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An Approach to a New Network Security Architecture of Nuclear and Research Facilities

By A.B. Ramadan & M. Hefnawi

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Keywords: computer network, LAN's security, zachaman, information technology (IT), Information systems architecture (ISA).

GJCST-G Classification: C.2.0

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Strictly as per the compliance and regulations of:

An Approach to a New Network Security Architecture of Nuclear and Research Facilities

A.B. Ramadan[α] & M. Hefnawi[σ]

Abstract- With the growth of information technology (IT) systems, network security is rapidly becoming a critical business concern. Due to the interconnectivity of IT systems, a comprehensive description of all of the key elements and relationships that make up an organization's network security is needed, which can be referred as network security architecture. The value of this architecture is often questioned by organizations in terms of its practical application. This paper has presents a new approach to the network security architecture by using the Zachman Framework capabilities. The network security architecture of nuclear and academic facilities academic centers is discussed to show how a conceptual model can be applied to a real organization. This new approach makes any Local Area Network LAN more secure and more flexible than any conventional security procedures without affecting the performance of the LAN. Applying Zachman matrix provides the answers to what data assets the nuclear and research facilities controls, how they are used, and where they are located.

Keywords: computer network, LAN's security, zachaman, information technology (IT), Information systems architecture (ISA).

I. Introduction

The industry is moving toward more formal development and documentation of enterprise architectures based on Enterprise Architecture Frameworks. The term "architecture" has been used for many years within the information technology (IT) community to refer to various types of overviews that provide guidance to software systems and applications developers. The term is obviously a metaphor derived from the building trade [1, 8]. Like a homeowner which is designing a home. Information technology managers work with an architect to provide an agreed upon architectural drawing of the enterprise's information systems and processes. This high-level

Architectural drawing does not change with tactical decisions to deploy improved technology since it is simply built around a framework of business processes and the information that they need [2].

Today, there is a growing movement among both business managers and IT managers to use the term "enterprise architecture" to refer to a comprehensive description of all of the key elements and relationships that make up an organization. Based on this, enterprise information architecture provides a framework for reducing information system complexity and enabling enterprise information sharing. Since most enterprises have existing information systems, the architectural drawing provides the future state and facilitates the best possible strategy to remodel with the least amount of inconvenience to the business [1].

The rapidly growing interconnectivity of IT systems, and the convergence of their technology, renders these systems increasingly vulnerable to malicious attacks. Network attacks cause organizations several hours or days of downtime and serious breaches in data confidentiality and integrity. Depending on the level of the attack and the type of information that has been compromised, the consequences of network attacks vary in degree from mildly annoying to completely debilitating, and the cost of recovery from attacks can range from hundreds to millions of dollars [3].

This paper presents a network security architecture based on the Zachman Framework. The aim of this architecture is to organize the data, process, and technology around the points of view taken by various players instead of representing them as entirely separate entities. For this, we'll consider the Zachman Framework in more detail in Section 2. In Section 3, the relation between network security and the Zachman Framework is discussed. An example for designing security architecture of Nuclear and Research facilities based on the Zachman Framework is presented in this work.

II. The Zachman Framework

The Zachman Framework for Information Systems Architecture (ISA), defined in 1987, is a logical construct to define and control the interfaces and integration of all components of a system. The framework of the Zachman model enables systematic capture of system specific information from the various perspectives with respect to system architecture [4]. Table 1 illustrates the Zachman model, tailored to support a network security system.

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Table 1: The Zachman Framework

	DATA	FUNCTION	NETWORK	PEOPLE	TIME	MOTIVATION
Planner	List of Things Important to the Enterprise	List of Processes	List of Locations	List of Organizational Units	List of Events	List of Business Goals
Owner	Semantic Model	Business Process Model	Network Logistics System	Work Flow Model	Master Schedule	Business Plan
Designer	Logical Data Model	Application Architecture	Distributed System Architecture	Human Interface Architecture	Processing Structure	Business Rule Model
Builder	Physical Data Model	System Design	Technology Architecture	Presentation Architecture	Control Structure	Rule Design
Sub-Contractor	Data Definition	Program	Network Architecture	Security Architecture	Timing Definition	Rule Specification
Functioning	Data	Function	Network	Organization	Schedule	Strategy

In this customization of the model, the system developers have an existing operational system in place. The rows at the top are the most abstract and are oriented toward very broad goals and plans. If we were building a house, this layer would describe the diagrams, pictures, and plans the architect would discuss with the owner. The next level is more specific, but still abstract. These are the diagrams that the architect would discuss with the contractor. In a similar way, the top level of the Zachman Framework, labeled "Scope," is focused on the concerns of senior executives. The second is focused on the slightly more detailed concerns of business managers. A lower level focuses on concerns that business and IS manager's work together on, and then, finally, on a detail that IS managers and developers work on [1]. The columns in the Zachman framework represent different areas of interest for each perspective. The columns describe the dimensions of the systems development effort. The Zachman Framework has two very distinctive features that make it ideal for information modeling. The framework may be applied at any level of abstraction in the system development process, from a global enterprise, to a system, subsystem, or major module level. The framework also gives the modeler latitude in that any data representation technique can be used to model the inner workings of each cell. The system model becomes more implementation specific. However, the requirements traceability between layers can be maintained through backward references to upper layers of cells. This traceability is critical in security requirements engineering, where tracing a global access control requirement may translate into explicit setting of access controls on specific files or directories within an operating system. The framework provides taxonomy: that helps us understand the perspectives of various players in the development of an information system and the descriptions of the system that can be produced during its creation [4].

The model is frequently used as a framework during information systems activities to support the solicitation, identification and mapping of the following information re-engineering associated with an information system's[4] such as goals, objectives, environment, customers served, time constraints, functional description, information architecture, supporting infrastructure. In short, the Zachman ISA can provide a consolidated view of a system, to whatever level of detail a modeler chooses.

III. Network Security and The Zachman Framework

The objective of network security architecture is to provide the conceptual design of the network security infrastructure, related security mechanisms, and related security policies and procedures. The security architecture links the components of the security infrastructure as one cohesive unit. The goal of this cohesive unit is to protect corporate information [3]. The security architecture should be developed by both the network design and the IT security teams. It is typically integrated into the existing enterprise network and is dependent on the IT services that are offered through the net-work infrastructure. The access and security requirements of each IT service should be defined before the network is divided into modules with clearly identified trust levels. Each module can be treated separately and assigned a different security model. The goal is to have layers of security so that a "successful" intruder's access is constrained to a limited part of the network. Just as the bulkhead design in a ship can contain a leak so that the entire ship does not sink, the layered security design limits the damage a security breach has on the health of the entire network. In addition, the architecture should define common security services to be implemented across the network [7].

For security architecture modeling purposes, the first three levels of the perspective hierarchy (planner, owner, and designer) and the Network cell of the Builder's view are useful. They provide the consumer perspective of the system's end user, the perspective of the system "owner" or contracting entity, and the perspective of the designer, or systems engineer. In other words, the "as built" and used in daily operation perspective, the "as desired" operation perspective, and "as actually specified" perspective. The highest level, the Planner View, defines a clear and coordinated boundary (domain) of the system for the purposes of identifying the people, subsystems, and needs impacted by the system. The Owner's View captures the business and organizational relationships, and their external interfaces. It also documents sources of system requirements, including those derived from legacy systems. The Designer's View establishes and documents the security architectural design and provides a basis for system measurement. Finally, the Builder's View provides a detailed description of the

design and methodology for monitoring and correcting system performance [2].

Similarly, the first three columns of the Zachman matrix (data, function, and network) provide the answers to what data assets the organization controls, how they are used and where they are located [5]. As shown in Table 1, these are:

Data: Each of the rows in this column address understanding of and dealing with an enterprise's data. This begins in Row One with a list of the security concerns of the enterprise and its directions and purposes. Row Two is a contiguous model of the security problems seen by the participants in the business. Also, relationships may be shown which themselves have attributes. Row Three provides more of an information based perspective of the network security, resolving the rules and relationships, along with relationships containing their own attributes. Indeed, attributes are more exhaustively defined and unique identifiers are specified.

Function: The rows in the function column describe the process of translating the mission of the network security system of the enterprise into successively more detailed definitions of its operations. Where Row One is a list of the kinds of network security related activities the enterprise conducts, Row Two describes these activities in a contiguous model. Row Three portrays them in terms of data transforming processes, described exclusively in terms of the conversion of input data into output data.

Network: This column is concerned with the geographical distribution of the enterprise's activities. At the strategic level (Row One), this is simply a listing of the places where the enterprise does business. At Row Two, this becomes a more detailed communications chart, describing how the various locations interact with each other. Row Three produces the network architecture for data distribution, itemizing the special security policy for the enterprise. In Row Four, this distribution is translated into the kinds of computer and network facilities that are required in each location to force the security policy.

IV. The Network Security of Nuclear and Academic Facilities

Nuclear and Research facilities, as major users of information and communication technology (especially Internet), also need security; however, because of their special structure and requirements, the traditional solutions and policies to limit access to the Internet are not effective for them. These institutions face concerns about the security of computing resources and information. The security problems in these environments are divided into two categories [3, 6]: problems with research information and problems with administrative information. Although the corporate and research environments face common security problems they can't choose similar methods to solve them, because of their different structures. In a corporate environment, the natural place to draw a security perimeter is around the corporation itself. However, in a nuclear and research facilities research environment, it is very difficult to draw a perimeter surrounding all of the people who need to access information resources and only those people. This is mainly because of different types of information resources in these environments and also different users who want to access them. So if the security perimeter chosen is too big it includes untrusted people and if it is chosen too small it excludes some of the authorized people.

In addition, corporations can put serious limitations on the Internet connectivity in the name of security but research organizations simply cannot function under such limitations. First, trusted users need unrestricted and transparent access to Internet resources (including World Wide Web (WWW), FTP, Gopher, and electronic mail) located outside the security perimeter. Researchers rely on fingertip access to online library catalogs and bibliographies, preprints of papers, and other network resources supporting collaborative work. Second, trusted users need the unrestricted ability to publish and disseminate information to people outside the security perimeter via anonymous FTP, or WWW. This dissemination of research results and papers is critical to the research community. Third, the security perimeter must allow access to protected resources from trusted users located outside the security perimeter. An increasing number of users work at home or while traveling. Research collaborators may also need to enter the security perimeter from remote hosts. If we consider these centers as an enterprise, the security architecture of their network can be designed based on the ZachmanFramework. For the first four rows and first three columns of the framework the cells can be completed as described in the following sections:

a) Planner's View

An overall organizational policy would be implemented in the Planner's View. The first cell is the list of things important to the Nuclear and Research facilities. Research groups often need to maintain the privacy of their work, ideas for future research, or results of research in progress. Administrative organizations need to prevent leakage of student grades, personal contact information, and faculty and staff personnel records. Moreover, the cost of security compromises is high. A research group could lose its competitive edge, and administrative organizations could face legal proceedings for unauthorized information release. On the other hand, nuclear and research facilities and research institutions are ideal environments for hackers

and intruders and many of them are physically located in these places and they are highly motivated to access and modify grades and other information. There are several reports of break-ins and deletion of data from educational institutions [3, 6].

The second cell in this row is the list of the processes important to the enterprise. This can also be divided into two categories: processes done by nuclear facilities, such as radiation monitoring and control; and research processes, such as conducting projects and disseminating information. The next cell (the network cell) is the locations of the entire research and nuclear facilities.

b) Owner's View

The next level down, the Owner's View, considers the groupings of data and means of access available to both internal and external users. For the first cell (data), we can see three categories of information in a university:

1. The information officially disseminated by the nuclear facilities (such as news and events articles).
2. The information gathered and used by network users.
3. The information not allowed to be publicly disseminated.

