *D* highlighted in Fig. 3, if $d_d = d_m = 35$ nm.

It is interesting to notice, that the lowest confinement in this case is produced for the lowest doping concentration of silicon.

It is valuable to confirm the presence of SP waves for all the investigated cases. In the insets of Figs. 2, 4 and 6 we show the nature of the magnetic fields for all the investigated cases.

IV. Conclusions

The surface waves at the boundary of hyperbolic metamaterial have been studied for three different cases: metamaterial/ air, metamaterial/metal, metamaterial/semiconductor. The dependences of the longitudinal propagation constant on the propagation frequency have been examined. It is established that one can tune the frequency range of surface waves by varying the thickness of dielectric sheets. It is also revealed that this frequency range can be broadened by three different manipulations:

- decreasing the thickness of the dielectric in the metal-dielectric compound;
- dealing with the metamaterial/metal structure;
- increasing the doping concentration of the semiconductor, if considering the metamaterial/semiconductor interface.

V. Acknowledgments

The authors gratefully acknowledge the financial support provided to this study by NSERC (Natural Sciences and Engineering Research Council) and NSERC's CREATE (Collaborative Research Training Experience) Program ASPIRE (Applied Science in Photonics and Innovative Research in Engineering), both of Canada, also by the projects "New creative teams in priorities of scientific research" and the IT4Innovations Centre of Excellence project (CZ.1.05/1.1.00/02.0070), Czech Republic. We gratefully acknowledge helpful discussions with members of Cada's photonics research group.

References Références Referencias

1. M. I. D'yakonov, Sov. Phys. JETP 67, 714-716 (1988).
2. O. Takayama, L.-C. Crasovan, S. K. Johansen, D. Mihalache, D. Artigas, and L. Torner, Electromagnetics 28, 126–145 (2008).
3. L. Torner, J. P. Torres, F. Lederer, D. Mihalache, D. M. Baboiu, M. Ciumac, Electron. Lett. 29, 1186–1188 (1993).
4. L. Torner, J. P. Torres, D. Mihalache, IEEE Photon. Technol. Lett. 5, 201–203 (1993).
5. L. Torner, J. P. Torres, C. Ojeda, D. Mihalache, J. Lightwave Technol. 13, 2027–2033 (1995).
6. S. M. Rytov, Sov. Phys. JETP 2, 466 (1956).
7. A. Yariv and P. Yeh, J. Opt. Soc. Am. 67, 438–448 (1977).
8. S. M. Vukovic, I. V. Shadrivov, Y. S. Kivshar, Appl. Phys. Lett 95, 041902 (2009).

9. D. R. Smith, D. Schurig, Phys. Rev. Lett. 90, 077405 (2003).
10. I. I. Smolyaninov, E. Hwang, E. Narimanov, Phys. Rev. B 85, 235122 (2012).
11. Y. Guo,W. Newman, C. L. Cortes, Z. Jacob, Advances in OptoElectronics 2012, 452502 (2012).
12. Z. Jacob, E. E. Narimanov, Appl. Phys. Lett. 93, 221109 (2008).
13. I. I. Smolyaninov, Y.-J. Hung, C. C. Davis, Science 315, 1699–1701 (2007).
14. V. M. Agranovich, V. E. Kravtsov, Solid State Commun. 55, 85–90 (1985).
15. M. Cada, J. Pistora, "Optical plamonics in semiconductors," ISMOT conference, June 20–23, 2011.
16. S. A. Maier, *Surface plasmon polaritons at metal/insulator interfaces, in Plasmonics: Fundamentals and Applications*, Springer, New York (2007).
17. M. Nakayama, J. Phys. Soc. Jpn., 36(2), 393 (1974).
18. V. V. Vodnik, D. K. Božani´c, N. Bibi´c, Zo. V. Šaponji´c, and J. M. Nedeljkovi´c, Journal of Nanoscience and Nanotechnology 8, 1–5 (2008).
19. J. Jung, T. G. Pedersen, J. Appl. Phys. 113, 114904 (2013).
20. Y. Xiang, J. Guo, X. Dai, S. Wen, D. Tang, Opt. Express 22, 3054-3062 (2014).

This page is intentionally left blank

Global Journal of Researches in Engineering: J
General Engineering
Volume 16 Issue 2 Version 1.0 Year 2016
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 Print ISSN:0975-5861

Performance Assessment of SARIMA Model with Holt-Winter's Trend and Additive Seasonality Smoothing Method on forecasting Electricity Production of Australia an Empirical Study

By Md. Matiur Rahman Molla, S.M. Nuruzzaman, Dr. M. Sazzad Hossain & Md. Shohel Rana
Islamic University, Bangladesh

Abstract- Australia is a leading developed country which is indispensable a proper planning and management of power generation. To take a unique planning decision forecasting of electricity production is badly in need so that electricity generation copes with the demand of the electricity smoothly. The main task of this study is to assess the performance of two time series models in forecasting electricity generation in Australia. Two time series forecasting methods such as ARIMA and Holt-Winter's additive trend and seasonality smoothing methods are considered. Applying Theil's U-statistic as the key performance measure, the study concludes that Holt-winter's method is more appropriate model.

Keywords: electricity production, seasonal ARIMA, smoothing, forecasting, time series analysis.

GJRE-J Classification : FOR Code: 291899p

Performance Assessment of SARIMA Model with Holt–Winter's Trend and Additive Seasonality Smoothing Method on forecasting Electricity Production of Australia an Empirical Study

Md. Matiur Rahman Molla [α], S.M. Nuruzzaman [σ], Dr. M. Sazzad Hossain [ρ] & Md. Shohel Rana [ω]

Abstract- Australia is a leading developed country which is indispensable a proper planning and management of power generation. To take a unique planning decision forecasting of electricity production is badly in need so that electricity generation copes with the demand of the electricity smoothly. The main task of this study is to assess the performance of two time series models in forecasting electricity generation in Australia. Two time series forecasting methods such as ARIMA and Holt-Winter's additive trend and seasonality smoothing methods are considered. Applying Theil's U-statistic as the key performance measure, the study concludes that Holt-winter's method is more appropriate model.

Keywords: electricity production, seasonal ARIMA, smoothing, forecasting, time series analysis.

I. Introduction

At present electricity has become a first and foremost precondition of macroeconomic development of a territory. Each day, electricity plays key rolein keeping homes and business running smoothly, powers transportation that take people work, school and other places, and supplies electricity to appliances in all sectors. The demand of electricity especially in for industrial sector need not to say. Without electricity not only a single day but also a moment is unimaginable. A country's economic growth directly related to electricity production. That's why sustainable electricity production badly in needs to fulfill the demand of households as well as industry and communication sectors. To manage such kind of demand of electricity a country's power development board has to take sophisticated decision to produce electricity that can cope with demand with supply of energy.

Being a developed country monthly electricity production of Australia is a seasonal and trending behavior. So, electricity production authority of Australia should take plan for proper management of production with demand. To overcome uncertainty of future production smoothing or forecasting approach time series analysis is the most applied method. For predicting Australian electricity production, we will use conventional smoothing methods and well known ARIMA modeling. Hence we want to show the comparative performance of referred model. This paper is divided into six sections. The section one of this study is the introductory part. The second section of the study will present forecasting approach where we present stationarity, Holt's-Winter trend and additive seasonality, Box-Jenkins methodology SARIMA modeling and accuracy measurement approach. Section three is the empirical data analysis and forecasting while sections four is the accuracy measurement and finally conclusion

Basic Terminologies: The following keywords are used throughout the research approach.

Stationarity: Stationarity means that there is no growth or decline in the data. The data must be horizontal along the axis. A time series is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance or gap or lag between the two time periods and not the actual time is computed.

Suppose y_t be a stochastic time series then,

$$E(y_t) = \mu$$

$$\operatorname{var}(y_t) = E(y_t - \mu)^2 = \sigma^2$$

Holt's-Winter's trend and additive seasonality method

The basic equations of Holt-Winters' trend and additive seasonality method are as follows:

Level $L_t = \alpha(Y_t - S_{t-s}) + (1-\alpha)(L_{t-1} + b_{t-1})$

Trend: $b_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1}$

Seasonal: $S_t = \gamma(Y_t - L_t) + (1-\gamma)S_{t-s}$

Forecast: $F_{t+m} = L_t + b_t m + S_{t-s+m}$

Where s is the length of seasonality (e.g., number of months or quarters in a year), L_t represents the level of the series, b_t denotes the trend, S_t is the seasonal component, and F_{t+m} is the forecast for m period ahead.

Box-Jenkin's methodology and ARIMA modeling

Author α σ ρ ω: Islamic University, Bangladesh.
e-mail: matiur508@gmail.com

The general ARIMA model proposed by Box and Jenkins (1970) is written as ARIMA (p, d, q) but when the characteristic of the data is seasonal behavior then it said to be SARIMA. And the seasonal ARIMA model is written as very formal notation like this

$$\text{ARIMA } (p,d,q) \quad \times \quad (P,D,Q)_m$$

$\downarrow \quad \downarrow$

Non-seasonal Seasonal
Part of the model part of the model

AR: p = order of the autoregressive part
*I:*d = degree of differencing involved
MA: q = order of the moving average part
m = number periods per season

The basis of the Box-Jenkins modeling in time series analysis is summarized the following figure and consist of three phases: identification, estimation and testing, and application.