Based on the above categories, three types of function servers (second cell) may be proposed in the research facilities which are supervised by nuclear facilities:

1. Public servers, which are used to support information dissemination.
2. Experimental servers, which are used for researchers to develop and test their own software packages and protocols.
3. Trusted servers, which are used for administrative purposes or keeping confidential information. These servers are the places where functions occur with respect to the data [9].

The other requirement of a nuclear facilities environment is to let its trusted members access the resources of the network from outside of the security perimeter (e.g., from home or on trips). Another problem that causes serious trouble for the university is network viruses. These viruses are distributed through the network when users are accessing special sites. Proxy servers can be used to control this problem. Of course these proxy servers should be transparent. The network cell of the framework in this layer is shown in Figure 2.
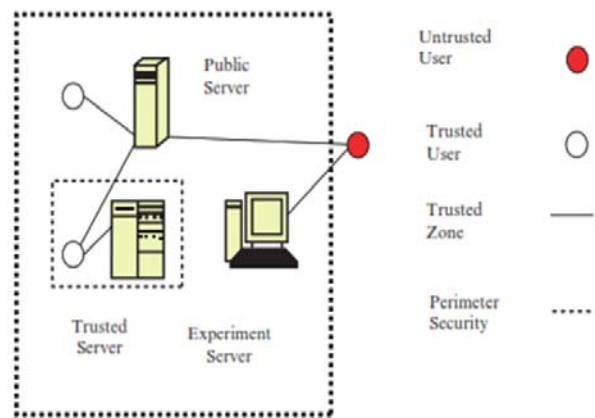
Figure 1: Network layer in Owner's View

c) Designer's View

At the next level, the Designer's View, we introduce mechanisms to protect the network. To achieve the goals described in owner's view, the logical data model (first cell) of the proposed network security policy was designed based on seven basic rules:

1. Packets to or from the public servers are unrestricted if they are from authorized ports. The authorized port is the port that the special service is on. Of course, each public server should be protected itself. The server level security means to enforce stronger access controls on that level.
2. Packets to or from the experimental servers are unrestricted. These servers can be located outside of the security perimeter.
3. Packets to or from the authorized ports of trusted servers are allowed only from or to the authorized clients inside the security perimeter.
4. All of the outgoing packets are allowed to travel outside after port address translation. The incoming packets are allowed if they can be determined to be responses to outbound requests.
5. The packets to or from trusted users of hosts outside the security perimeter are allowed.
6. All of the requests from particular applications such as http should be passed through a proxy server.
7. All the packets to or from outside the security perimeter should be passed through the Intrusion Detection System (IDS).

Rule 1 is based on our need to support information dissemination in a research environment. Public servers must be separated from trusted hosts and protect them at the server level. Because of they may be compromised, so it should make a plan to recover them from information kept securely behind the security perimeter.

Rule 2 follows from recognition that researchers sometimes need to develop and test insecure software packages and protocols on the Internet. Of course they should be alerted that their server is not secure and their information may be corrupted.

Rule 3 is based on the fact that confidential information must be protected. These servers are most important resources to be protected and therefore they should be put in a special secure zone.

Rule 4 follows from recognition that open network access is a necessary component of a research environment. On the other hand it is not allowed to any user to set up Internet servers without permission. The address translation prevents outside systems from accessing internal resources except those listed as public servers.

Rule 5 grants access to protected resources to users as they work from home or while traveling, as well as to collaborators located outside the research group.

Rule 6 is based on the need to block some Internet sites that contain viruses.

Rule 7 follows from recognition that the above rules should be monitored somehow. IDS can be a proper tool to monitor the network and check if there is any violation of proposed rules. The network cell is shown in Figure 2.
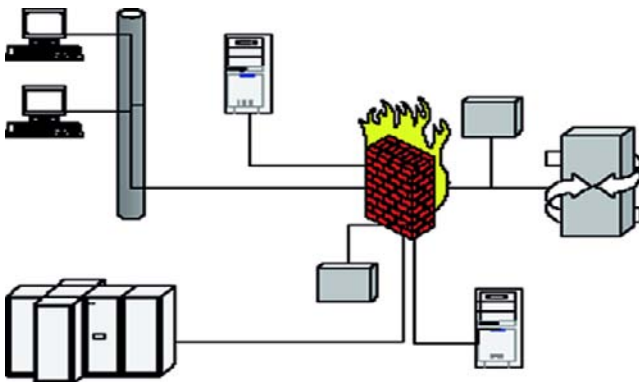
Figure 2: Network layer in Designer's View

d) *Builder's View*

Finally, the Builder's View describes how technology may be used to address the information processing needs identified in the previous rows. For network security purposes, mainly the network cell is needed. Generally, two ways can be proposed to implement the designed network: first, to use hardware firewalls and caches; and second, to use general purpose servers with proper software packages as cache, proxy, and firewall. In our case study in the nuclear facilities the proxy and cache is used as transparent server, and IPTABLES as the firewall for packet filtering, in which the different zones of the network were defined. Also Network Address is used as Translation of the IPTABLES for implementing the rules in design view. Of course each server in the network had also its own security rules and guards. For restricting access to special websites (mainly to avoid viruses) special software was utilized. SNORT is used as as IDS. The network cell is shown in Figure 3.
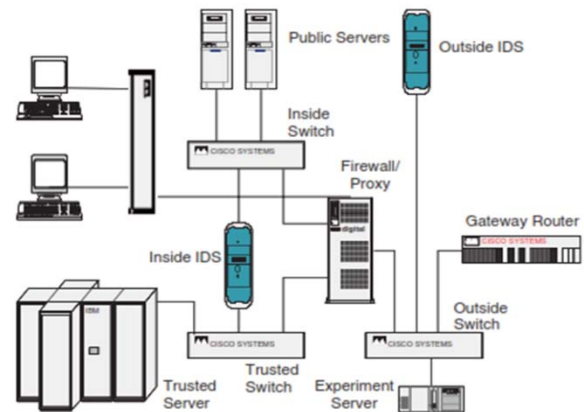
Figure 3

V. CONCLUSION

Security architecture for computer network makes any Local Area Network LAN more secure and more flexible than any conventional security procedures without affecting the performance of the LAN. Creating Security architecture for nuclear and research facilities, it is possible to develop descriptive security architecture. It provides the "as built" and used in daily operation perspective, the "as desired" operation perspective, and "as actually specified" perspective. Similarly, Creating security architecture for nuclear and research facilities by the Zachman matrix (data, function, and network) provide the answers to what data assets the organization controls, how they are used, and where they are located. Nuclear facilities, as one of the major users of information and communication technology, present a good case study for applying the proposed architecture. The key point of the research is to design the network security architecture of these facilities based on a framework so it provides the consumer perspective of the system's end user, the perspective of the system "owner" or contracting entity, and the perspective of the designer or systems engineer simultaneously.

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6

Simulation and Design of University Area Network Scenario (UANS) using Cisco Packet Tracer

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Abstract- Computer network has become the most significant issue in our day to day life. Networking companies depend on the proper functioning and analysis of their networks for education, administration, communication, e-library, automation, etc. Mainly interfacing with the network is induced by one of the other user/users to share some data with them. So, this paper is about communication among users present at remote sites, sharing this same network UANS. UANS stands for the University Area Network Scenario. So in this work the network is designed using Cisco Packet Tracer. The paper describes how the tool can be used to develop a simulation model of the Pabna University of Science and Technology, Pabna, Bangladesh. The study provides into various concepts such as topology design, IP address configuration and how to send information in the form of packets in a single network and the use of virtual Local Area Network (VLANs) to separate the traffic generated by a different department.

Keywords: computer networks, IP addresses, ping test, Cisco Packet Tracer Simulation Tool, VLANs, Router.

GJCST-G Classification: C.2.1

SIMULATIONANDDESIGNOFUNIVERSITYAREANETWORKSCENARIOUANSUSINGCISCOPACKETTRACER

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Simulation and Design of University Area Network Scenario (UANS) using Cisco Packet Tracer

Md. Anwar Hossain[α] & Mahabuba Zannat[σ]

Abstract- Computer network has become the most significant issue in our day to day life. Networking companies depend on the proper functioning and analysis of their networks for education, administration, communication, e-library, automation, etc. Mainly interfacing with the network is induced by one of the other user/users to share some data with them. So, this paper is about communication among users present at remote sites, sharing this same network UANS. UANS stands for the University Area Network Scenario. So in this work the network is designed using Cisco Packet Tracer. The paper describes how the tool can be used to develop a simulation model of the Pabna University of Science and Technology, Pabna, Bangladesh. The study provides into various concepts such as topology design, IP address configuration and how to send information in the form of packets in a single network and the use of virtual Local Area Network (VLANs) to separate the traffic generated by a different department.

Keywords: computer networks, IP addresses, ping test, Cisco Packet Tracer Simulation Tool, VLANs, Router.

I. Introduction

Computer network borne out of the need to use personal computers for sharing information within an organization in the form of messages, sharing files, resources and so forth. Whether the organization is located in a small area like as in one building or spread over a large area, the need for networking the computers cannot be over emphasized. A university area network is an essential part of university system. A university network has several uses such as teaching, learning, result publishing, resource sharing, file sharing, communication, etc. The University Area Network design is about designing a topology of a network that is a LAN (Local Area Network) for a university in which various computers of different departments and buildings are set up so that they can interact and communicate with each other by interchanging data. To design a network

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for a University which connects various departments and buildings to each other's, it puts forward communication among them. One of the purpose of networking is to reduce isolated users. The systems should be capable of communicating with others and should provide the desired information. A simulation tool offers a way to predict the impact on the network of a hardware upgrade, a change in topology. So in this dissertation, a UANS network is designed using Cisco Packet Tracer. Cisco Packet Tracer (CPT) is multi-tasking network simulation software that can be used to perform and analyze various network activities such as the implementation of different topologies, selection of optimum path based on various routers, analysis of different network configurations [4]. This University Area Network Scenario is about designing a topology of a network that is Local Area Network (LAN) for a university area in which different department has some computers in different buildings set up their network so that they can interact and communicate with each other by interchanging data.

II. Technology to be Used

CCNA: Cisco discovered Cisco Certified Network Associate (CCNA) to identify and analyzethe basic capability of the installation and maintenance of different size networks. This technology used for connecting various devices like routers, switches with each other for transferring and interchanging data. To contract a disciplined and trustworthy network is scalable too. Portability is one of the characteristics of this network application of the UANS.