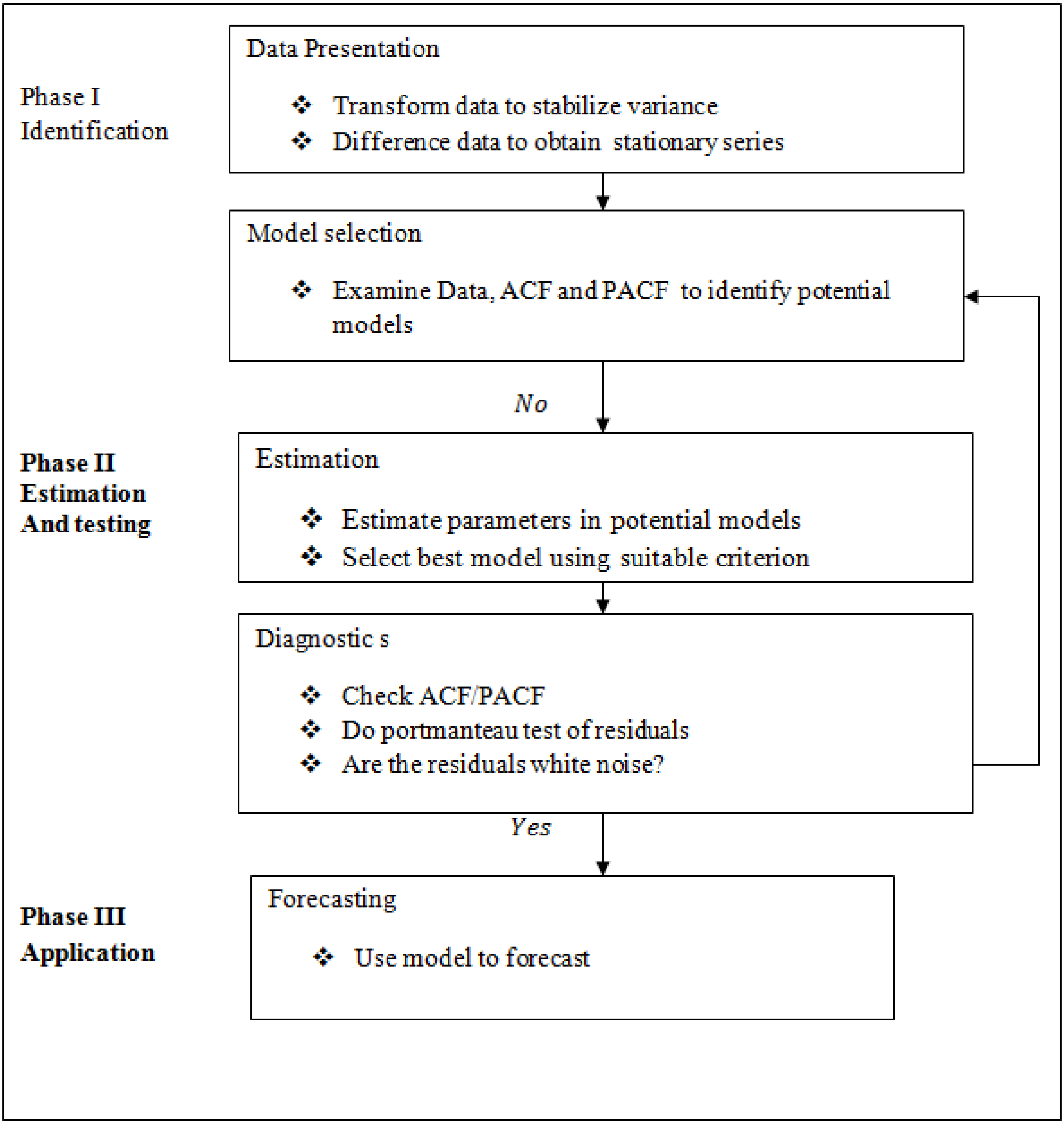


Figure 1.1 : Schematic representation of the Box-Jenkins methodology for time series modeling

Assessment Approach: The validity of the forecasting in time series analysis can be assessedvia couples of approaches such as Mean error (ME), root mean square error (RMSE), mean absolute error (MAE), mean percentage error (MPE), mean absolute percentage error (MAPE), mean square error (MSE), Mean absolute scaled error (MASE) and The il's U statistic.

Percentage Error: If Y_t is the actual observation for time period t and F_t is the forecast for the same period, then the percentage error is defined as

$$PE_t = (\frac{Y_t - F_t}{Y_t}) \times 100$$

Mean Percentage Error (MPE):

$$MPE = \frac{1}{n}\sum_{t=1}^{n} PE_t$$

Mean Absolute Percentage Error:

$$MAPE = \frac{1}{n}\sum_{t=1}^{n} |PE_t|$$

If smaller the any above index is considered the better forecasting technique.

Theil's U Statistic: It is defined as follows:

$$U = \sqrt{\frac{\sum_{t=1}^{n-1}(FPE_{t+1} - APE_{t+1})^2}{\sum_{t=1}^{n-1}(APE_{t+1})^2}}$$

Where $FPE_{t+1} = \frac{F_{t+1} - Y_t}{Y_t}$ (forecast relative change)

And $APE_{t+1} = \frac{Y_{t+1} - Y_t}{Y_t}$ (actual relative change)

If $U < 1$: the forecasting technique being used is better than the naïve method. The smaller the U statistic is considered the better forecasting technique.

II. Empirical Results

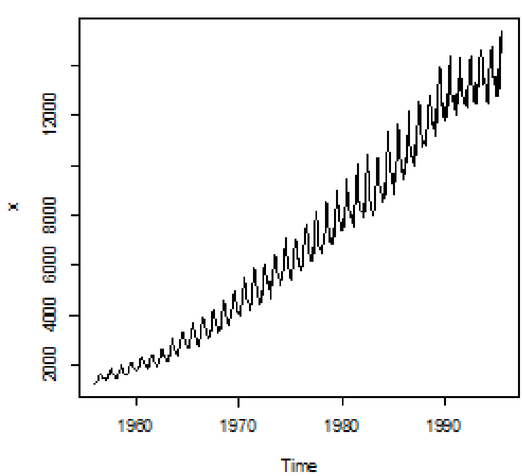


Fig: 1. 2 : Australian monthly electricity productions from January, 1980 to August, 1995

Now, it is revealed to us that the above figure of monthly Australian electricity production exhibits an additive seasonal and steadily increasing trend pattern. Obviously the data series is non-stationary.

Before model building first and foremost task is to differentiate the original data first difference as well as seasonal first difference.

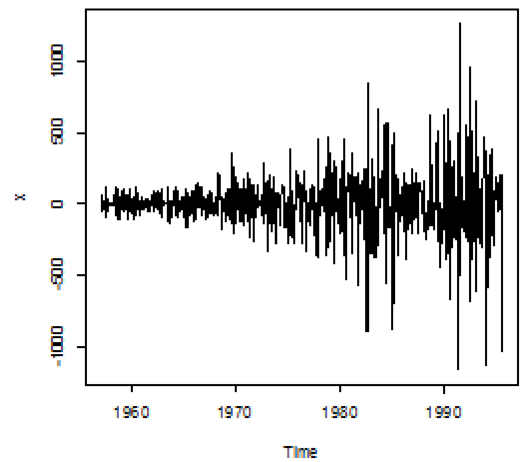


Figure: Time series plot of first difference of the original data

Obviously, first difference of original time series data is now of stationary.

The model SARIMA (0, 1, 1) (0, 1, 2) [12] has chosen on the basis AIC & BIC criterion. The minimum of AIC & BIC that model is taken as the ultimate model for forecasting.

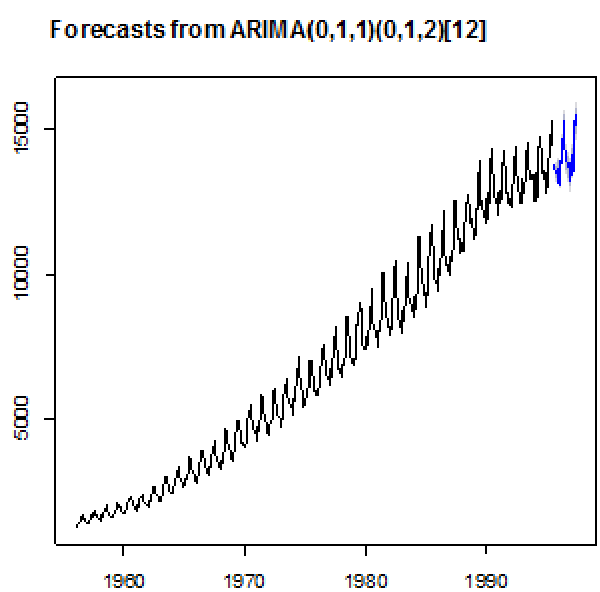


Figure: 1.3 : Forecasting the electricity production of Australia

Diagnostic Checking: we want to compare the performance of the SARIMA with Holt's-Winter trend and additive smoothing approach.

Method	RMSE	MAE	MAPE	MASE	Theil's U
SARIMA*	163.8559	115.0209	1.7778	0.3446	0.368217*
SES	457.0500	334.7208	4.9454	1.0029	--------
HOLT's	456.1791	342.0339	5.1885	1.0248	--------
SNAIVE	394.9866	330.5348	5.6245	0.9903	--------
HOLT -WINTER*	167.4026	119.0757	1.8704	0.3567	0.6557*

We may say from the above accuracy measurement table that the performance of SARIMA (0, 1, 1) (0, 1, 2) [12] model is better than Holt's-Winter method.

Now, we want to represent the histogram of the respective method sequentially

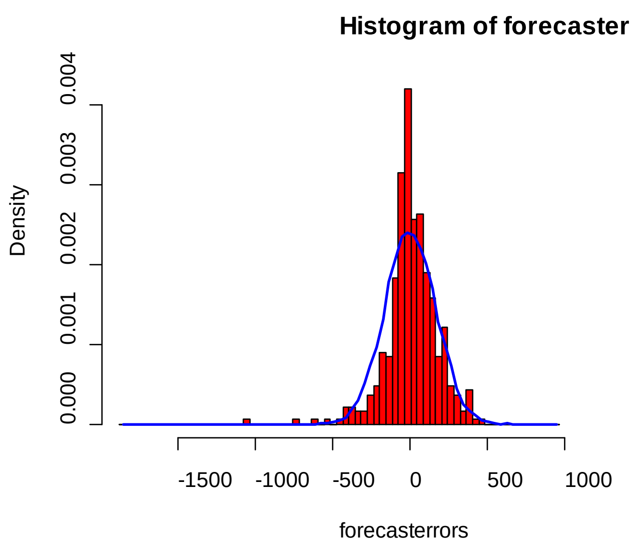


Figure: Histogram of forecast error of SARIMA (0,1,1)(0,1,2)[12] model

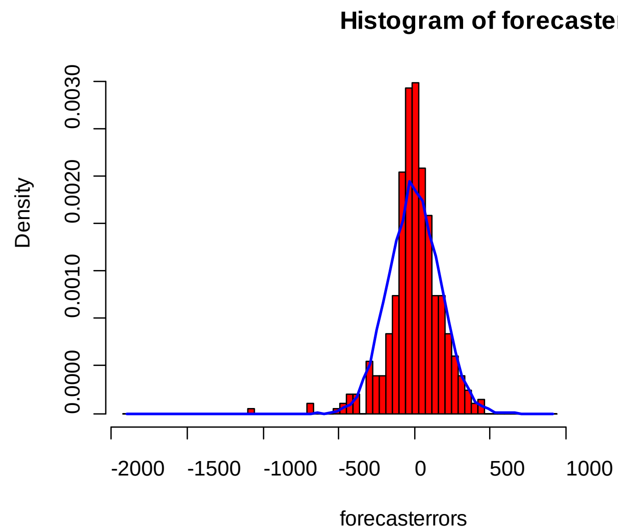


Figure: Histogram forecast error of Holt-winter's trend and additive seasonality model

Comment: On the basis of above two histogram of forecast error, it is revealed that the both of two error terms shape is approximately normal distribution. So, the both of the error term represent white-noise. But the SARIMA (0, 1, 1) (0, 1, 2) [12] model exhibits better normality of forecast error than counterpart.

White Noise Test: The following Table represents the white noise assessment of the error term of the fitted model

Test	P-value	H_0	Decision
Ljung-Box	0.7863	accept	stationary
KPSS	0.1	accept	Stationary
ADF	0.01	Do not accept	Stationary

Above white noise testing approach suggests there is lack of correlation in error term. So, the model is well fitted.

III. Conclusion

The main goal of this paper was the performance assessment between seasonal ARIMA modeling with Holt–Winters' exponential smoothing approach. The empirical analysis revealed that SARIMA (0, 1, 1) (0, 1, 2) [12] were the better model than counterpart

References Références Referencias

1. Anderson, T.W. (1994), The statistical Analysis of Time Series, Willey India pvt. Ltd, New Delhi, India.
2. AKAIKE, h. (1974) A new look at statistical model identification, *IEEE transaction and automatic control*, AC-19, 716-723.
3. AWAL, M.A. and M.A.B. Siddique (2011), Rice Production in Bangladesh Employing by ARIMA Model, *Bangladesh Agricultural Journal*.