III. Basic Architecture
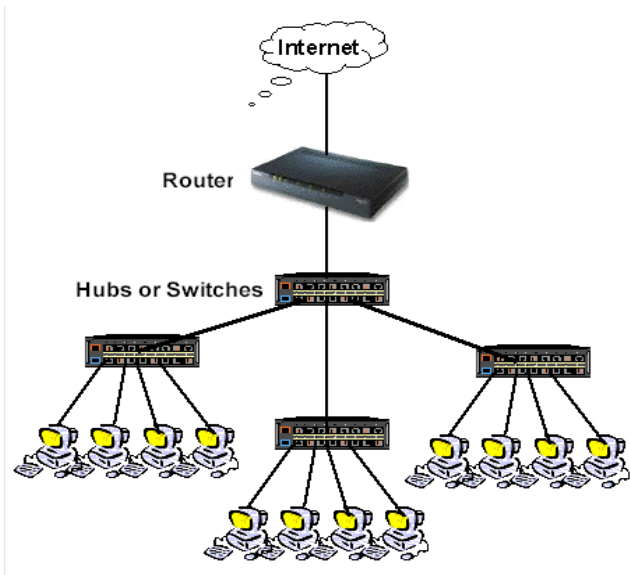
Fig. 1: The architecture of UANS use of various computers, routers, switches, VLAN connections, etc

IV. Working of UANS

This University Area Networking Scenario is to provide a well-connected, secure, reliable, dependable communication among different departments. Several departments can simply split the required data without any problem and can exchange their data without going physically to them thus conserving time and energy.
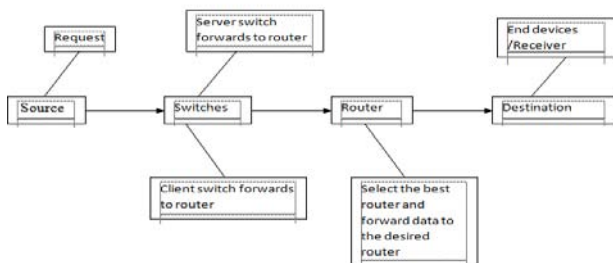
Fig. 2: A major component and their communication

V. Requirements

The following section discusses the requirements related to the interfaces used to communicate with lots of data. These data combine clients, software interfaces and other hardware that permit the system to carry out its task.

a) User Interface

The requirements represent in this module describes the UANS interface. The requirements are picked up to the main characteristics provided by the system. The necessities always maintain the activities interconnected with the subheading characteristics.

b) Interface Formats

1. This screen is displayed the virtual topology designed for the university.
2. The network simulation, i.e. Cisco Packet Tracer (CPT) is simple, easy for implementation and straightforward.
3. It cultivates visual graphical user interface.
4. It will display twelve switches, different VLANs and one router interconnected with each other.
5. The Command Line Interface (CLI) use for configuration.
6. The CPT allows the user to run the project on run time mode or simulation.
7. When the administrator clicks on any device, then the graphical user interface is open for the particular device.

c) System Interface

In this UANS, giving data to end device, a Graphical User Interface is needed and appear a login form to the authorized user. We can reset the password by the help of network administration. Whereas unauthorized user prohibits to access the network.

d) Hardware Interface

To run the simulator software (i.e. CPT) some basic hardware requirements are need. That are-
- RAM:512MB
- CPU: Intel Pentium Dual core
- Storage:500MB of free disk space
- Display Resolution:800*600
- Adobe Flash Player.

Recommended Hardware:
- RAM: > 512 MB
- CPU: Intel Pentium III 1.0 GHz
- Display resolution: 1024 x 768
- Storage: 300 MB free disk space

For run the module, the hardware requirements are:
- 12 Switches (Cisco 2950 switch)
- 1 Router (Cisco 1841 router)
- Computer Systems (Generic)
- One Computer system for server
- Cross over cable
- Straight through cable

e) Software Interfaces
The requirements required in the UANS are as follows:
- Operating System: Microsoft Windows 7.
- Adobe Flash Player.
- Cisco Packet Tracer

f) Communication Interfaces
- The system will execute over the university area network.
- The system based on a client-server application where the server provide data services only.

VI. IP Addressing

An Internet Protocol address is a logical, numerical address that is assigned to every single computer, printer, switch, router or any device that is part of an IP based network [5]. No network architecture exists without an IP address. Due to an IP address is logical address, so it used to identify the specific nodes in the network. So the IP address gives the location an address so that they can interact with each other via email or so on. An IP address is a 32-bit number. It has two versions one is IPv4 and other is IPv6. There are five classes of IPv4 address shown in Table-1.

Table 1: Classes of IP addresses

Address Class	Value in 1ST octet
A	1-126
B	128-191
C	192-223
D	224-239
E	240-255

In the UANS is used IPv4. An IPv4 is of 32 bits numbers. The address is written in dotted-decimal notation represent it X.X.X.X each octet divide by a dot. For UANS network the IP Address is used 192.168.0.0 with a subnet mask of 255.255.0.0. IP 192.168.0.0 is the class C address. IP address divide among various VLANs and ports for communication. The greater IP address is divide into small parts by using VLSM (Various Length Subnet Mask). VLSM is a method that categorized an IP address into a subnet and shares it according to the necessity of a network.

VII. Scope of UANS

This project gives us an effective method to connect among all computers in the respective university area. Apart from interconnection, this topology has been created keeping in mind the matter of cost. One of the important points is security and authentication to oppose unauthorized access. This topology transmits data very fast from one place to another.

VIII. Result of UANS

In Fig.3 show the complete diagram of University Area Network and it consists of router, switches and end devices. Here the different department's personal computers are connected with switch. IP address and subnet mask are assigned to all the departments and area of this UANS.
IP Address of personal computer (PC):
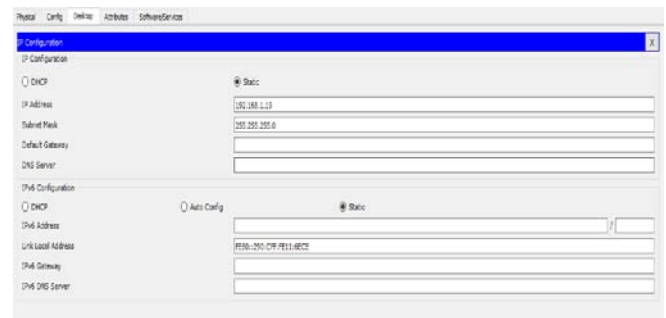
Fig. 4: IP Address accessing for PC-0

Table 2 shows the IP Addresses all PCs which are used in UANS network.
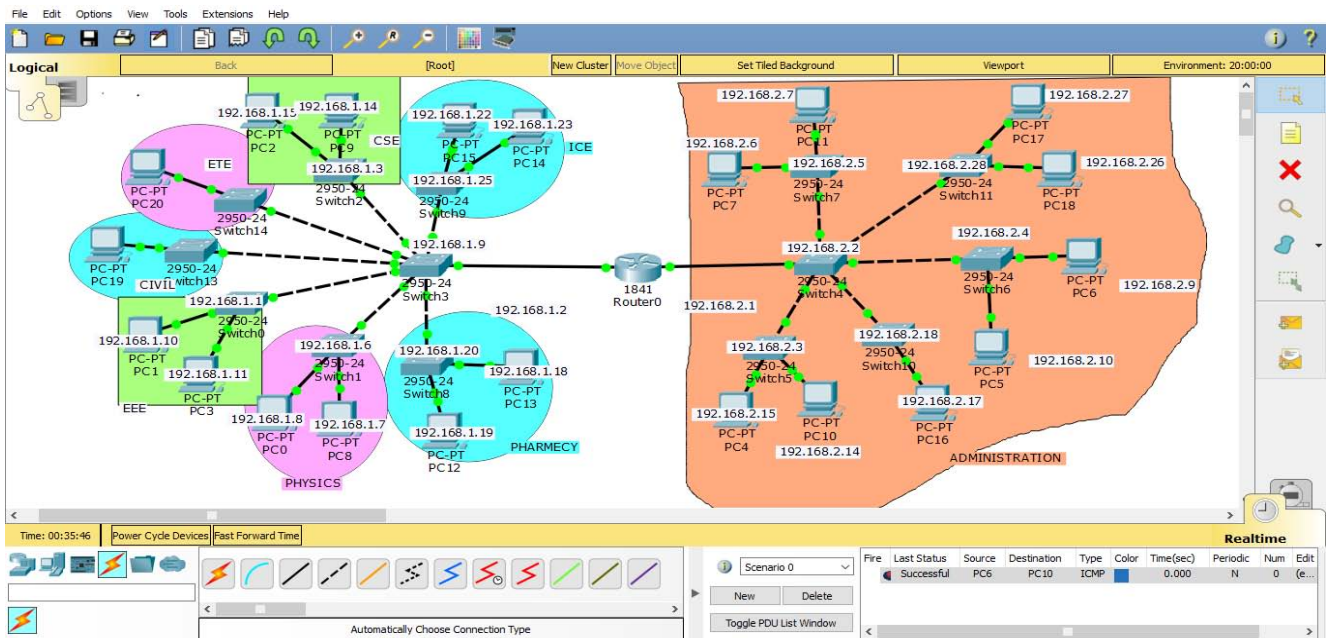
Fig. 3: The complete diagram of University Area Network Scenario created in Packet Tracer environment

Table 2: List of IP Address of PCs

PC	IP ADDRESS
PC-0	192.168.1.8
PC-1	192.168.1.10
PC-2	192.168.1.15
PC-3	192.168.1.11
PC-4	192.168.2.15
PC-5	192.168.2.10
PC-6	192.168.2.9
PC-7	192.168.2.6
PC-8	192.168.1.7
PC-9	192.168.1.14
PC-10	192.1682.14
PC-11	192.168.2.7
PC-12	192.168.1.19
PC-13	192.168.1.18
PC-14	192.168.1.23
PC-15	192.168.1.22
PC-16	192.168.2.17
PC-17	192.168.2.27
PC-18	192.168.2.26
PC-19	192.168.1.52
PC-20	192.168.1.53

Command line interface (CLI) for Switch:

```
switch>enable
switch#config t
Enter configuration commands. One per line. End with CNTL/Z.
switch(config)#hostname s1
switch(config)#interface vlan1
switch(config-if)#IP address 192.168.1.1 255.255.0.0
switch(config-if)#no shut
```

Fig. 4: Configuration of a switch

Table 3 shows the IP Addresses all switches which are used in the UANS network.

Table 3: List of IP Address of switches

SWITCH	IP ADDRESS
SWITCH-0	192.168.1.1
SWITCH-1	192.168.1.6
SWITCH-2	192.168.1.3
SWITCH-3	192.168.1.9
SWITCH-4	192.168.2.2
SWITCH-5	192.168.2.3
SWITCH-6	192.168.2.4
SWITCH-7	192.168.2.5
SWITCH-8	192.168.1.20
SWITCH-9	192.168.1.25
SWITCH-10	192.168.2.18
SWITCH-11	192.168.2.28
SWITCH-13	192.168.1.51
SWITCH-14	192.168.1.50

Command Line Interface (CLI) for Router:

```
Continue with configuration dialog? (yes/no)
no
Press RETURN to get started!
Router>enable
Router#config t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface fa
Router(config)#interface fastEtharnet 0/0
Router(config-if)#ip address192.168.1.2 255.255.255.0
Router(config-if)#no shut
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
Router(config-if)#exit
Router(config)#interface fastEtharnet 1/0
Router(config-if)#ip address192.168.2.1 255.255.255.0
Router(config-if)#no shut
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
%LINK-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
```

Fig. 5: Configuration of router

8.1 Ping Test: Network connectivity and communication can be tested using ping command, followed by the domain name or the IP address of the device (equipment) one wishes to verify connectivity. Two VLANs have been added to the existing network and the ping command was performed to verify if the devices connected to those VLANs are communicating with the rest of the nodes on the network. [2]

Academic area ⟶ Administration area

Administration area ⟶ Academic area

Civil ➤ ICE

Data transfer one pc to another pc

Fig. 5: Checking result using 'ping' command

IX. Conclusion

In this paper, a UANS (University Area Network Scenario) that uses networking topology implemented with concepts like VLANs in a multiple area networks using Cisco Packet Tracer. VLANs have been used to logical UANS and with the aid of a router and switch configurations, data packet routed from one device to another. The procedures provide a design and approach for UANS using VLANs for an end to end IP network connectivity for next generation network architecture implementations. To design the network for UANS produces the substructure for all the service framework such as security of the network, wireless area network, operational efficiencies, virtual learning environments, and secure classrooms. Finally, the network foundation services such as switching, routing multicast, and high availability are giving for the UNAS.