4. BROCKWELL, P., J. and R.A .DAVIS (1996) *An introduction to time series and forecasting*, New York: Springer-Verlag.
5. Box, G.E.P., G.M. Jenkins, and G.C. Reinsell (1994) *Time series analysis: Forecasting and control*, 3rd ed., Englewood Cliffs, NJ: Prentice-Hall.
6. BOX, G.E.P AND D.A. PIERCE (1970) Distribution of the residual autocorrelation in autoregressive-integrated moving average time series models, *Journal of the American Statistical Association,* 65, 1509-1526.
7. Chattfield, C. and M. YAR (1988) Holt-Winters' forecasting: some practical issues, *The Statistician*, 37, 129-140.
8. Dougherty, C.,(2011), Introduction to Econometrics, Oxpord University Press Inc., Newyork.
9. DICKEY, D.A. and W.A. FULLER (1979) Distribution of the estimators for autoregressive time series with a unit root, Journal of the *American Statistical Association*, 74, 427-431.
10. Faisal, F. (2012) Time Series ARIMA Forecasting of Natural Gas Consumption in Bangladesh's power sector *Elixir International Journal*, Elixir Prod. Mgt. 49(2012) 9985-9990.
11. Gujarati, D.N. (2014), *Basic Econometrics*, Tata Mc Graw Hill Edition, New Delhi, India.
12. LEPOJEVIC, V. and M. A. PESIC (2011) Forecating Electricity Consumption by Using Holts'-Winters and Seasonal Regression Model, University Servia Economic Organization, Vol.8 pp. 421-431.
13. Makridakis, S., and S.C. Wheelwright and R. J. Hyndman ( ) *Forecastin Method and applications*, Willey and Sons (Asia).
14. PEGELS, C.C.(1969) Exponential forecasting: some new variations, Management Science, 12, No. 5, 311-315.

This page is intentionally left blank

Global Journal of Researches in Engineering: J
General Engineering
Volume 16 Issue 2 Version 1.0 Year 2016
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 Print ISSN:0975-5861

Low Probability of Intercept Frequency Hopping Signal Characterization Comparison using the Spectrogram and the Scalogram[1]

By Daniel L. Stevens & Stephanie A. Schuckers
Clarkson University, United States

Abstract- Low probability of intercept radar signals, which are often problematic to detect and characterize, have as their goal 'to see and not be seen'. Digital intercept receivers are currently moving away from Fourier-based analysis and towards classical time-frequency analysis techniques for the purpose of analyzing these low probability of intercept radar signals. This paper presents the novel approach of characterizing low probability of intercept frequency hopping radar signals through utilization and direct comparison of the Spectrogram versus the Scalogram. Two different frequency hopping low probability of intercept radar signals were analyzed(4-component and 8-component). The following metrics were used for evaluation: percent error of: carrier frequency, modulation bandwidth, modulation period, and time-frequency localization. Also used were: percent detection, lowest signal-to-noise ratio for signal detection, and plot (processing) time. Experimental results demonstrate that overall, the Scalogram produced more accurate characterization metrics than the Spectrogram. An improvement in performance may well translate into saved equipment and lives.

GJRE-J Classification : FOR Code: 091599

LOWPROBABILITYOFINTERCEPTFREQUENCYHOPPINGSIGNALCHARACTERIZATIONCOMPARISONUSINGTHESPECTROGRAMANDTHESCALOGRAM1

Strictly as per the compliance and regulations of :

Low Probability of Intercept Frequency Hopping Signal Characterization Comparison using the Spectrogram and the Scalogram[1]

Daniel L. Stevens [α] & Stephanie A. Schuckers [σ]

Abstract- Low probability of intercept radar signals, which are often problematic to detect and characterize, have as their goal 'to see and not be seen'. Digital intercept receivers are currently moving away from Fourier-based analysis and towards classical time-frequency analysis techniques for the purpose of analyzing these low probability of intercept radar signals. This paper presents the novel approach of characterizing low probability of intercept frequency hopping radar signals through utilization and direct comparison of the Spectrogram versus the Scalogram. Two different frequency hopping low probability of intercept radar signals were analyzed(4-component and 8-component). The following metrics were used for evaluation: percent error of: carrier frequency, modulation bandwidth, modulation period, and time-frequency localization. Also used were: percent detection, lowest signal-to-noise ratio for signal detection, and plot (processing) time. Experimental results demonstrate that overall, the Scalogram produced more accurate characterization metrics than the Spectrogram. An improvement in performance may well translate into saved equipment and lives.

I. Introduction

A low probability of intercept (LPI) radar that uses frequency hopping techniques changes the transmitting frequency in time over a wide bandwidth in order to prevent an intercept receiver from intercepting the waveform. The frequency slots used are chosen from a frequency hopping sequence, and it is this unknown sequence that gives the radar the advantage over the intercept receiver in terms of processing gain. The frequency sequence appears random to the intercept receiver, and so the possibility of it following the changes in frequency is remote [PAC09]. This prevents a jammer from reactively jamming the transmitted frequency [ADA04]. Frequency hopping radar performance depends only slightly on the code used, given that certain properties are met. This allows for a larger variety of codes, making it more difficult to intercept.

Time-frequency signal analysis involves the analysis and processing of signal s with time - varying frequency content. Such signals are best represented by a time-frequency distribution [PAP95], [HAN00], which is intended to show how the energy of the signal is distributed over the two-dimensional time-frequency plane [WEI03], [LIX08], [OZD03]. Processing of the signal may then exploit the features produced by the concentration of signal energy in two dimensions (time and frequency), instead of only one dimension (time or frequency) [BOA03], [LIY03]. Since noise tends to spread out evenly over the time-frequency domain, while signals concentrate their energies within limited time intervals and frequency bands; the local SNR of a noisy signal can be improved simply by using time-frequency analysis [XIA99]. Also, the intercept receiver can increase its processing gain by implementing time-frequency signal analysis [GUL08].

Time-frequency distributions are useful for the visual interpretation of signal dynamics [RAN01]. An experienced operator can quickly detect a signal and extract the signal parameters by analyzing the time-frequency distribution [ANJ09].

The Spectrogram is defined as the magnitude squared of the Short-Time Fourier Transform (STFT) [HIP00], [HLA92], [MIT01], [PAC09], [BOA03]. For non-stationary signals, the STFT is usually in the form of the Spectrogram [GRI08].

The STFT of a signal $x(u)$is given in equation 1 as:

$$F_x(t,f;h) = \int_{-\infty}^{+\infty} x(u)h(u-t)e^{-j2\pi fu}\,du \qquad (1)$$

Where $h(t)$ is a short time analysis window localized around $t = 0$ and $f = 0$. Because multipli-cation by the relatively short window $h(u-t)$ effectively suppresses the signal outside a neighborhood around the analysis point $u = t$, the STFT is a 'local' spectrum of the signal $x(u)$ around t. Think of the window $h(t)$ as sliding along the signal $x(u)$ and for each shift $h(u-t)$ we compute the usual Fourier transform of the product function $x(u)h(u-t)$. The observation window allows localization of the spectrum in time, but also smears the spectrum in frequency in accordance with the uncertainty principle, leading to a trade-off between time resolution and frequency resolution. In general, if the window is short, the time resolution is good, but the frequency resolution is poor, and if the window is long,

Author α: Air Force Research Laboratory Rome, NY 13441. e-mail: daniel.stevens.7@us.af.mil
Author σ: Department of Electrical and Computer Engineering, Clarkson University Potsdam, NY 13699. e-mail: sschucke@clarkson.edu

[1] Approved for Public Release; Distribution Unlimited : 88ABW-2016 2140 20160428

Global Journal of Researches in Engineering (J) Volume XVI Issue II Version I Year 2016

the frequency resolution is good, but the time resolution is poor.

The STFT was the first tool devised for analyzing a signal in both time and frequency simultaneously. For analysis of human speech, the main method was, and still is, the STFT. In general, the STFT is still the most widely used method for studying non-stationary signals [COH95].

The Spectrogram (the squared modulus of the STFT) is given by equation 2 as:

$$S_x(t,f) = \left| \int_{-\infty}^{+\infty} x(u)\, h(u-t) e^{-j2\pi f u}\, du \right|^2 \qquad (2)$$

The Spectrogram is a real-valued and non-negative distribution. Since the window h of the STFT is assumed of unit energy, the Spectrogram satisfies the global energy distribution property. Thus we can interpret the Spectrogram as a measure of the energy of the signal contained in the time-frequency domain centered on the point (t, f) and whose shape is independent of this localization.

Here are some properties of the Spectrogram: 1) Time and Frequency covariance - The Spectrogram preserves time and frequency shifts, thus the spectrogram is an element of the class of quadratic time-frequency distributions that are covariant by translation in time and in frequency (i.e. Cohen's class); 2) Time-Frequency Resolution - The time-frequency resolution of the Spectrogram is limited exactly as it is for the STFT; there is a trade-off between time resolution and frequency resolution. This poor resolution is the main drawback of this representation; 3) Interference Structure - As it is a quadratic (or bilinear) representation, the Spectrogram of the sum of two signals is not the sum of the two Spectrograms (quadratic superposition principle); there is a cross-Spectrogram part and a real part. Thus, as for every quadratic distribution, the Spectrogram presents interference terms; however, those interference terms are restricted to those regions of the time-frequency plane where the signals overlap. Thus if the signal components are sufficiently distant so that their Spectrograms do not overlap significantly, then the interference term will nearly be identically zero [ISI96], [COH95], [HLA92].

The Scalogram is defined as the magnitude squared of the wavelet transform, and can be used as a time-frequency distribution [COH02], [GAL05], [BOA03].

The idea of the wavelet transform (equation (3)) is to project a signal x on a family of zero-mean functions (the wavelets) deduced from an elementary function (the mother wavelet) by translations and dilations:

$$T_x(t,a;\Psi) = \int_{-\infty}^{+\infty} x(s)\Psi_{t,a}^{*}(s)ds \qquad (3)$$

Where $\Psi_{t,a}(s) = |a|^{-1/2}\Psi\left(\frac{s-t}{a}\right)$. The variable a corresponds to a scale factor, in the sense that taking $|a| > 1$ dilates the wavelet Ψ and taking $|a| < 1$ compresses Ψ. By definition, the wavelet transform is more a time-scale than a time-frequency representation. However, for wavelets which are well localized around a non-zero frequency ν_0 at a scale $= 1$, a time-frequency interpretation is possible thanks to the formal identification $\nu = \frac{\nu_0}{a}$.

The wavelet transform is of interest for the analysis of non-stationary signals, because it provides still another alternative to the STFT and to many of the quadratic time-frequency distributions. The basic difference between the STFT and the wavelet transform is that the STFT uses a fixed signal analysis window, whereas the wavelet transform uses short windows at high frequencies and long windows at low frequencies. This helps to diffuse the effect of the uncertainty principle by providing good time resolution at high frequencies and good frequency resolution at low frequencies. This approach makes sense especially when the signal at hand has high frequency components for short durations and low frequency components for long durations. The signals encountered in practical applications are often of this type.