X. Future Work

The configuration and specifications are for the initial prototype and can further be developed and additional functionality can be added to increase support and coverage.

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12

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Auditory Source Localization by Time Frequency Analysis and Classification of Electroencephalogram Signals

By Cesar A. Aceros-Moreno, Vidya Manian, Domingo Rodriguez & Juan Valera

University of Puerto Rico

Abstract- The temporal lobe or auditory cortex in the brain is involved in processing auditory stimuli. The auditory data processing capability in the brain changes as a person ages. In this paper, we use the hrtf method to produce sound in different directions as auditory stimulus. Experiments are conducted with auditory stimulation of human subjects. Electroencephalogram (EEG) recording from the subjects are made during the exposure to the sound. A set of time frequency analysis operators consisting of the cyclic short time Fourier transform and the continuous wavelet transform is applied to the pre-processed EEG signal and a classifier is trained with time-frequency power from training data. The support vector machine classifier is then used for source localization of the sound. The paper also presents results with respect to neuronal regions involved in processing multi source sound information.

Index Terms: auditory stimulus, electroencephalogram, time frequency analysis, Fourier transform, wavelet transform, support vector machine, classifier, source localization.

AUDITORYSOURCELOCALIZATIONBYTIMEFREQUENCYANALYSISANDCLASSIFICATIONOFELECTROENCEPHALOGRAMSIGNALS

Strictly as per the compliance and regulations of:

Auditory Source Localization by Time Frequency Analysis and Classification of Electroencephalogram Signals

Cesar A. Aceros-Moreno[α], Vidya Manian[σ], Domingo Rodriguez[ρ] & Juan Valera[ω]

Abstract- The temporal lobe or auditory cortex in the brain is involved in processing auditory stimuli. The auditory data processing capability in the brain changes as a person ages. In this paper, we use the hrtf method to produce sound in different directions as auditory stimulus. Experiments are conducted with auditory stimulation of human subjects. Electroencephalogram (EEG) recording from the subjects are made during the exposure to the sound. A set of time frequency analysis operators consisting of the cyclic short time Fourier transform and the continuous wavelet transform is applied to the pre-processed EEG signal and a classifier is trained with time-frequency power from training data. The support vector machine classifier is then used for source localization of the sound. The paper also presents results with respect to neuronal regions involved in processing multi source sound information.

Index Terms: auditory stimulus, electroencephalogram, time frequency analysis, Fourier transform, wavelet transform, support vector machine, classifier, source localization.

I. Introduction

Auditory information such as sound, speech, and music are processed in the brain through auditory pathways from the ear to the temporal lobe. Auditory signals are decoded in the brain, and interpreted. There are 3 mains stages of sound processing. When a person pays attention to a particular sound, this involves processing through a primary auditory pathway that starts as a reflex and passes from the cochlea to a sensory area of the temporal lobe called the auditory cortex.

Each sound signal is decoded in the brain stem to its components such as time of duration, frequency and intensity. After two additional processing steps the brain localizes the sound source, or it knows from which direction the sound is coming. Once the sound is localized by the brain, the thalamus region of the brain is involved in producing a response through any other sensory area such as a motor response, or a vocal response. Source localization of sound from different directions has been addressed by researchers in several ways.

Sound localization has been analyzed by different researchers. Virtual auditory stimuli was presented in 6 directions using headphones to human subjects, simultaneously recorded EEG data was classified using Support Vector Machines (SVMs) in I. Nambu et al. [1]. In S. Makeig et al. [2], Independent Component Analysis (ICA) was used to analyze Event Related Potentials for sound stimulus. Monaural and binaural auditory stimulus was classified using ERPs in A. Bednar et al. [3]. Interaural Time Difference (ITD) was used in Letawski [4] for auditory localization.

However, the methods presented do not present a deeper comprehensive analysis of EEG responses to auditory stimulus, in as much as EEG is a stochastic signal, that varies in both time and frequency varying. In this paper, we present time frequency analysis as an alternate and viable method for identifying the source of sound by processing EEG responses to auditory stimulus. This paper is organized as follows. Section II presents a background on Electroencephalogram. Section III presents the time frequency analysis methods, Section IV presents the methodology for feature extraction and sound localization using the SVM classifier. Section V presents the results, and VI the conclusions.

II. EEG Data Collection with Auditory Stimulation

Electroencephalogram (EEG) signals are electrical activity of the brain recorded using electrodes placed on the scalp using an EEG cap. The number of electrodes can vary from as few as 8 to 256. Each electrode provides a time series of voltage measurements at a particular sampling rate. The experiments for this paper were done in the Brain Computer Interface Lab (BCI Lab) at the University of Puerto Rico at Mayaguez (UPRM). The human subjects were college students with normal health. Informed consent was obtained from the participants according to an approved protocol by the institutional review board (IRB) of UPRM. The EEG equipment used to collect the data is the BrainAmp from BrainVission, LLC which has 32 channels in the Acticap arranged according to the 10-20 system of electrode placement. The acticap with the

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32 electrodes is worn by the subject. Conducting gel is used to lower the impedance of electrodes making contact to the scalp. The impedance of the electrodes were adjusted to be below 10 kilo Ohms. The experiments were conducted in a quiet room, with only the subject and the investigator. A series of 16 sound stimuli were presented to the subject in right and left ear through wearing headphones. Two classes of 2 secs stimuli were applied randomly. The first is a pure tone of 3 kHz with 500 ms increasing tone, steady during 1 second, and then decreasing tone during 500 ms. The second stimulus was a burst of 3 kHz pure tone with durations of 100 ms ON, and 100 ms OFF for 10 trials. This give a total of 224 auditory stimuli (112 right/112 left). Each series of 16 stimuli takes around 2 minutes and the participant is allowed one minute to rest between trials. The sound stimuli were presented through a program written in Matlab. The National Instruments device was used to put markers in the EEG data as they were recorded simultaneously when auditory stimuli were presented. The results presented in this paper are from the analysis of EEG data collected from 3 different subjects.
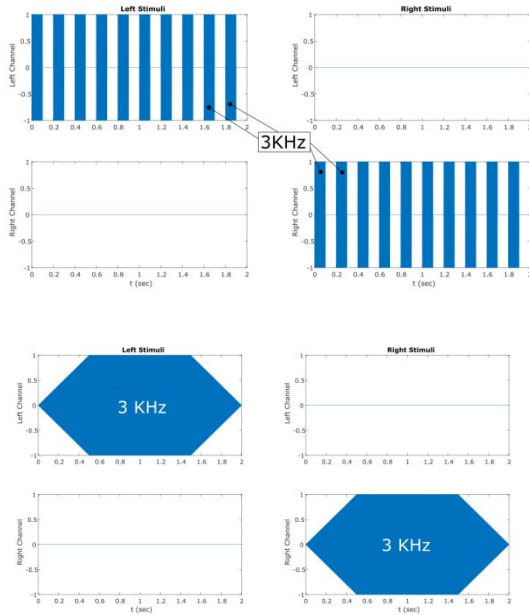
Figure 1: Pure tone and burst sound stimulus

Apart from 2 directions of Left and Right for sound stimulus presentation, four direction stimuli were also presented to the subjects. For the four direction sound data presentation, we used sound localization using the head related transfer function. The HRTF is a novel technique to simulate direction of arrival of sounds. HRTF is also called as transfer function from the free field to a specific point of the ear canal. In mathematical terms the transfer functions for Left and Right are shown below:

$$H_L = H_L(r,\theta,\psi,w,\alpha) = P_L(r,\theta,\psi,w,\alpha)/P_0(r,w)$$

$$H_R = H_R(r,\theta,\psi,w,\alpha) = P_R(r,\theta,\psi,w,\alpha)/P_0(r,w)$$

In the equations above, L and R are the left ear and right ear respectively. P_L and P_R represent the amplitude of sound pressure at entrances to the left and right ear canal. P_0 is the sound pressure at the center of the head. The HRTFs for Left and Right are H_L and H_R, respectively. The HRTF are functions of distance between source and center of the head r, and the parameters of the function are: the source angular position θ, the elevation angle ψ, the angular velocity w, and the equivalent dimension of the head α. Figures 2 and 3 show the directional sound stimulation implementations using HRTF.
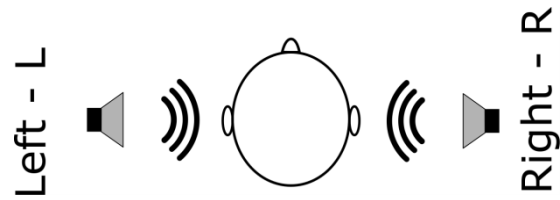
Figure 2: Two direction sound stimulus presentation
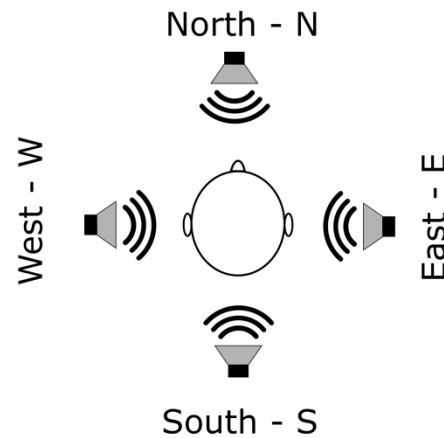
Figure 3: Four direction sound stimulus presentation using HRTF

III. TIME-FREQUENCY ANALYSIS

The 32 channel EEG data collected are pre-processed using band-pass filtering to remove low frequency noise, artifacts due to eye blinks and hardware induced artifacts. In order to extract meaningful features from signals for source identification, it is necessary to map data in overlapping feature spaces to a separable space by high dimensional feature mapping. This increases the dimensionality of the feature space, but the classes are easily separable in this space, and linear classifiers can be used to classify the data in this high dimensional space. In this project, we have mapped 1-D signal spaces to 2-D signal spaces through time-frequency methods (TFM). The group of signals taken from the electrodes on the scalp are in the space of continuous physical signals $L(\square)$ (see Fig. 4). These

sequences are the mapping from $L(\square)$ to $\ell(\mathbf{Z})$ through an analog to digital process. The sampled/quantized version is computing using a window operator that transform $\ell(\mathbf{Z})$ to $\ell^2(\mathbf{Z}_N)$ when an EEG experiment is conducted. These signals now are in $\ell^2(\mathbf{Z}_N)$ and is the space of discrete finite signals with finite energy. EEG signals can be processed by a computer using time-frequency tools to map the signals from space $\ell^2(\mathbf{Z}_N)$ to the space $\ell^2(\mathbf{Z}_N \times \mathbf{Z}_N)$. The increased dimensionality of the signal space reveals more information about the original signal. The mapping from $\ell^2(\mathbf{Z}_N) \rightarrow \ell^2(\mathbf{Z}_N \times \mathbf{Z}_N)$ also additional computations while processing the EEG signal analysis in the transformed space.
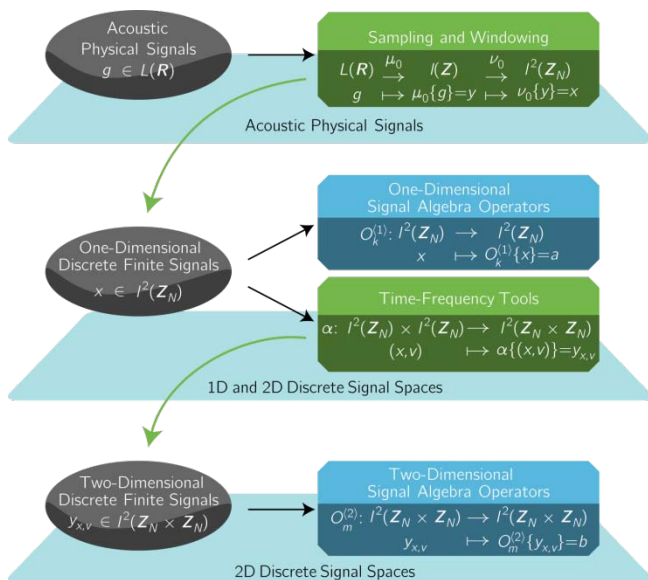
Figure 4: A general approach for time-frequency signal analysis

In multiway signal-processing the selection of efficient and optimal methods for the processing of electroencephalographic signals is a problem addressed by many authors [5], [6], [7]. Fig. 5 shows the stages or levels of neural signal analysis presented in this paper.

Time-frequency methods allow the observation of details in signals that would not be noticeable using a traditional Fourier transform. One of the problems of conversion to time-frequency spaces is that, according to the length of the input signal, the conversion can be time, and memory consuming. The two methods for time frequency analysis considered here are the Short Time Fourier Transform (STFT), and the Wavelet Transform (WT).
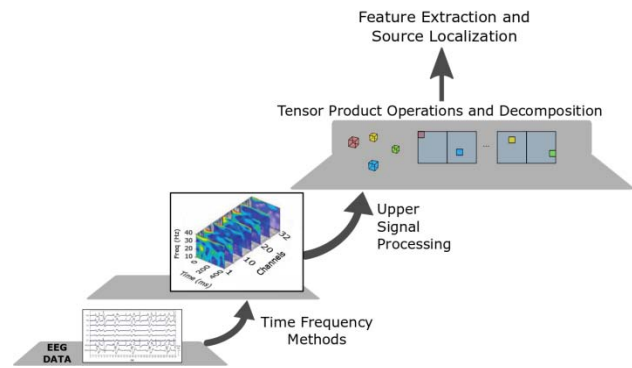
Figure 5: Stages of EEG signal analysis using time frequency methods

a) Short Time Fourier Transform Analsys

The STFT has been a widely-used time-frequency signal processing operator. The CSTFT has certain advantages over STFT that are mentioned below.

I. *Short Time Fourier Transform Definition*

Given a signal $x[n] \in \ell(\mathbf{Z}_N)$ and let $w[n] \in \ell(\mathbf{Z}_N)$ a rectangular window function, the STFT is defined as follows:

$$X[m,k] = \sum_{n=-\infty}^{\infty} x[n]w[m-n]e^{-\frac{j2\pi kn}{N}} \quad (1)$$

A special variation of STFT is the cyclic short time Fourier transform. The CSTFT is a STFT with a window function $w[n]$ that performs a cyclic shift with the $\langle \ddot{} m - n \rangle_N$ that is the modulo operation which finds the remainder after the division of $m-n$ by N.

II. *Cyclic Short Time Fourier Transform Definition*

Given a signal $x[n] \in \ell(\mathbf{Z}_N)$ and let $w[n] \in \ell(\mathbf{Z}_N)$ a rectangular window function, the CSTFT is defined as follows:

$$S_{x,v}[m,k] = \sum_{n \in \mathbf{Z}_N} x[n]w\left[\langle m-n \rangle_N\right]W_N^{kn} \quad (2)$$

where, $W_N^{kn} = e^{-\frac{j2\pi}{N}(kn)}$, $m \in \mathbf{Z}_N$ (time shift) and $k \in \mathbf{Z}_N$ (frequency axis). The CSTFT makes a mapping from the space $\ell(\mathbf{Z}_N)$ to the space $\ell(\mathbf{Z}_N \times \mathbf{Z}_N)$. The advantage of CSTFT is that signals are mapped from the signal space $\ell(\mathbf{Z}_N)$ to the signal space $\ell(\mathbf{Z}_N \times \mathbf{Z}_N)$. This ensures that the mapping is constant, independent of the length of the input signal because through, a different segmentation, it can be ensured that the conversion falls into the same signal space. The new signal space gives richer information. A special group of the STFT is the Gabor transform, a generalized version is given in Equation 3. This time-

frequency transform uses a window defined as a Gaussian function.

$$G_x(t,f) = \int_{-\infty}^{\infty} e^{-\pi(\tau-t)^2} e^{-j2\pi f\tau} x(\tau)d\tau \qquad (3)$$

b) *Continuous Wavelet Transform and Discrete Wavelet Transform*

Wavelet Transform is based on a group or class of translated and dilated functions called wavelets. The continuous wavelet functions are defined in Blu et al. [8] as:

$$\psi_{t',a}(t) = \frac{1}{\sqrt{a}} \psi\left(\frac{t-t'}{a}\right), \qquad (4)$$

And the CWT is defined based on these wavelets.

$$CWT(t',a) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{a}} \psi^*\left(\frac{t-t'}{a}\right) dt = \langle x, \psi_{t',a}\rangle. \qquad (5)$$

The CWT gives a time frequency representation in terms of delay and dilation. The CWT representation has advantages over the CSTFT at low frequencies. In EEG, the presence of information at low frequency is very common. Therefore, CWT is better than the CSTFT for EEG time-frequency analysis.

IV. FEATURE EXTRACTION AND CLASSIFICATION

Figure 6 shows the EEG ERP responses to 2 direction auditory stimulation.
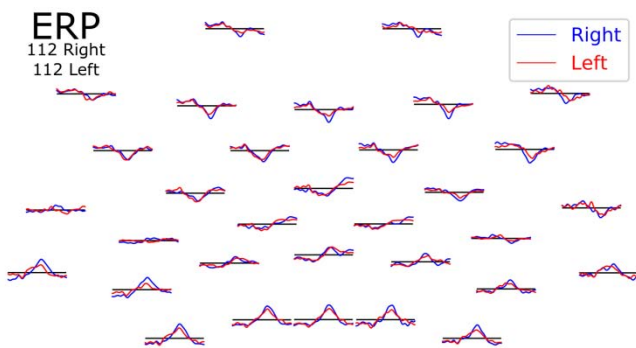
Figure 6: Time Domain Event-Related Potentials for Auditory Stimuli N=112 Right and Left

The algorithm for feature extraction and classification using a support vector machine (SVM) classifier is shown in Figure 7. Time Frequency Method (TFM) is either the CSTFT or the CWT. The 32 channel EEG data were organized as tensors [9-12] and the time frequency methods were implemented in Python and visualized using MNE [13-15]. The EEG data of 112 trials is divided in to 56 for trials for training and 56 trials for testing. 40 random trial averaging was done for training and testing of the SVM classifier. The results for two subjects is shown in Table 1.
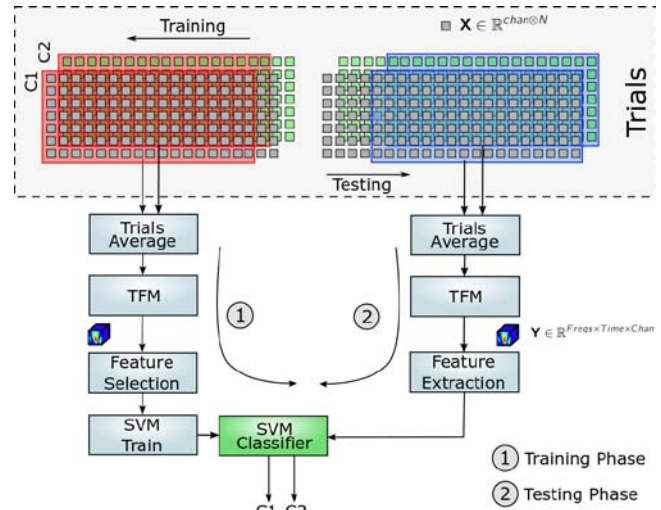
Figure 7: Flow chart of the classification algorithm

Figure 8 shows the ERPs for 3 EEG channels that are from the frontal and temporal regions of the brain involved in processing of auditory stimulus. The time delay in these evoked potentials can be clearly seen. Similarly, Figures 9 and 10 shows the time delays in the evoked potentials for a 4 and 8 direction auditory stimulation, respectively. In this case, the occipital and parietal lobes are involved. This shows that as more complex sounds are presented, different neuronal pathways are activated in processing these auditory stimuli. Figure 11 shows the time frequency representation for the 3 features for the 2 direction auditory ERPs. Figure 12 shows the topoplots for the EEG signals recorded during left and right direction auditory stimulation. Figures 13 to 15 shows the time frequency representation for the 3 features for the EEG signals evoked by auditory stimulation in 4 directions.
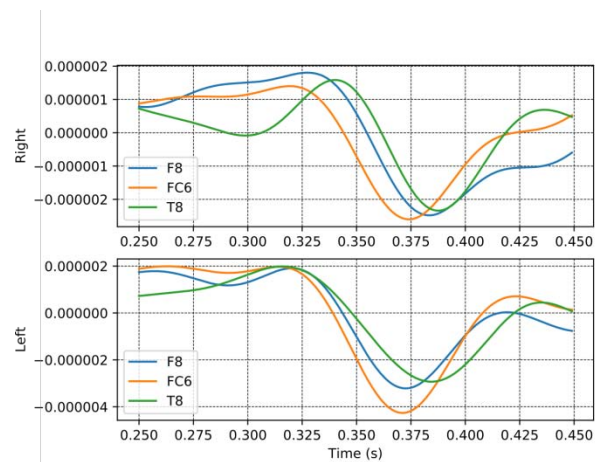
Figure 8: Time Delay Two Class, Three Features Evoked Potentials

V. RESULTS

Table 1 shows very good accuracies for source localization when two directions auditory stimulus are presented. For the 4 direction case, in Table 2 it can be seen that the classifier has difficulty in identifying the South direction.