The wavelet transform allows localization in both the time domain via translation of the mother wavelet, and in the scale (frequency) domain via dilations. The wavelet is irregular in shape and compactly supported, thus making it an ideal tool for analyzing signals of a transient nature; the irregularity of the wavelet basis lends itself to analysis of signals with discontinuities or sharp changes, while the compactly supported nature of wavelets enables temporal localization of a signal's features [BOA03]. Unlike many of the quadratic functions such as the Wigner-Ville Distribution (WVD) and Choi-Williams Distribution (CWD), the wavelet transform is a linear transformation, therefore cross-term interference is not generated. There is another major difference between the STFT and the wavelet transform; the STFT uses sines and cosines as an orthogonal basis set to which the signal of interest is effectively correlated against, whereas the wavelet transform uses special 'wavelets' which usually comprise an orthogonal basis set. The wavelet transform then computes coefficients, which represents a measure of the similarities, or correlation, of the signal with respect to the set of wavelets. In other words, the wavelet transform of a signal corresponds to its decomposition with respect to a family of functions obtained by dilations (or contractions) and translations (moving window) of an analyzing wavelet.

A filter bank concept is often used to describe the wavelet transform. The wavelet transform can be interpreted as the result of filtering the signal with a set of bandpass filters, each with a different center frequency [GRI08], [FAR96],[SAR98], [SAT98].

Like the design of conventional digital filters, the design of a wavelet filter can be accomplished by using a number of methods including weighted least squares [ALN00], [GOH00], orthogonal matrix methods [ZAH99], nonlinear optimization, optimization of a single parameter (e.g. the passband edge) [ZHA00], and a method that minimizes an objective function that bounds the out-of-tile energy [FAR99].

Here are some properties of the wavelet transform: 1) The wavelet transform is covariant by translation in time and scaling. The corresponding group of transforms is called the Affine group; 2) The signal x can be recovered from its wavelet transform via the synthesis wavelet; 3) Time and frequency resolutions, like in the STFT case, are related via the Heisenberg-Gabor inequality. However in the wavelet transform case, these two resolutions depend on the frequency: the frequency resolution becomes poorer and the time resolution becomes better as the analysis frequency grows;4) Because the wavelet transform is a linear transform, it does not contain cross-term interferences [GRI07], [LAR92].

A similar distribution to the Spectrogram can be defined in the wavelet case. Since the wavelet transform behaves like an orthonormal basis decomposition, it can be shown that it preserves energy:

$$\iint_{-\infty}^{+\infty} |T_x(t,a;\Psi)|^2 \; dt\frac{da}{a^2} = E_x \qquad (4)$$

where E_x is the energy of x . This leads us to define the Scalogram (equation (4)) of x as the squared modulus of the wavelet transform. It is an energy distribution of the signal in the time-scale plane, associated with the measure $\frac{da}{a^2}$.

As is the case for the wavelet transform, the time and frequency resolutions of the Scalogram are related via the Heisenberg-Gabor principle.

The interference terms of the Scalogram, as for the spectrogram, are also restricted to those regions of the time-frequency plane where the corresponding signals overlap. Therefore, if two signal components are sufficiently far apart in the time-frequency plane, their cross-Scalogram will be essentially zero [ISI96], [HLA92].

For this paper, the Morlet Scalogram will be used. The Morlet wavelet is obtained by taking a complex sine wave and by localizing it with a Gaussian envelope. The Mexican hat wavelet isolates a single bump of the Morlet wavelet. The Morlet wavelet has good focusing in both time and frequency [CHE09].

II. Methodology

The methodologies detailed in this section describe the processes involved in obtaining and comparing metrics between the classical time-frequency analysis techniques of the Spectrogram and the Scalogram for the detection and characterization of low probability of intercept frequency hopping radar signals.

The tools used for this testing were: MATLAB (version 7.12), Signal Processing Toolbox (version 6.15), Wavelet Toolbox (version 4.7), Image Processing Toolbox (version 7.2), Time-Frequency Toolbox (version 1.0) (http://tftb.nongnu.org/).

All testing was accomplished on a desktop computer (HP Compaq, 2.5GHz processor, AMD Athlon 64X2 Dual Core Processor 4800+, 2.00GB Memory (RAM), 32 Bit Operating System).

Testing was performed for 2 different waveforms (4 component frequency hopping, 8 component frequency hopping). For each waveform, parameters were chosen for academic validation of signal processing techniques. Due to computer processing resources they were not meant to represent real-world values. The number of samples for each test was chosen to be 512, which seemed to be the optimum size for the desktop computer. Testing was performed at three different SNR levels: 10dB, 0dB, and the lowest SNR at which the signal could be detected. The noise added was white Gaussian noise, which best reflects the thermal noise present in the IF section of an intercept receiver [PAC09]. Kaiser windowing was used, when windowing was applicable. 50 runs were performed for each test, for statistical purposes. The plots included in this paper were done at a threshold of 5% of the maximum intensity and were linear scale (not dB) of analytic (complex) signals; the color bar represented intensity. The signal processing tools used for each task were the Spectrogram and the Scalogram.

Task 1 consisted of analyzing a frequency hopping (prevalent in the LPI arena [AMS09]) 4-component signal whose parameters were: sampling frequency=5KHz; carrier frequencies=1KHz, 1.75KHz, 0.75KHz, 1.25KHz; modulation bandwidth=1KHz; modulation period=.025sec.

Task 2 was similar to Task 1, but for a frequency hopping 8-component signal whose parameters were: sampling frequency=5KHz; carrier frequencies=1.5 KHz, 1KHz, 1.25KHz, 1.5KHz, 1.75KHz, 1.25KHz, 0.75KHz, 1KHz; modulation bandwidth=1KHz; modulation period=.0125sec.

After each particular run of each test, metrics were extracted from the time-frequency representation. The different metrics extracted were as follows:

1) *Plot (processing) time:* Time required for plot to be displayed.
2) *Percent detection:* Percent of time signal was detected - signal was declared a detection if any portion of each of the signal components (4 or 8 signal components for frequency hopping) exceeded a set threshold (a certain percentage of

Global Journal of Researches in Engineering (J) Volume XVI Issue II Version I Year 2016

the maximum intensity of the time-frequency representation).

Threshold percentages were determined based on visual detections of low SNR signals (lowest SNR at which the signal could be visually detected in the time-frequency representation) (see Figure 1).

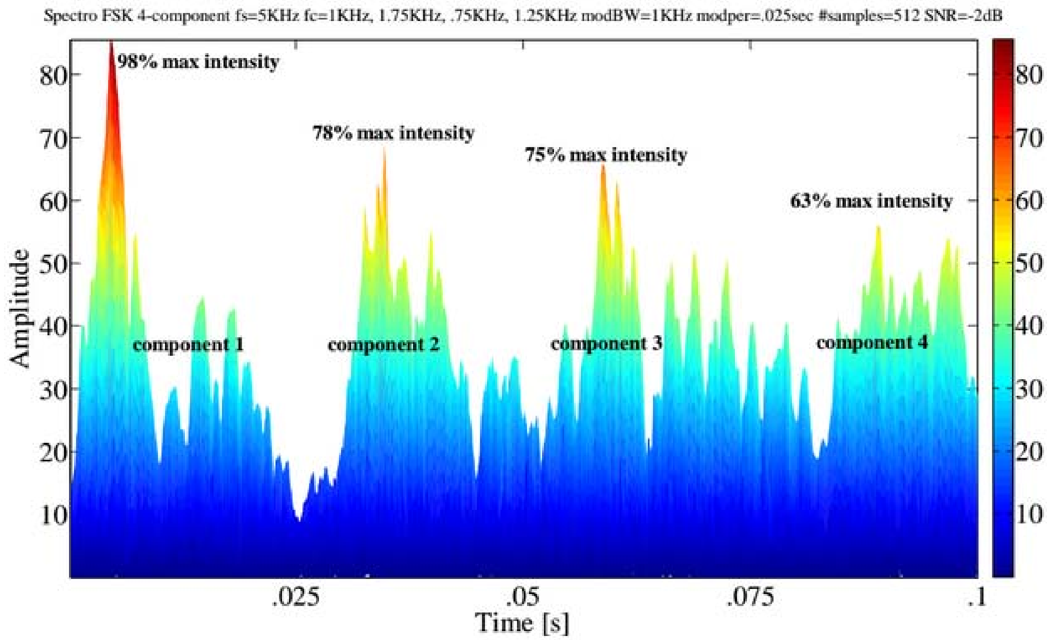


Figure 1 : Threshold percentage determination. This plot is an amplitude vs. time (x-z view) of the Spectrogram of a frequency hopping 4-component signal (512 samples, SNR= -2dB). For visually detected low SNR plots (like this one), the percent of max intensity for the peak z-value of each of the signal components was noted (here 98%, 78%, 75%, 63%), and the lowest of these 4 values was recorded (63%). Ten test runs were performed for both time-frequency analysis tools (Spectrogram and Scalogram) for this waveform. The average of these recorded low values was determined and then assigned as the threshold for that particular time-frequency analysis tool. Note - the threshold for the Spectrogram is 60%.

Thresholds were assigned as follows: Spectrogram (60%); Scalogram (50%).

For percent detection determination, these threshold values were included in the time-frequency plot algorithms so that the thresholds could be applied automatically during the plotting process. From the threshold plot, the signal was declared a detection if any portion of each of the signal components was visible (see Figure 2).

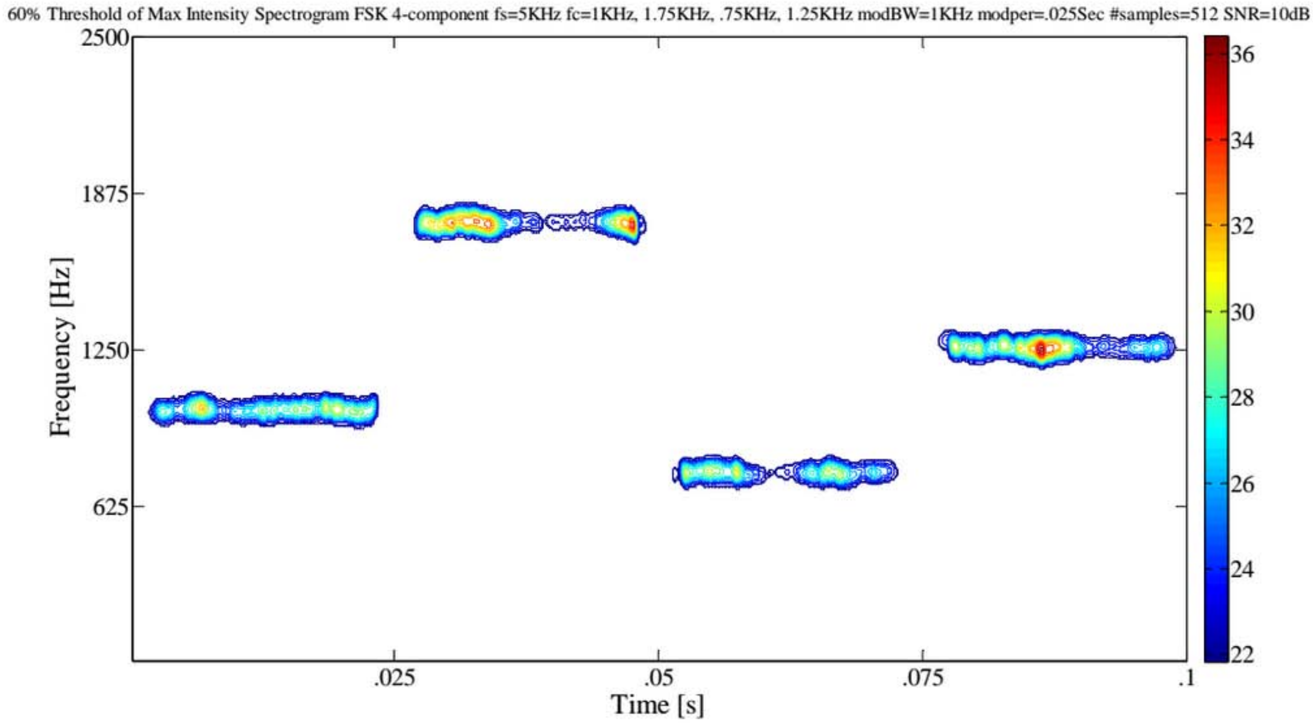


Figure 2 : Percent detection (time-frequency). Spectrogram of 4-component frequency hopping signal (512 samples, SNR=10dB) with threshold value automatically set to 60%. From this threshold plot, the signal was declared a (visual) detection because at least a portion of each of the 4 FSK signal components was visible.

3) *Carrier frequency:* The frequency corresponding to the maximum intensity of the time-frequency representation (there are multiple carrier frequencies (4 or 8) for the frequency hopping waveforms).

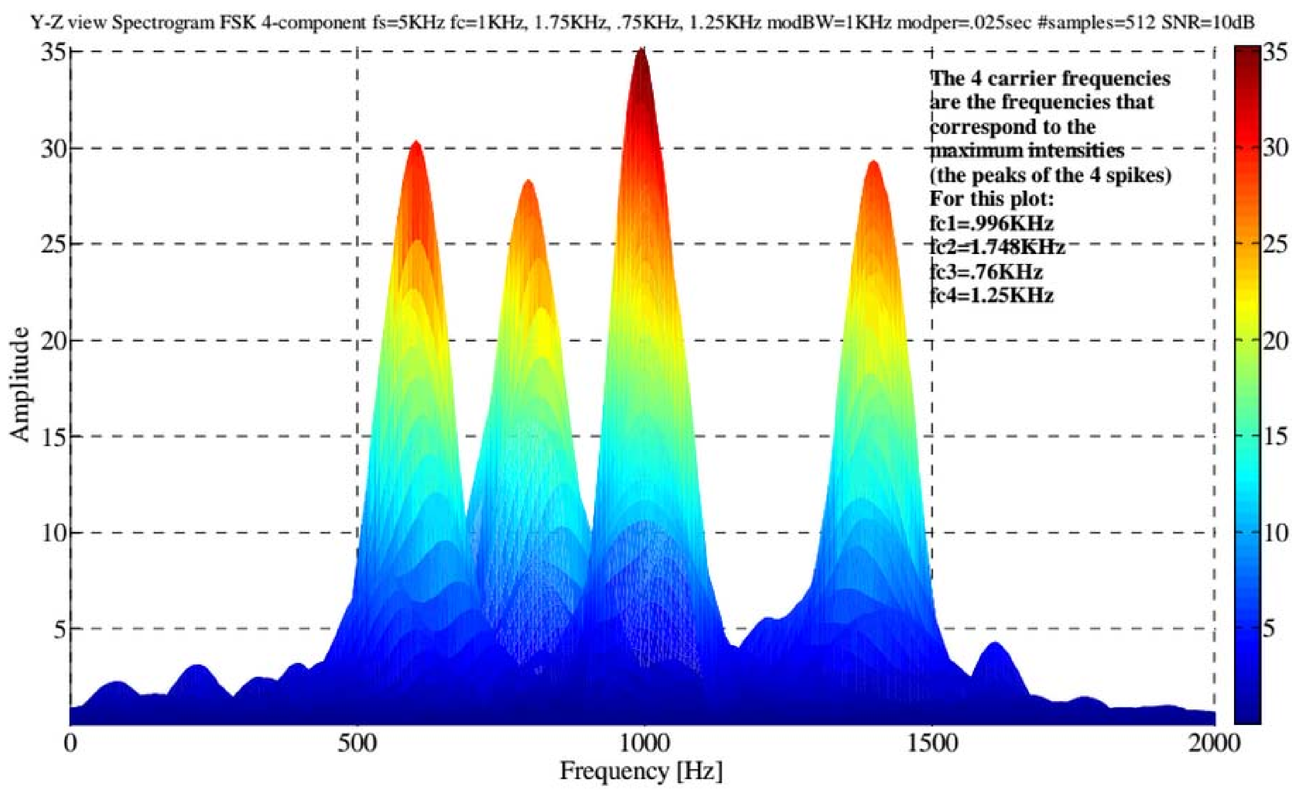


Figure 3: Determination of carrier frequency. Spectrogram of a 4-component frequency hopping signal (512 samples, SNR=10dB). From the frequency-intensity (y-z) view, the 4 maximum intensity values (1 for each carrier

Global Journal of Researches in Engineering (J) Volume XVI Issue II Version I Year 2016

frequency) are manually determined. The frequencies corresponding to those 4 max intensity values are the 4 carrier frequencies (for this plot fc1=996 Hz, fc2=1748Hz, fc3=760Hz, fc4=1250Hz).

4) *Modulation bandwidth:* Distance from highest frequency value of signal (at a threshold of 20% maximum intensity) to lowest frequency value of signal (at same threshold) in Y-direction (frequency).

The threshold percentage was determined based on manual measurement of the modulation bandwidth of the signal in the time-frequency representation. This was accomplished for ten test runs of each time-frequency analysis tool (Spectrogram and Scalogram), for each of the 2 waveforms. During each manual measurement, the max intensity of the high and low measuring points was recorded. The average of the max intensity values for these test runs was 20%. This was adopted as the threshold value, and is representative of what is obtained when performing manual measurements. This 20% threshold was also adapted for determining the modulation period and the time-frequency localization (both are described below).

For modulation bandwidth determination, the 20% threshold value was included in the time-frequency plot algorithms so that the threshold could be applied automatically during the plotting process. From the threshold plot, the modulation bandwidth was manually measured (see Figure 4).

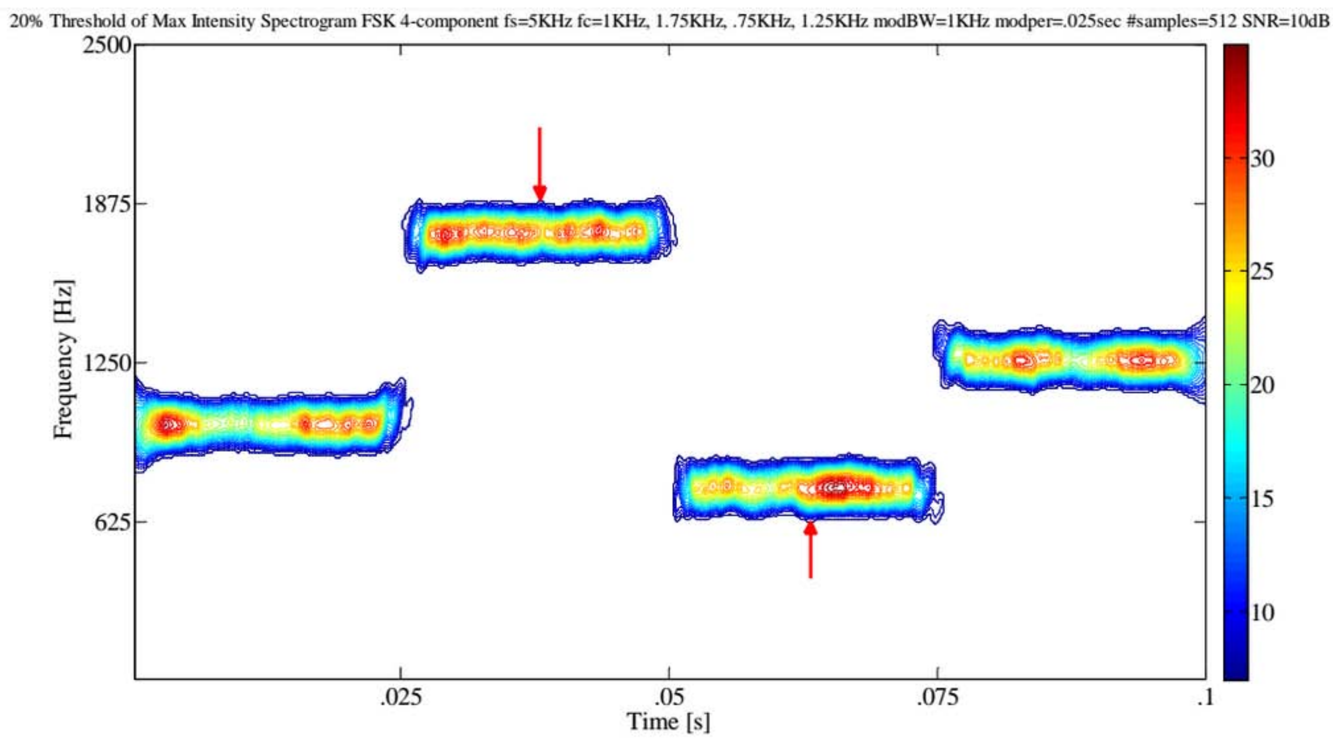


Figure 4 : Modulation bandwidth determination. Spectrogram of a 4-component frequency hopping signal (512 samples, SNR=10dB) with threshold value automatically set to 20%. From this threshold plot, the modulation bandwidth was measured manually from the highest frequency value of the signal (top red arrow) to the lowest frequency value of the signal (bottom red arrow) in the y-direction (frequency).

5) *Modulation period:* From Figure 5 (which is at a threshold of 20% maximum intensity), the modulation period is the manual measurement of the width of each of the 4 frequency hopping signals in the x-direction (time), and then the average of the 4 signals is calculated.