Table 1: Confusion Matrix 2 Class Using SVM Classifier for 3 Subjects

	L (W)	R (E)
L (W)	100%	0.10%
R (E)	8%	92%

	L(W)	R(E)
L(W)	88%	12%
R(E)	15%	85%

	L (W)	R (E)
L (W)	100%	0.0%
R (E)	0.0%	100%
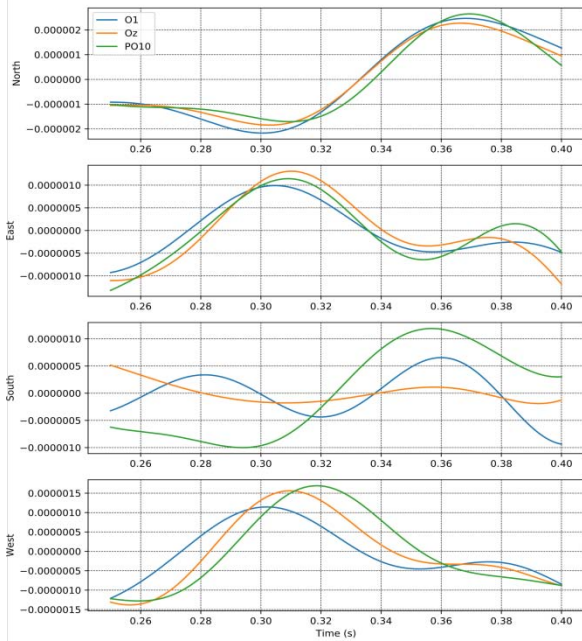
Figure 9: Time Delay Four Class, Three Features Evoked Potentials
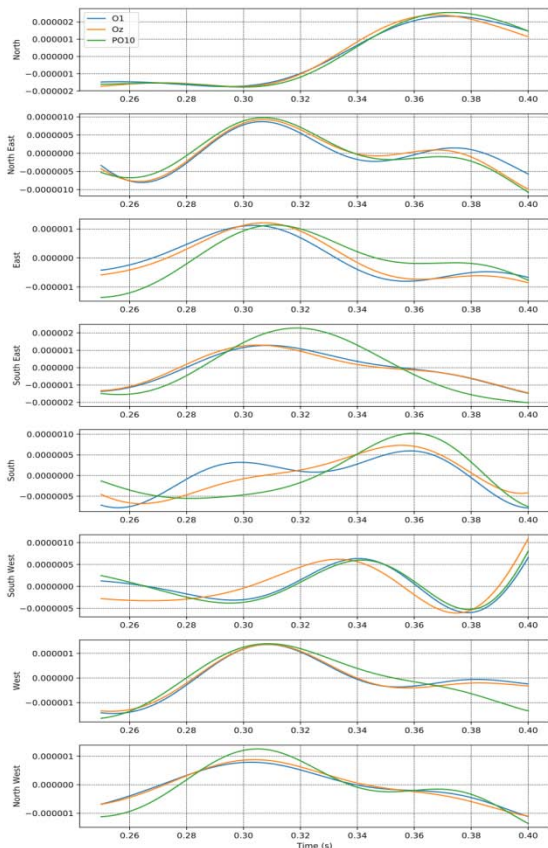
Figure 10: Time Delay Eight Class, Three Features Evoked Potentials
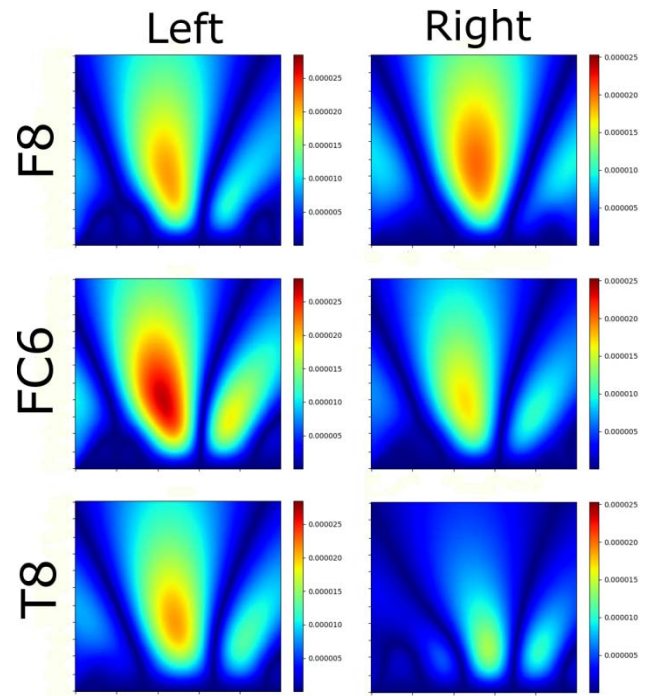
Figure 11: Time Frequency Representations for the Three Features for Binary Classification
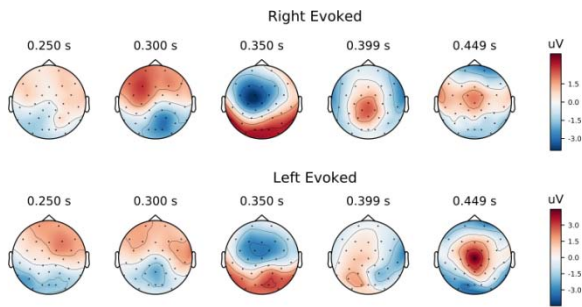
Figure 12: Event Related Potentials Topomaps for Left and Right Events

Table 2: Confusion Matrix for 4 Class Using SVM Classifier

	N	E	S	W
N	100%	0%	0%	0%
E	0%	82%	0%	18%
S	35%	1%	27%	38%
W	0%	4%	0%	79%
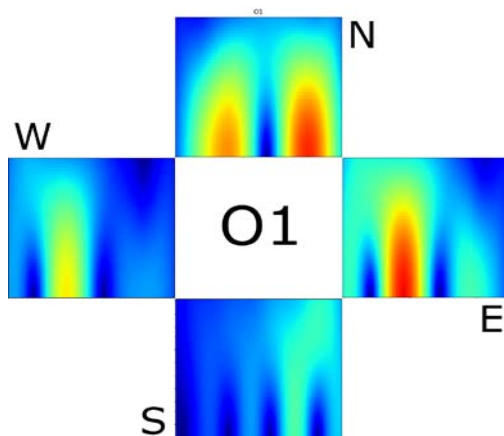
Figure 13: Time Frequency Representations for Feature One in the Four Directions
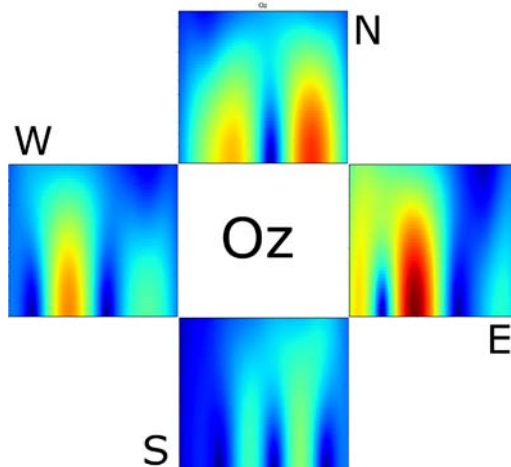
Figure 14: Time Frequency Representations for Feature Two in the Four Directions
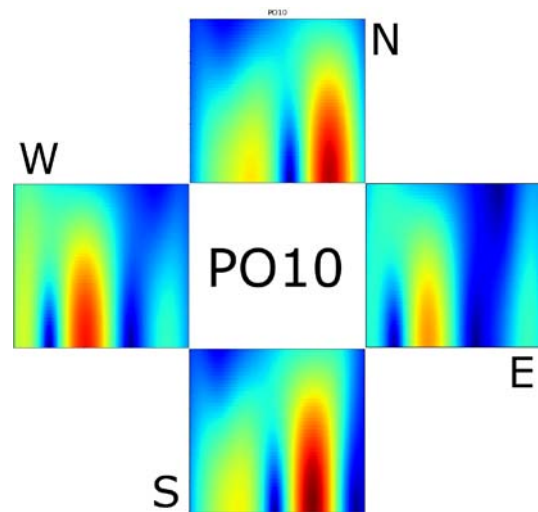
Figure 15: Time Frequency Representations for Feature Three in the Four Directions

The salient features from the CWT in each of the neuronal regions for multiple direction auditory stimulation can be seen from the time frequency representations. The CWT features performed well for 4 directions auditory stimulus localization. As can be seen, results for 2 directions is close to 100%. The time delay plots in Figures 9 and 10 show that for more source directions, neuronal signals from the occipital and parietal regions have higher discriminatory power than frontal or temporal regions.

VI. CONCLUSION

Auditory processing in the brain was analyzed using time frequency analysis of EEG signals acquired from the brain using sound stimulus presentation. The results show that as number of source directions is increased, different regions of the brain are involved in processing the signals. This implies that as sound becomes more complex such as in speech, music, and language perception, higher intricate auditory pathways in the brain are involved in processing and decoded these sound patterns.

The comparison of the time domain vs time-frequency domain factorization of EEG shows that increasing the dimensionality of the EEG signals, provides a better way to discriminate the ERP of auditory stimuli and localize sources. Apart from sound direction localization from EEG, it is evident that EEG can also be used as a neuroimaging modality for understanding and decoding sensory and motor functional pathways in the brain. This work can be extended to analyzing complex music, speech and language perception in the brain.

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Implementation of Back Propagation Neural Network with PCA for Face Recognition

By Md. Manik Ahmed, A F M Zainul Abadin, Md. Anwar Hossain & Md. Imran Hossain

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Abstract- Face recognition is truly one of the demanding fields of biometric image processing system. Within this paper, we have implemented Back Propagation Neural Network for face recognition using MATLAB, where feature extraction and face identification system completely depend on Principal Component Analysis (PCA). Face images are multidimensional and variable data. Hence we cannot directly apply Back Propagation Neural Network to classify face without extracting the core area of face. So, the dimensionality of face image is reduced by the Principal Component Analysis algorithm then we have to explore unique feature for all stored database images called eigenfaces of eigenvectors. These unique features or eigenvectors are given as parallel input to the Back Propagation Neural Network (BPNN) for recognition of given test images. Here test image is taken from the integrated webcam which is applied to the BPNN trained network. The maximum output of the tested network gives the index of recognized face image. BPNN employing PCA is more robust and reliable than PCA based face recognition system.

Keywords: face detection, face recognition, principal component analysis (PCA), eigenfaces, back propagation neural network (BPNN).

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Abstract- Face recognition is truly one of the demanding fields of biometric image processing system. Within this paper, we have implemented Back Propagation Neural Network for face recognition using MATLAB, where feature extraction and face identification system completely depend on Principal Component Analysis (PCA). Face images are multidimensional and variable data. Hence we cannot directly apply Back Propagation Neural Network to classify face without extracting the core area of face. So, the dimensionality of face image is reduced by the Principal Component Analysis algorithm then we have to explore unique feature for all stored database images called eigenfaces of eigenvectors. These unique features or eigenvectors are given as parallel input to the Back Propagation Neural Network (BPNN) for recognition of given test images. Here test image is taken from the integrated webcam which is applied to the BPNN trained network. The maximum output of the tested network gives the index of recognized face image. BPNN employing PCA is more robust and reliable than PCA based face recognition system.

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I. Introduction

The human face represents a significant role in our social conversation, contain people's identity. In the past several years, Face recognition has been regarded as an important research subject in the area of Digital image processing (DIP) and Computer Vision mainly because of over growing security demand and both law or non-law enforcement.

The human face plays an important role in our social interaction; also contain people's identity and emotions among them. The human faces represent complex, multidimensional, meaningful visual stimulant. Developing a computational model for face recognition is difficult [1].

The primary approach for face recognition is face detection. It is easy and efficient for highly correlated biological neuron in the human brain. Even a small child can perfectly authenticate a human but it is difficult task for a computer. Here we present a mathematical model and computational model for face recognition that act as like as a human brain.

Due to the variational behavior of human face image, we need to extract unique feature. There are numerous strategies applied for this purpose. In this paper we have used principal component analysis algorithm to extract feature called Eigenfaces by modifying the image into one column and building a single matrix i.e. we must find the axis in which covariance matrix is diagonal or we determine a direction or a new axis where the data variation is the greatest. Then we find another direction where the remaining data variation is the greatest. But this two axes or direction is orthogonal from one another. The objective of PCA is usually to decrease the dimensionality of the image while retaining as a lot of information as possible in the original image. Using PCA we have calculated eigenface then all database face image projected on this eigenface space and we got a new face descriptor or feature vectors or weights matrix.