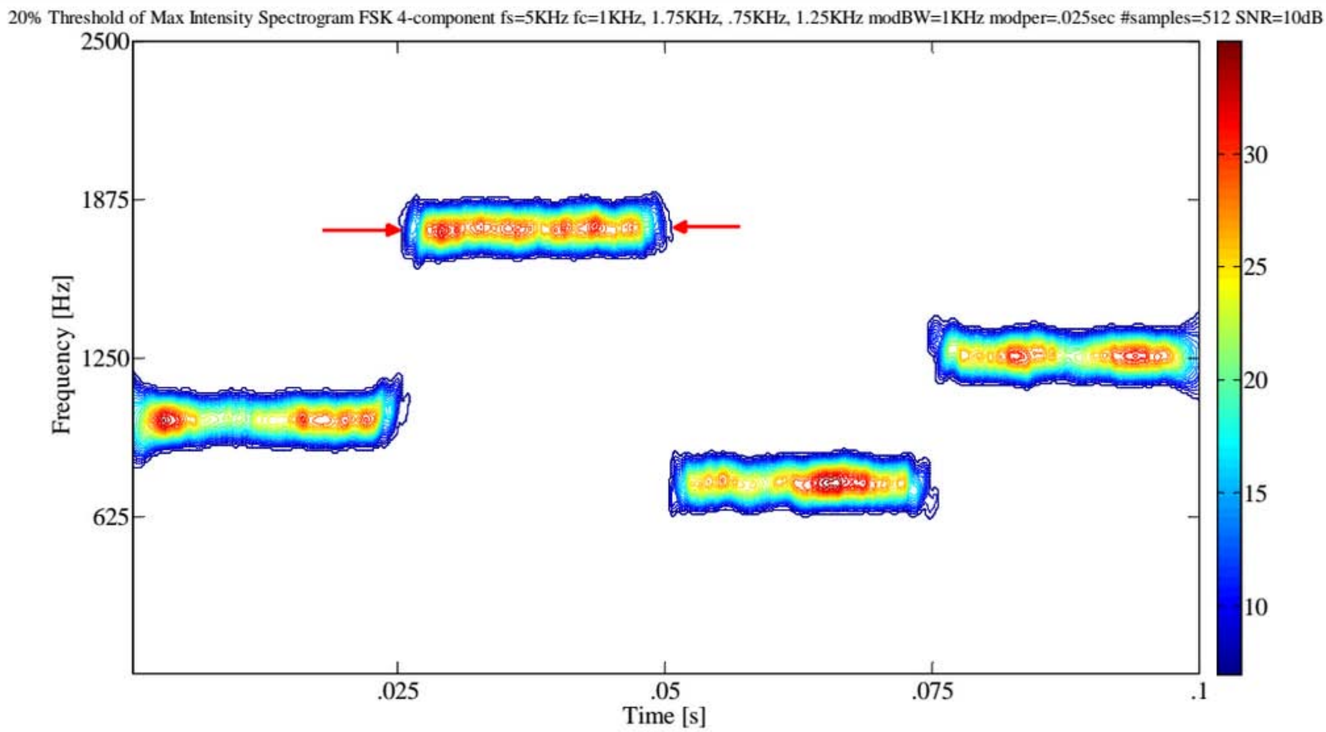


Figure 5 : Modulation period determination. Spectrogram of a 4-component frequency hopping signal (512 samples, SNR=10dB) with threshold value automatically set to 20%. From this threshold plot, the modulation period was measured manually from the left side of the signal (left red arrow) to the right side of the signal (right red arrow) in the x-direction (time). This was done for all 4 signal components, and the average value was determined.

6) *Time-frequency localization:* From Figure 6, the time-frequency localization is a manual measurement (at a threshold of 20% maximum intensity) of the 'thickness' (in the y-direction) of the center of each of the 4 frequency hopping signal components, and then the average of the 4 values are determined. The average frequency 'thickness' is then converted to: percent of the entire y-axis.

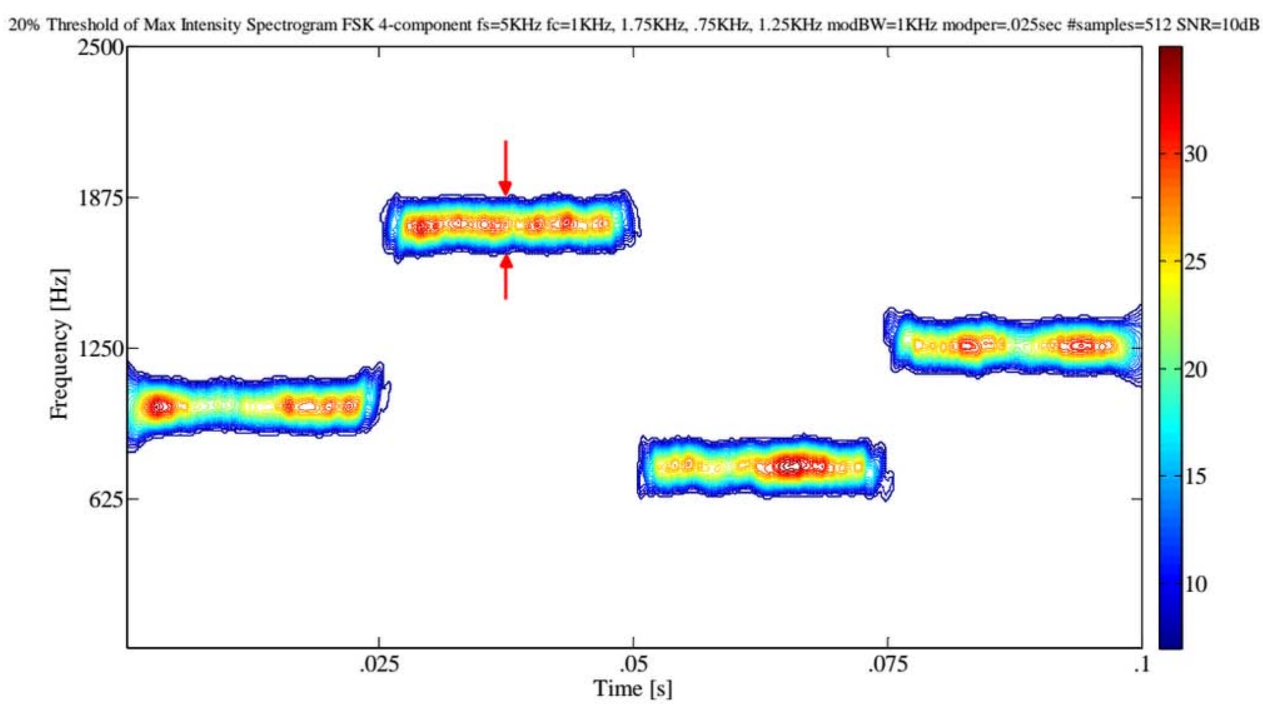


Figure 6 : Time-frequency localization determination for the Spectrogram of a 4-component frequency hopping signal (512 samples, SNR=10dB) with threshold value automatically set to 20%. From this threshold plot, the time-

frequency localization was measured manually from the top of the signal (top red arrow) to the bottom of the signal (bottom red arrow) in the y-direction (frequency). This frequency 'thickness' value was then converted to: % of entire y-axis.

7) *Lowest detectable SNR:* The lowest SNR level at which at least a portion of each of the signal components exceeded the set threshold listed in the percent detection section above.

For lowest detectable SNR determination, these threshold values were included in the time-frequency plot algorithms so that the thresholds could be applied automatically during the plotting process. From the threshold plot, the signal was declared a detection if any portion of each of the signal components was visible. The lowest SNR level for which the signal was declared a detection is the lowest detectable SNR (see Figure 7).

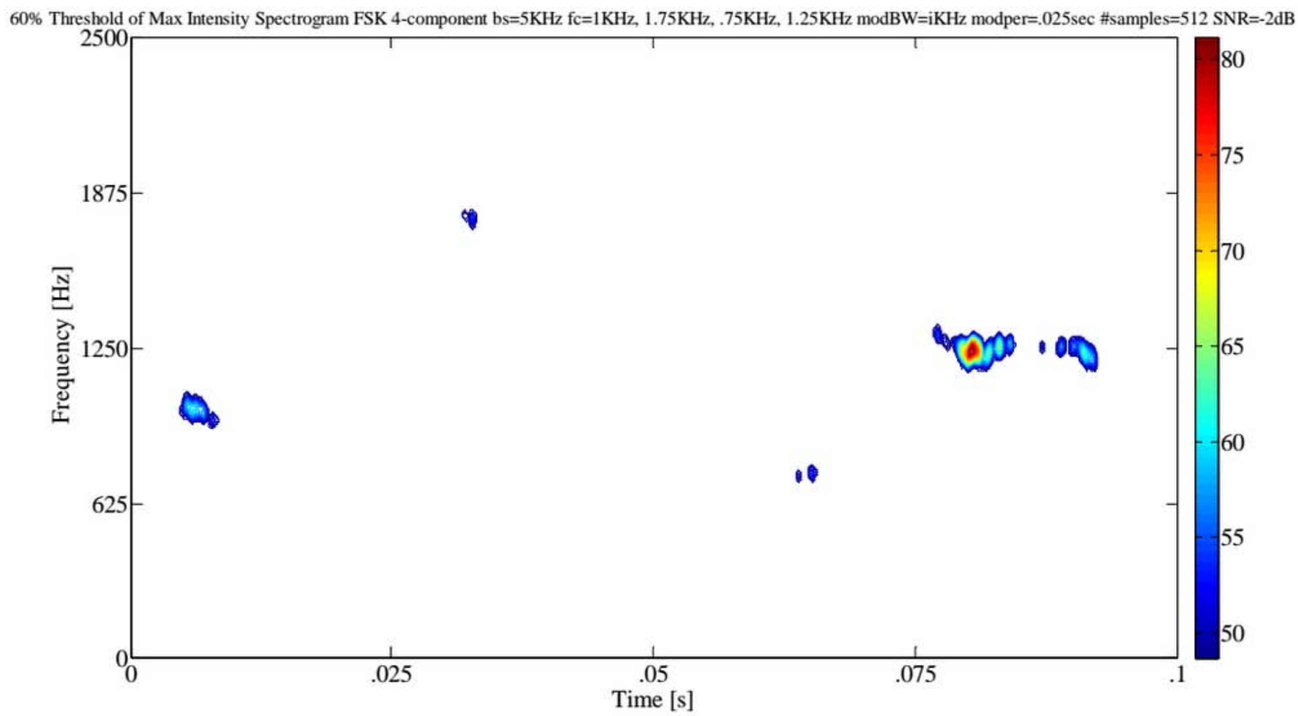


Figure 7 : Lowest detectable SNR. Spectrogram of 4-component frequency hopping signal (512 samples, SNR=-2dB) with threshold value automatically set to 60%. From this threshold plot, the signal was declared a (visual) detection because at least a portion of each of the 4 frequency hopping signal components was visible. For this case, any lower SNR would have been a non-detect. Compare to Figure 2, which is the same plot, except that it has an SNR level equal to 10dB.

The data from all 50 runs for each test was used to produce the actual, error, and percent error for each of these metrics listed above.

The metrics from the Spectrogram were then compared to the metrics from the Scalogram. By and large, the Scalogram outperformed the Spectrogram, as will be shown in the results section.

III. Results

Table 1 presents the overall test metrics for the two classical time-frequency analysis techniques used in this testing (Spectrogram versus Scalogram).

Table 1 : Overall test metrics (average percent error: carrier frequency, modulation bandwidth, modulation period, time-frequency localization-y; average: percent detection, lowest detectable snr, plot time) for the two classical time-frequency analysis techniques (Spectrogram versus Scalogram).

parameters	Spectrogram	Scalogram
carrier frequency	0.67%	0.44%
modulation bandwidth	25.70%	21.62%
modulation period	11.37%	10.25%
time-frequency localization-y	9.77%	9.44%

percent detection	69.67%	80.84%
lowest detectable snr	-2.0db	-3.0db
Plot time	3.43s	5.62s

From Table 1, the Scalogram outperformed the Spectrogram in average percent error: carrier frequency (0.44% vs. 0.67%), modulation bandwidth (21.62% vs. 25.70%), modulation period (10.25% vs. 11.37%), and time-frequency localization (y-direction) (9.44% vs. 9.77%);and in average: percent detection (80.84% vs. 69.67%), and lowest detectable SNR (-3.0db vs. -2.0db), while the Spectrogram outperformed the Scalogram in average plot time (3.43s vs. 5.62s).