The eigenfaces or the principal Components of the faces are eigenvectors of the matrix and it is the eigenvectors. This combination of eigenvectors parallely given to the Back Propagation Neural Network input neuron. Training process in BPNN happens by back propagate the error and adjusting weights of each and every link. After training and testing is done by test image applied to the fully trained network. The maximum value of the tested network gives the recognized image index.

Face image is actually a biometrics physical feature which is used to verify the individuality of people. The main components involved in the face image space include mouth, nose, and eyes. Among various biometrics characteristics face is the most physical entity for identify among people [2]. Face identification can be done significantly by capturing devices using digital cameras or webcam.

II. Literature Review

This section quickly discusses the pattern recognition process and after that highlights some of the current research in the area of autonomous face recognition. Traditionally, pattern recognition is split up three areas: (1) segmentation, (2) feature extraction, and (3) classification [3]. Segmentation is the first step; it is finding regions of possible signals. The second stage is feature extraction and in this task we search for the most

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important or significant features of the regions passed by the segmentor which can be used in the last step, classification. Classification analyzes the extracted features to those of previously identified objects and identifies the object as one of the previously identified classes.

There are broadly two approaches used in face recognition [4]. The first approach is local based, this approach based on some number of distinct feature on the face are recorded manually or through feature extraction modules. The features used in local based face recognition are the nose position, nostril position, eye brows positions, eyes position, mouth position and chin position etc. This data is then processes usually either through the neural network or some statistical method is used for the recognition process. Yullie and Cohen used deformable templates in contour extraction of face images [5]. Another approach is holistic based, in this approach; the whole face is used for face recognition instead of taking only some local data. This may include a simple template matching or more sophisticated method such as PCA based method to extract the principle components for that huge set of data and reduced it into a smaller group of data. Matthew Turk and Alex Pentland, from the Massachusetts Institute of Technology Media Lab, have implemented this system for face recognition that also makes use of the Karhunen-Lobve Transform [1].

III. Methods and Methodologies

Our proposed technique based upon Principal Component analysis and Back Propagation Neural Network multilayer Classifier. Our proposed block diagram of face recognition procedure is as shown Figure 1.

a) Preprocessing and Face Database

The preprocessing of the images are Image size normalization, Histogram equalization, Median filtering and conversion RGB image to gray scale image. This module automatically takes same dimension image and perform preprocessing step in order to improve face recognition performance. The first criteria for face recognition is create a face database which contains all face images for training. There are two step to create face database: first, one is image taken from the live webcam and stored it to face database. Another one is image taken from a folder or disk storage or another external memory. Suppose total number of face image in this database is 'M'. Another important thing we should take all images in same dimension. In our system we take all image in the dimension of 306×251.
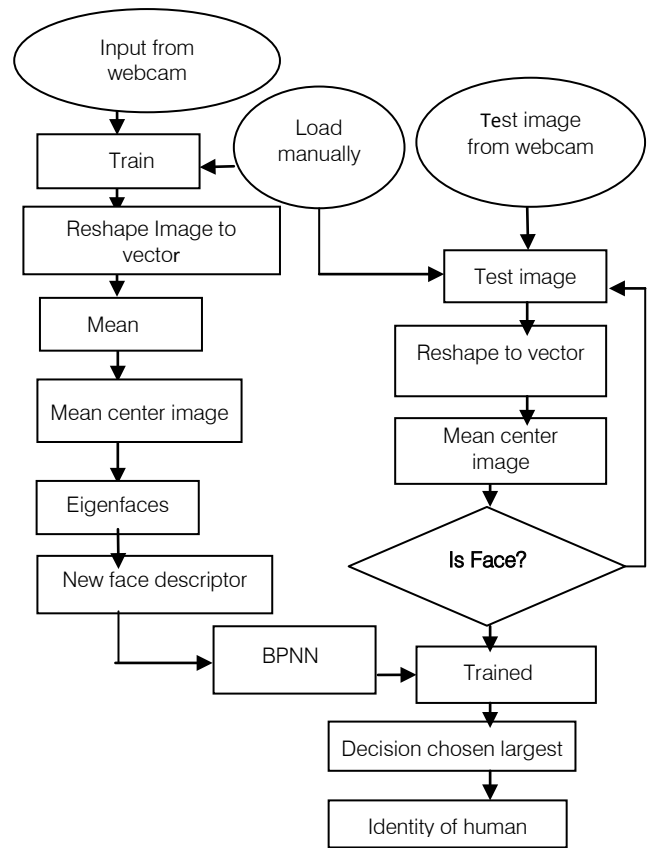
Fig. 1: Proposed Block diagram

b) Eigenface Calculation and Feature Extraction by PCA

An image is a two dimensional function I(x, y); so we consider the 2D case where we have an input image and compare this with the database to achieve the recognition goal. We also consider that the images are all of the same resolution. Each pixel can be regarded as a variable thus we have a very large dimensional problem which can be simplified by PCA. In image recognition an input image or test image with n×n pixels can be considered as a point in n^2 dimensional space called the image space. The coordinates of this point describes the values of each and every pixel of the image and form a column vector. This vector is formed by concatenating each column of 306×251 resolution image; it will dimension 76806 so form of the vector is 76806 rows and 1 column.

After face database D is set then all images in the face database reshape to vector and forming a matrix which indicate the image matrix where number of column equal to the number of face image in database or training set. Here we have M images each with n^2 pixels. We can write our entire data set as an $n^2 \times M$ data matrix D. Each column of D represents one image of our data set. Then concatenate column images form into one matrix.

$$D = \{\Gamma_1, \Gamma_2, \Gamma_3, \ldots \ldots \ldots, \Gamma_M\} \quad (1)$$

Then we calculated mean image of whole face image in database using the reshaped face matrix. We accomplished this by finding a mean image Ψ by averaging the columns of D matrix.

$$\Psi = \frac{1}{M}\sum_{n=1}^{M}\Gamma_n \qquad (2)$$

The calculation process is,

$$\text{Mean image} = \frac{\sum \text{Column of reshaped face matrix}}{\text{Total number of column}}$$

We need to adjust the images by subtract the computed average image from each image in the database. Consequently, the origin is moved to the mean of the data and this creates the mean centered data matrix.

$$\Phi_i = \Gamma_i - \Psi \qquad (3)$$

So the Adjusted image matrix is,

$$A = [\Phi_1, \Phi_2, \Phi_3, \Phi_4 \ldots\ldots\ldots\ldots\Phi_M] \qquad (4)$$

These Adjusted images determine how each of the images in database differs from the average face.

We need calculate the M×M matrix to find its eigenvalues and eigenvectors and we selected the k eigenvectors with the highest related eigenvalues. As a property to the eigenvector, each of them has an eigenvalue associated with it. More valuable eigenvectors with greater eigenvalues supply more information on the face variation than those with smaller eigenvalues. Here images are matrix represented so we must need to compute covariance matrix of image matrix for determine the eigenvector. It is extremely simple to compute the covariance matrix from the mean centered data matrix. So, the equation of covariance matrix is,

$$C = \frac{1}{M}\sum_{n=1}^{M}\Phi_n\Phi_n^T$$
$$= AA^T \qquad (5)$$

But Here a little problem in the output of covariance matrix. Where matrix dimension $n^2 \times n^2$ that is too big, even it exceeds the total quantity of face images in the database and also break the condition eigenface $\leq$ M.

Then the correct calculation of eigen vector V_i of $A^T A$

$$A^T A V_i = \lambda_i * U_i \qquad (6)$$

Eigenvectors with smaller eigenvalues lead tiny information in the data representation. Now compute the M best eigenvectors from covariance matrix and keep exactly the K eigenvectors equivalent to the K largest eigenvalues.To calculate the eigenfaces, the normalized or mean centered face multiplied with the highest eigenvector. These vectors describe the linear combinations of the M training set of stored face images which is called eigenfaces U_i.

$$U_i = \sum_{k=1}^{M}V_k\Phi_k \qquad (7)$$

Once the eigenfaces are taken from the covariance matrix of a collection of faces, every single face is projected onto the eigenface space and represented with a linear combination of the eigenfaces or provide a new descriptor related to a point under the high dimensional space with the eigenfaces as axes. A new face is turned into its eigenface components. Primary we compare our input image with our mean image and multiply their difference with each eigenvector. Every single value would represent a weight and would be saved on a vector $\boldsymbol{\Omega}$.

$$\omega_k = U_k^T(\Gamma - \Psi) \qquad (8)$$

Where, k = 1……..M. This represents a set of point which determined by image multiplications and summations operations executed at approximately frame rate on current image processing hardware. The weights form a feature vector calculated from the above (8) where each image project on the each of the eigenfaces. So, the new face descriptor is,

$$\Omega^T = [\omega_1, \omega_{2,}\omega_3 \ldots\ldots\ldots\omega_M] \qquad (9)$$

That describes the best contribution of every eigenfaces in addressing the input face image. The vector are able to be used in a conventional pattern recognition algorithm to find out what of a number of predetermined face class if any best describes the face. The face class can be calculated by averaging the weight vectors for the images of a single person face.

c) *Face Detection*

The image of a face when projected into the face space does not radically change, while non-face image projection is quite different. Basic idea is always to detect the existence of a face in a scene by calculating the distance from face space. If distance is low then it is a face.

For an unknown image Γ, compute the mean centered image

$$\Phi = \Gamma - \Psi \qquad (10)$$

Now every face inside the training database set (minus the mean), Φ_i can be described as a linear combination of these Eigenvectors or eigenfaces.

$$\Phi_i = \sum_{i=1}^{k}(\omega_i U_i) \qquad (11)$$

These weights may be computed as,

$$\omega_i = U_i^T\Phi_i \qquad (12)$$

Then compute the Euclidean distance e_d of unknown image from face Space.

$$e_d = \|\Phi - \Phi_i\| \qquad (13)$$

If e_d is less than specific threshold then Γ is a face

d) *Face Reconstruction*

Each Normalized face Φ_i in A can be represented as a linear combination of the best k

eigenvectors. So face reconstruction is very easy process by using eigenvectors. First we need to calculate weighted sum of all eigenfaces which is the reconstructed original image is equivalent to sum of all eigenfaces with every eigenface contain a certain weight. This weight describes to what amount of specific feature is present in the original image. If one face uses all the eigenfaces which is obtained from original face images it is possible to rebuild the main images from the eigenfaces exactly. Then this reconstructed image is definitely an approximation of the original image.

Now every face inside the training database set (minus the mean), Φ_i can be described as a linear combination of these Eigenvectors or eigenfaces.

$$\Phi_i = \sum_{i=1}^{k}(\omega_i U_i) \qquad (14)$$

These weights may be computed as,

$$\omega_i = U_i^T \Phi_i \qquad (15)$$

Where i = 1, 2... M. This means we have to calculate such a vector corresponding to every image in the training set and store them as template. In Φ_i, where i is a number which indicates that which person face we want to reconstruct

e) Back Propagation Neural Network

In 1986, a group of scientists led by Rumelhart. J.L. McClelland and D.E. put forward a type of error back-propagation algorithm for training multilayer feedforward neural network, which is one of the widely used networks [6]. The generalized delta rule [7 8] also referred to as backpropagation algorithm criteria is explained here briefly for feed forward neural network (NN). The NN explained here consist of 3 layers. This 3 layer are input, hidden, and output Layers. During the training phase, the training data is fed parallel to the input layer. The data are propagated to the hidden layer and then to the output layer. This process is known as the forward move of the BPNN algorithm. The error involving in actual output values and target output values is calculated and propagated back toward hidden layer to input layer. This process is known as the backward move of the BPNN algorithm.

f) BPNN Algorithm

The back propagation algorithm performs like this,

Step 1: First apply the inputs to the network to get the network output simply. Now remember this initial output could be anything, as the initial weights were random numbers between -0.3 to 0.3.