Figure 8 shows comparative plots of the Spectrogram vs. the Scalogram (4 component frequency hopping) at SNRs of 10dB (top), 0dB (middle), and -3dB (bottom).

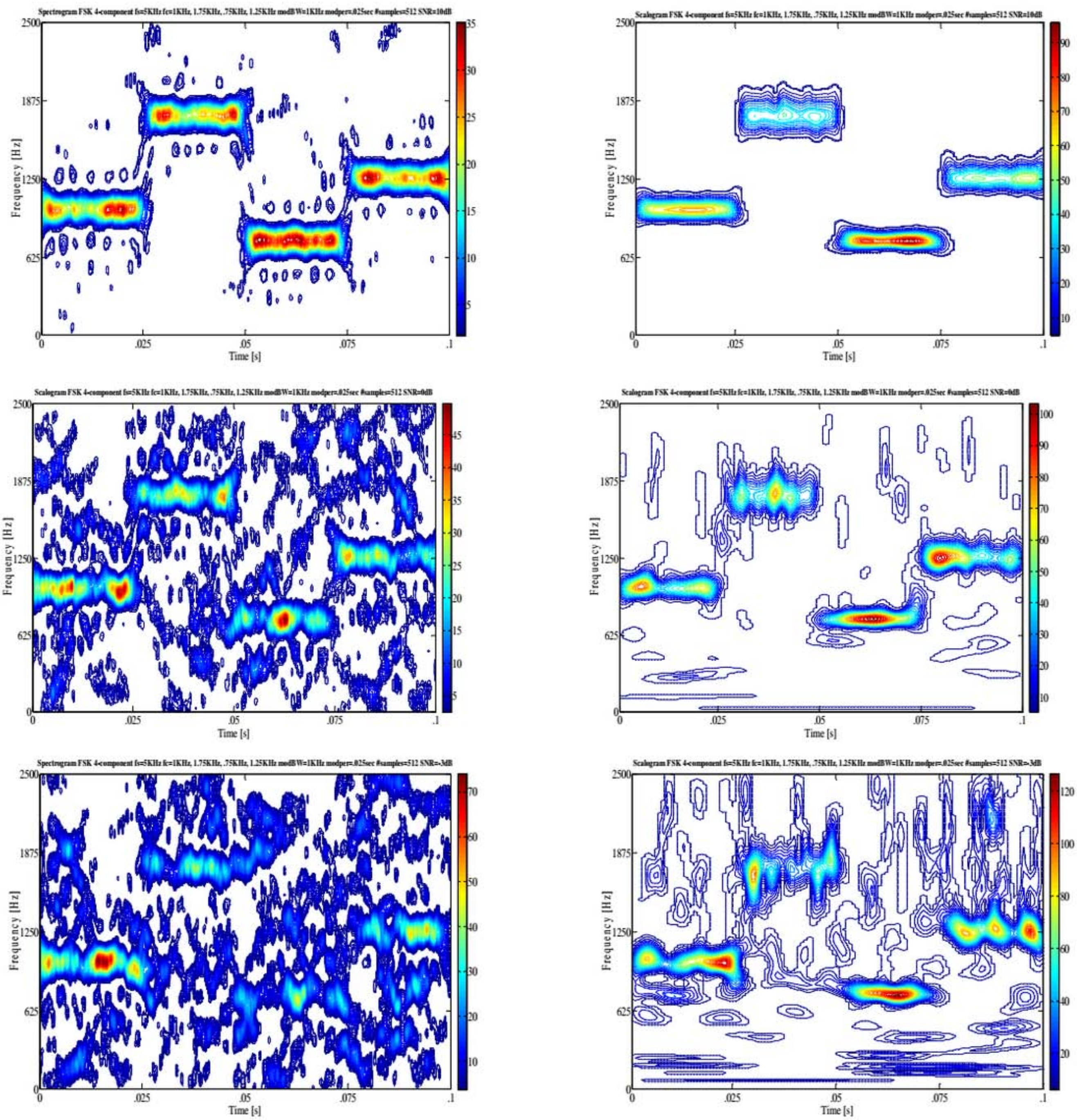


Figure 8 : Comparative plots of the 4-component frequency hopping low probability of intercept radar signals (Spectrogram (left-hand side) vs. the Scalogram (right-hand side)). The SNR for the top row is 10dB, for the middle

row is 0dB, and for the bottom row is -3dB. In general, the Scalogram signals appear more localized ('thinner') than do the Spectrogram signals. In addition, the Scalogram signals appear more readable than the Spectrogram signals at every SNR level.

Figure 9 shows comparative plots of the Spectrogram vs. the Scalogram (8 component frequency hopping) at SNRs of 10dB (top), 0dB (middle), and -3dB (bottom).

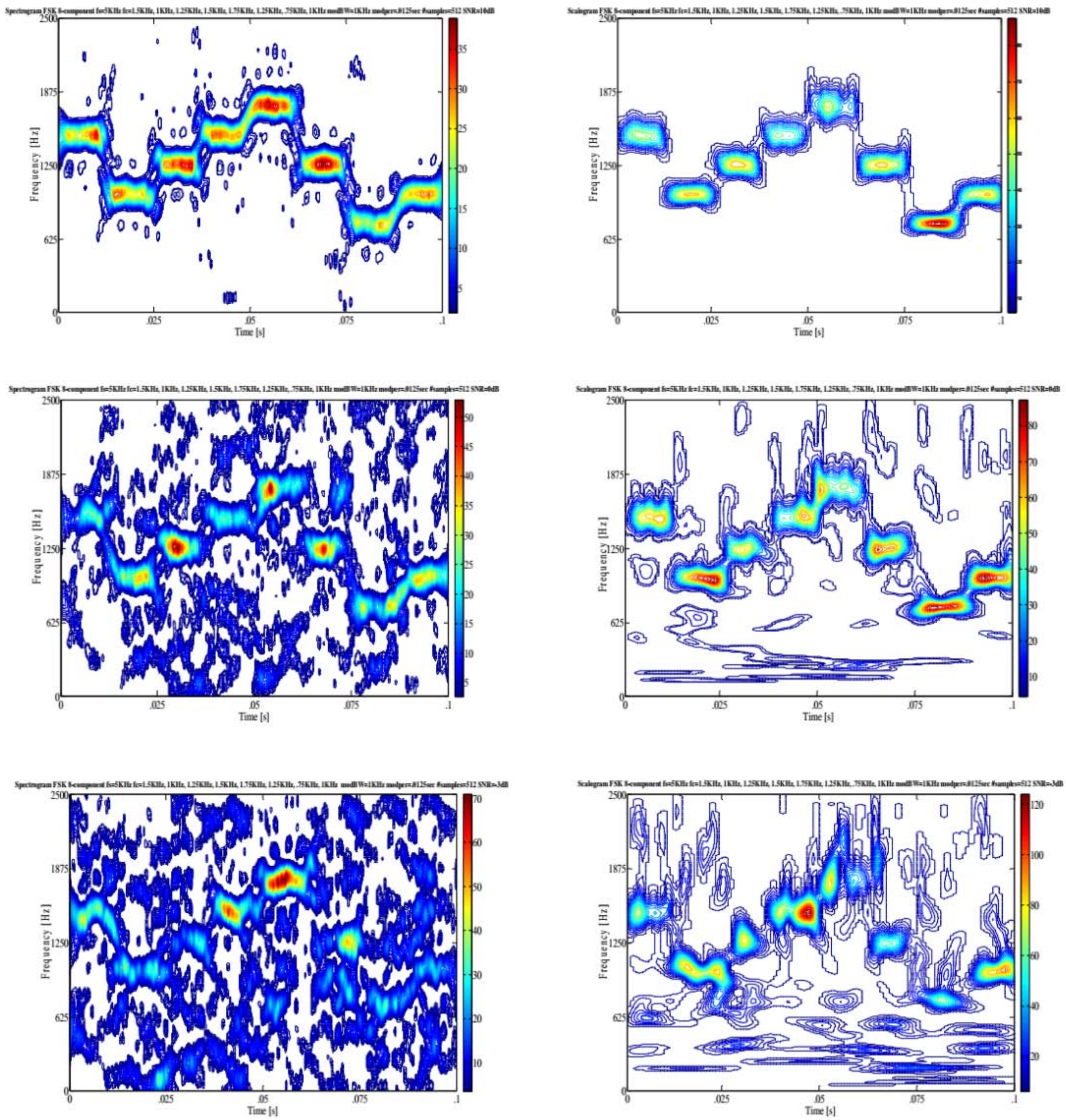


Figure 9 : Comparative plots of the 8-component frequency hopping low probability of intercept radar signals (Spectrogram (left-hand side) vs. the Scalogram (right-hand side)). The SNR for the top row plots is 10dB, for the middle row plots is 0dB, and for the bottom row plots is -3dB (which is a non-detect for the Spectrogram).In general, the Scalogram signals appear more localized ('thinner') than do the Spectrogram signals. In addition, the Scalogram signals appear more readable than the Spectrogram signals at every SNR level.

IV. Discussion

This section will elaborate on the results from the previous section.

From Table 1, the performance of the Spectrogram and the Scalogram will be summarized, including strengths, weaknesses, and generic scenarios in which each particular signal analysis tool might be used.

Spectrogram: The Spectrogram outperformed the Scalogram in average plot time (3.43s vs 5.62s). However, the Spectrogram was outperformed by the Scalogram in every other category. The Spectrogram's extreme reduction of cross-term interference is grounds for its good plot time, but at the expense of signal localization (i.e. it produces a 'thicker' signal (as is seen in Figure 8 and Figure 9) – due to the trade-off between cross-term interference and signal localization). This poor signal localization ('thicker' signals) can account for the Spectrogram being outperformed in the areas of average percent error of modulation bandwidth, modulation period, and time-frequency localization (y-direction). The spectrogram might be used in a scenario where a short plot time is necessary, and where signal localization is not an issue. Such a scenario might be a 'quick and dirty' check to see if a signal is present, without precise extraction of its parameters.

Scalogram: The Scalogram outperformed the Spectrogram in every category but plot time. Because of the Spectrogram's extreme reduction of cross-terms at the expense of signal localization (i.e. it produces a 'thicker' signal), the Scalogram was more localized than the Spectrogram, accounting for its better performance in the areas of average percent error of modulation bandwidth, modulation period, and time-frequency localization (y-direction). In addition, since the compactly supported nature of thewavelet (basis of Scalogram) enables temporal localization of a signal's features, this may also have contributed to the the Scalogram's better average percent error of modulation period. Average percent detection and lowest detectable SNR are both based on visual detection in the Time-Frequency representation. Figures 8 and 9 clearly show that the signals in the Scalogram plots are more readable than those in the Spectrogram plots, which accounts for the Scalogram's better average percent detection and lowest detectable SNR. Since the irregularity of the wavelet basis (basis of Scalogram) lends itself to analysis of signals with discontinuities (such as the frequency hopping signals used in this testing), this may have been a contributing factor to the Scalogram's better overall performance versus the Spectrogram. Also, since the wavelet is irregular in shape and compactly supported, it makes it an ideal tool for analyzing signals of transient nature (such as the frequency hopping signals used in this testing), which may also have been a contributing factor to the Scalogram's better overall perfromance. The scalogram might be used in a scenario where you need good signal localization in a fairly low SNR environment, without tight time constraints.