Step 2: For every node of output, simply calculate the error. The error is what you want - What you actually get. In other words,

$$\delta_K = O_K(1-O_K)(O_K - T) \qquad (16)$$

The $O_K(1-O_K)$ term is essential in the equation due to the Sigmoid Function, if we were only using a threshold neuron it would just be $(O_K - T)$.

Step 3: Then calculate the Errors for theneurons of hidden layer.

$$\delta_J = O_K(1-O_K)\sum_{k\varepsilon K}\delta_K W_{JK} \qquad (17)$$

Where, W_{JK} is the weight between layers J to layer K.

Step 4: For every Iteration, Update the weights and biases are as follows

Updated weight, $\Delta W = -\eta\delta_l O_{l-1}$

Updated Bias, $\Delta\theta = -\eta\delta_l$

Where negative signs determine back propagate the errors and the constant η is the learning rate is put in to speed up or slow down the learning if required.
Then apply,

$$W + \Delta W \rightarrow W$$
$$\theta + \Delta\theta \rightarrow \theta$$

Step 5: Having acquired the Error for that hidden layer neurons now proceed as in step 4 to change the hidden layer weights. By reiterating this method, we can train a network of any number of layers. Back Propagation Neural network is broadly used pattern classification algorithm which reverse propagates the error and adjusts the weights to near the target output.

g) Face Recognition Using BPNN

After feature extraction we have to create neural network. We created neural network one for each person in the database. Then extracted feature vectors are fed as inputs to train each person's networks.

In training, the faces feature vectors that belong to same person are used as positive examples for the person's network i.e. network gives 1 as output, and negative examples for the others network i.e. Network gives 0 as output which the target value were. The algorithm used to train the network is the back propagation Algorithm. The basic idea with the back propagation algorithm is to use gradient descent to update the weights so as to minimize the mean squared error between the network output values and the target output values. The update procedures are derived by taking the partial derivative from the error function with regards to the weights to find out each weight's contribution to the error. Then every weight is modified using gradient descent based on its participation to the error. The activation or transfer function use in Back Propagation neural network is sigmoid function which maps the output 0 to 1. With the effective operation of the back propagation network it is necessary for the appropriate selection of the parameters used for training. We have used initialize weights between -0.3 to 0.3 and here number of output neuron equal to number of input neuron because each network equal to the one person. In this training process we keep the learning rate 0.05 and hidden neuron 50.Also we have an option to change the hidden neuron for every execution. Here

too few hidden units will prevent the network from being able to learn the required function, because it will have too few degrees of freedom. Too many hidden units may cause the network have a tendency to over fit the training data thus reducing generalization accuracy. Though learning rate is low but it gives the better accuracy than highest one. Additionally a small learning rate is used to avoid main disruption of the direction of learning when extremely unusual pair of training patterns is presented. When neural network met the stopping condition then it stops and gives the train output.

In testing, a new image is taken for recognition from face database or live webcam. We reshape this image to vector and calculated normalized image. This normalized face images are compared with the reconstructed face image. If Euclidian distance between two images is minimum or less than predefined threshold, then it is face otherwise this is not face. If this is face, then we are ready for testing the human face for recognition.

Before testing we need to extract feature of this unknown human face. Its feature vectors are determined from the eigenfaces identified before, and this image receives its new descriptors. These new descriptors are inputted to each network and also the networks are simulated using these descriptors. The network outputs are compared. If the maximum output exceeds the predefined threshold level, then this new face is decided to belong to person with this maximum output.

IV. Experimental Results and Discussions

The Graphical User Interface was constructed using MATLAB GUIDE or Graphical User Interface Design Environment. Using the layout tools provided by GUIDE, we have designed the following graphical user interface figure (mainguinn.fig) for the face recognition user application.
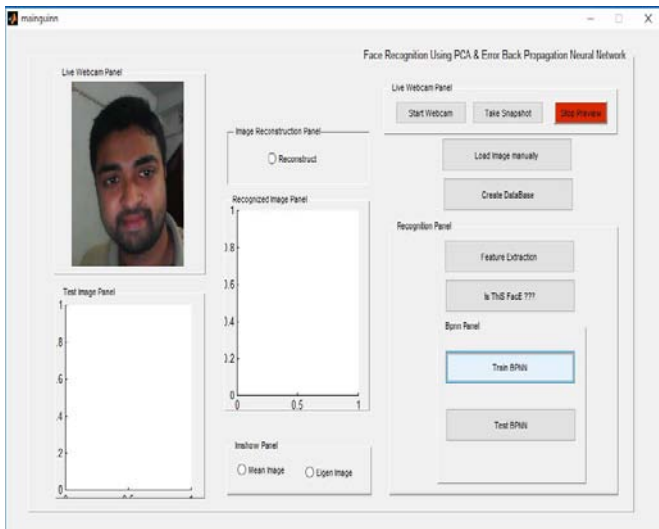
Fig. 2: Graphical interface of proposed system with test image from webcam

Training and Testing Images: Training images are taken by the webcam and we have created a database which contains 25 images under different lighting condition. Also we have an option for load image manually to create database. Here some images of our database,
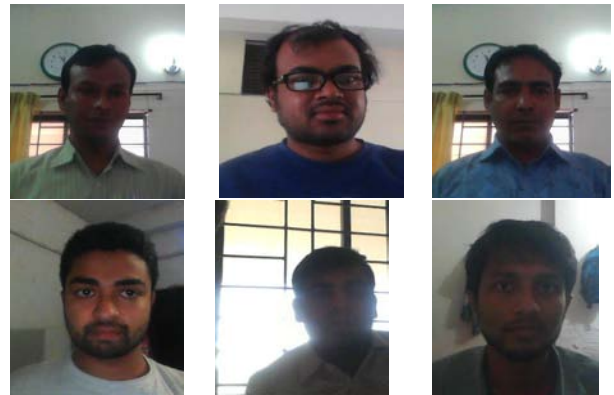
Fig. 3: Training images of image database taking from webcam

Fig. 4: Test image *Fig. 5:* Mean image *Fig. 6:* Recognized image

Also our system checks the provide test image face or not face which is the part of face detection and give a confirmation message after face recognition.
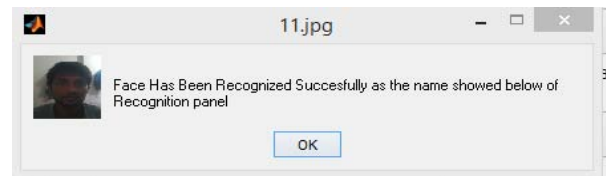
Fig. 7: Face detection confirmation message
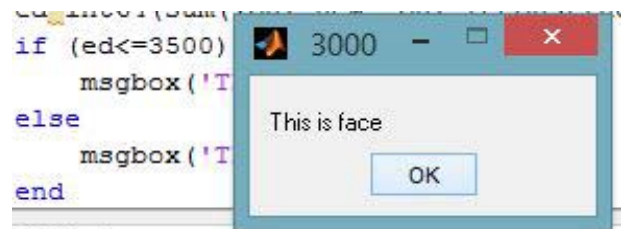
Fig. 8: Face recognition confirmation message
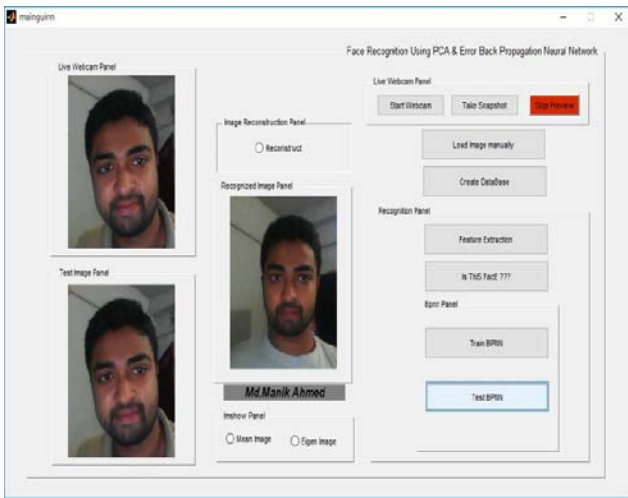
Fig. 9: Graphical interface after face recognition

Face Reconstruction: The reconstructed image is undoubtedly an approximation of the original image.

Fig.10: Original image   *Fig.11:* Reconstructed image

Accuracy Calculation: We have tested on 25 images which are taken from webcam and database. Accuracy can be calculated using the following formula,

$$\text{Accuracy} = \frac{\text{Correctly tested}}{\text{Total number of image to be tasted}} \times 100$$

Face detection Accuracy$= \frac{20}{25} \times 100 = 80\%$

Face Recognition Accuracy when test image taken from webcam

$$= \frac{23}{25} \times 100 = 92\%$$

Face Recognition Accuracy when test image taken from Database

$$= \frac{25}{25} \times 100 = 100\%$$

V.   CONCLUSION

In this paper, Eigen face represented features vectors are used for face recognition. The features are obtained from the face image to shows unique identity of human face utilized as inputs to the neural network for classification. Eigenfaces are the most significant feature and reduce the size of input of neural network. This system performs human face recognition at a very high degree of accuracy. We encountered several problems in these experiments due to the lighting variation. However, we can overcome this issue by normalize the illumination. This is a biometric system and the work can be surely used in biometric applications like access control and verification systems.

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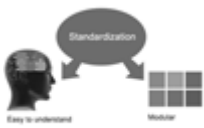
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Once you are designated as MARSC, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

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.
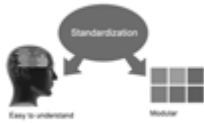
After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after 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.
"

Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

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Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

*   Words (language)
*   Ideas
*   Findings
*   Writings
*   Diagrams
*   Graphs
*   Illustrations
*   Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

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

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

PREPARING YOUR MANUSCRIPT

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
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.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

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

FORMAT STRUCTURE

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

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative 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) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

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

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning 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 a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be 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. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

PREPARATION OF ELETRONIC FIGURES FOR PUBLICATION

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). 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.

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TIPS FOR WRITING A GOOD QUALITY COMPUTER SCIENCE RESEARCH PAPER

Techniques for writing a good quality computer science research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. 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.

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

4. Use of computer is recommended: As you are doing research in the field of computer science then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

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

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

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. 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 for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

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

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon 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 for 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 of 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 criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to 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 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 avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

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

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite 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 approaches 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. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a 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 limit the initial two items to no more than one line each.

Reason for writing the article—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 for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity 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 of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

o Explain the value (significance) of the study.
o Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
o Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
o Briefly explain the study's tentative purpose and how it meets 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 for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory 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 soundly written procedures segment allows a capable scientist to replicate 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 to give the least amount of information that would permit another capable scientist to replicate 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 section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show 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:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

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

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

o Resources and methods are not a set of information.
o Skip all descriptive information and surroundings—save it for the argument.
o 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 as 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. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give 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 manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit 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 section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an 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 implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully 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 the prospect, and let it drop at that. Make a decision as to whether each premise is supported or 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.

o   You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
o   Give details of all of your remarks as much as possible, focusing on mechanisms.
o   Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
o   One piece of 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?
o   Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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