V. Conclusions

Digital intercept receivers, whose main job is to detect and extract parameters from low probability of intercept radar signals, are currently moving away from Fourier-based analysis and towards classical time-frequency analysis techniques, such as the Spectrogram, and Scalogram, for the purpose of analyzing low probability of intercept radar signals. Based on the research performed for this paper (the novel direct comparison of the Spectrogram versus the Scalogram for the signal analysis of low probability of intercept frequency hopping radar signals) it was shown that the Scalogram by-and-large outperforms the Spectrogram for analyzing these low probability of intercept radar signals - for reasons brought out in the discussion section above. More accurate characterization metrics could well translate into saved equipment and lives.

Future plans include analysis of an additional low probability of intercept radar waveform (triangular modulated FMCW), again using the Spectrogram and the Scalogram as time-frequency analysis techniques.

References Références Referencias

1. [ADA04] Adamy, D., EW 102: A Second Course in Electronic Warfare. Artech House, Norwood, MA, 2004.
2. [ALN00] Al-Namiy, F., Nigam, M., On the Design of 2-Band FIR QMF Filter Banks Using WLS Techniques. Proceedings of the Fourth IEEE International Conference on High Performance Computing in the Asia-Pacific Region, Vol. 2, pp. 772-776, May 2000.
3. [AMS09] Anjaneyulu, L., Murthy, N., Sarma, N., Identification of LPI Radar Signal Modulation using Bi-coherence Analysis and Artificial Neural Networks Techniques. NCC 2009, IIT Guwahati, pp. 19-22, January 16-18, 2009.
4. [ANJ09] Anjaneyulu, L., Murthy, N., Sarma, N., A Novel Method for Recognition of Modulation Code of LPI Radar Signals. International Journal of Recent Trends in Engineering, Vol. 1, No. 3, pp. 176-180, May 2009.
5. [BOA03] Boashash, B., Time Frequency Signal Analysis and Processing: A Comprehensive Reference. Elsevier, Oxford, England, 2003.
6. [CHE09] Chen, C., He, M., Jin, H., Li, H., Shen, Z., A Novel Method for Extraction of In-Pulse Feature of Multi-Component LFM Signal. ICEMI 2009, pp. 4-627 – 4-630, 2009.

7. [COH02] Cohen, L., The Wavelet Transform and Time-Frequency Analysis. in: Debnath, L., Wavelet Transforms and Signal Processing, Birkhauser, pp. 3-22, 2002.
8. [COH95] Cohen, L., Time-Frequency Analysis. Prentice Hall, Upper Saddle River, NJ, 1995.
9. [FAR96] Farrell, T.C., Prescott, G., A Low Probability of Intercept Signal Detection Receiver Using Quadrature Mirror Filter Bank Trees. IEEE Proceedings, pp. 1558-1561, 1996.
10. [FAR99] Farrell, T., Prescott, G., A Method for Finding Orthogonal Wavelet Filters with Good Energy Tiling Characteristics. IEEE Transactions on Signal Processing, Vol. 47, No. 1, pp. 220-223, Jan. 1999.
11. [GAL05] Galleani, L., Cohen, L., Noga, A., A Time-Frequency Approach to the Adjustable Bandwidth Concept. Digital Signal Processing, Vol. 16, Issue 5, pp. 454-467, Sept. 2006.
12. [GOH00] Goh, C., Lim, T., A WLS Algorithm for the Design of Low-Delay Quadrature Mirror Filter Banks. Proceedings of the IEEE International Symposium on Circuits and Systems, Vol. 1, pp. 615-618, May 2000.
13. [GRI07] Grishin, Y., Janczak, D., Computer-Aided Methods of the LPI Radar Signal Detection and Classification. Proc. of SPIE Vol. 6937, pp. 1-5, 2007.
14. [GRI08] Grishin, Y., Interferences Excision Via Time-Frequency Distribution in Radio Communication Systems. EMD 2008, XVIII-th International Conference on Electromagnetic Disturbances, Vilnius, Lithuania, pp. 85-88, 25-26 September 2008.
15. [GUL08] Gulum, T., Pace, P., Cristi, R., Extraction of Polyphase Radar Modulation Parameters Using a Wigner-Ville Distribution-Radon Transform. IEEE International Conference on Acoustics, Speech, and Signal Processing, Las Vegas, NV, April 2008.
16. [HAN00] Han, S., Hong, H., Seo, D., Choi, J., Target Position Extraction Based on Instantaneous Frequency Estimation in a Fixed-Reticle Seeker. Opt. Eng., Vol. 39, pp. 2568-2573, September 2000.
17. [HIP00] Hippenstiel, R., Fargues, M., Moraitakis, I., Williams, C., Detection and Parameter Estimation of Chirped Radar Signals. Final Report, Naval Postgraduate School, Monterey, CA, Jan. 10, 2000.
18. [HLA92] Hlawatsch, F., Boudreaux-Bartels, G.F., Linear and Quadratic Time-Frequency Signal Representations. IEEE Signal Processing Mag., Vol. 9, No. 2, pp. 21-67, April 1992.
19. [ISI96] Auger, F., Flandrin, P., Goncalves, P., Lemoine, O., Time-Frequency Toolbox Users Manual. Centre National de la Recherche Scientifique and Rice University, 1996.
20. [LAR92] Lari, F., Zakhor, A., Automatic Classification of Active Sonar Data Using Time-Frequency Transforms. Proceedings of IEEE-SP International Symposium on Time-Frequency and Time-Scale Analysis, Victoria, BC, pp. 21-24, Oct. 4-6, 1992.
21. [LIX08] Li, X., Bi, G., A New Reassigned Time-Frequency Representation. 16th European Signal Processing Conference, Lausanne, Switzerland, pp. 1-4, August 25-29, 2008.
22. [LIY03] Li, Y., Xiao, X., Recursive Filtering Radon-Ambiguity Transform Algorithm for Detecting Multi-LFM Signals. Journal of Electronics (China), Vol. 20, No. 3, pp. 161-166, May 2003.
23. [MIT01] Mitra, S., Digital Signal Processing, A Computer-Based Approach, Second Edition. McGraw-Hill, Boston, MA, 2001.
24. [OZD03] Ozdemir, A., Time-Frequency Component Analyzer. Dissertation, Bilkent University, Ankara, Turkey, Sept. 2003.
25. [PAC09] Pace, P., Detecting and Classifying Low Probability of Intercept Radar. Artech House, Norwood, MA, 2009.
26. [PAP95] Papandreou, A., Boudreaux-Bartels, G.F., Kay, S., Detection and Estimation of Generalized Chirps Using Time-Frequency Representations. 1994 Conference Record of the Twenty-Eighth Asilomar Conference on Signals, Systems and Computers, pp. 50-54, 1994.
27. [RAN01] Rangayyan, R., Krishnan, S., Feature Identification in the Time-Frequency Plane by Using the Hough-Radon Transform. Pattern Recognition, Vol. 34, pp. 1147-1158, 2001.
28. [SAR98] Sarkar, T., Su, C., et al., A Tutorial on Wavelets from an Electrical Engineering Perspective, Part 1: Discrete Wavelet Techniques. IEEE Antennas and Propagation Magazine, Vol. 40, No. 5, pp. 49-70, October 1998.
29. [SAT98] Sarkar, T., Su, C., A Tutorial on Wavelets from an Electrical Engineering Perspective, Part 2: The Continuous Case. IEEE Antennas and Propagation Magazine, Vol. 40, No. 6, pp. 36-49, December 1998.
30. [WEI03] Wei, G., Wu, S., Mao, E., Analysis of Multi-component LFM Signals Using Time-Frequency and The Gray-Scale Inverse Hough Transform. IEEE Workshop on Statistical Signal Processing, pp. 190-193, September 28 – October 1, 2003.
31. [XIA99] Xia, X., Chen, V., A Quantitative SNR Analysis for the Pseudo Wigner-Ville Distribution. IEEE Transactions on Signal Processing, Vol. 47, No. 10, pp. 2891-2894, October, 1999.
32. [ZAH99] Zahhad, A., Sabah, M., Design of Selective M-Channel Perfect Reconstruction FIR Filter Banks. IEE Electronics Letters, Vol. 35, No. 15, pp. 1223-1225, 1999.
33. [ZHA00] Zhang, Z., Jiao, L., A Simple Method for Designing Pseudo QMF Banks. Proceedings of the IEEE International Conference on Communication Technology, Vol. 2, pp. 1538-1541, Aug. 2000.

Global Journals Inc. (US) Guidelines Handbook 2016

www.GlobalJournals.org

Fellows

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (FARSE)

Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSE " title to individuals. The 'FARSE' title is accorded to a selected professional after the approval of the Editor-in-Chief /Editorial Board Members/Dean.

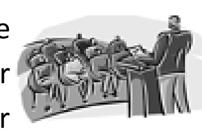
- The "FARSE" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSE or William Walldroff, M.S., FARSE.

FARSE accrediting is an honor. It authenticates your research activities. After recognition as FARSE, you can add 'FARSE' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

The following benefits can be availed by you only for next three years from the date of certification:

FARSE designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSE title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA).The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.

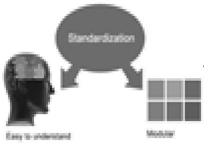


You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

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.

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.



The FARSE will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

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.

The FARSE members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

The FARSE member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

The FARSE is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSE can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSE member can decide its price and we can help in making the right decision.

The FARSE member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (MARSE)

The ' MARSE ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The “MARSE” is a dignified ornament which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., MARSE or William Walldroff, M.S., MARSE.

MARSE accrediting is an honor. It authenticates your research activities. After becoming MARSE, you can add 'MARSE' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

MARSE designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSE, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

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.

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.

It is mandatory to read all terms and conditions carefully.

Auxiliary Memberships

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

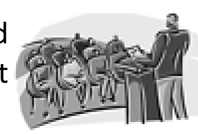
Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

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%.



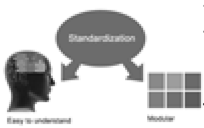
The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

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.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

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.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

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

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- 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 :

"

- 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. "

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

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:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not conveninet , and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

MANUSCRIPT STYLE INSTRUCTION **(Must be strictly followed)**

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, “Abstract” word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript’s Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

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

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

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.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(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.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

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

Format

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.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

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.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

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.

Key Words

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.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

You must strictly follow above Author Guidelines before submitting your paper or else we will not at all be responsible for any corrections in future in any of the way.

Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

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.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

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.

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.
- Do not give permission to anyone else to "PROOFREAD" your manuscript.
- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

CRITERION FOR GRADING A RESEARCH PAPER (COMPILATION) BY GLOBAL JOURNALS INC. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

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

Index

save our planet

Global Journal of Researches in Engineering

Visit us on the Web at www.GlobalJournals.org | www.EngineeringResearch.org
or email us at helpdesk@globaljournals.org

ISSN 9755861