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# A Knowledge Based System Design for the Diagnosis and Control of Ebola Virus Disease (EVD) Using GRNN

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## ABSTRACT

This research, an intelligent based system design for the diagnosis of Ebola Virus Disease (EVD) has presented an application of expert system for the diagnosis of Ebola Virus Disease with better performance, reliability and increased efficiency. The aim is to design an intelligent system using GRNN for the diagnosis of EVD. The EDSS is designed using Java platform (Netbeans 6.9.1), SQlite, and other tools such as UML Ucase diagrams, system flowchart etc, which are used to capture the basic functionalities needed for the design on the system needed to optimally actualize the overall objective of the new system design.
**Keywords** : Intelligent, Diagnosis, GRNN, Reliability, Design.

## I. INTRODUCTION

Ebola virus is a severe infection affecting currently several African countries, mainly Guinea, Sierra Leone, and Liberia. It was first discovered in 1976 in the Democratic Republic of Congo, near the Ebola River, where the virus takes its name, but recently was also identified in West Africa [5].

The outbreak of the disease was first reported in Guinea in 1976 (before it later spread to the neighbouring countries of Liberia, Sierra Leone and Nigeria). An initial report by the World Health Organization (WHO) showed that as at July 2nd 2014, the total number of deaths attributed to this epidemic in Guinea, Liberia and Sierra Leone was 481, out of the 779 known cases (approximately 62% case fatality rate), making it the 'largest and deadliest' Ebola outbreak in history. The odds of the disease moving further to other African countries, especially along the West African coasts with cross boarder commercial and social activities were distressing. The fear was that Ebola in densely populated cities like Lagos in Nigeria could spell huge catastrophe, given our history of a weak health system, poor planning and delayed emergency responses. Eventually, Ebola was reported in Lagos, Nigeria in July 2014. By August 31, the WHO epidemiology and surveillance report indicated there have been 21 cases and 7 deaths in Nigeria, while 3685 cases and 1841 deaths have been reported in Guinea, Liberia and Sierra Leone, while Senegal has only one case. The disease was confirmed in Port Harcourt, with possible incidence in other states in the country [1].

The Ebola virus is one of the viruses in the filoviridae category of virus, and it is a virus that horror-filled tales of biological warfare. The word "Ebola" invokes fear of the highest order in patients and medical professionals alike. This could be attributed to the fact that there is no known cure for the infection and because typical antibiotics do not work to fight it, or it could be because of the devastating effects the virus has on the body. While the virus is concentrated in Africa at epidemic levels, there have been cases diagnosed in America as well. "It is thought that fruit bats of the Pteropodidae family are natural Ebola virus hosts". It then spreads through human-to-human transmission, becoming the deadliest pathogen. Ebola virus is transmitted to an initial human by contact with an infected animal's body fluid. On the other hand, human-to-human transmission can take place by direct contact (through broken skin or mucous membranes, for example, the eyes, nose, or mouth) with blood or body fluids of a person who is sick with or has died from Ebola [12]. It is also transmitted indirectly via exposure to objects or environment contaminated with infected secretions. There is yet no licensed treatment proven to neutralise the virus, but a range of blood, immunological and drug therapies are under development [2].

This research is geared towards designing an intelligent system for the diagnosis of Ebola Virus disease since Ebola is one of the serious diseases which demands expensive treatment, spreads rapidly over a short period of time with severe side effect and with high mortality rate.

Artificial Neural Network (ANN) is at present, a hot research area in medicine with extensive application to biomedical systems. Essentially, this research seeks to propose a Generalized Regression Neural Network (GRNN) based expert systems for the diagnosis of Ebola Viral Disease (EVD).

## II. THE PROGNOSIS OF EVD

According to the author in [5], the virus is transmitted to people as a result of direct contact with body fluids containing virus (vomits, sweat, stool, urine, tears, breast milk, saliva and respiratory secretions) of an infected patient during the acute stage of disease.

Epidemiological studies have revealed that family members are at high risk of infection because they may come in contact with infected body fluids or may help to prepare the corpse of an infected person for burial. Direct contact with virus containing material from contaminated hands of caregivers to their own mouth or eyes is the most common cause. Caregivers who work both at home and in hospitals are at greatest risk of exposure. While studies have proved the spread of EVD via aerosol particles under controlled laboratory conditions, such transmission rarely appeared in humans in a hospital or household setting during epidemics.

Further, infection can occur through sexual contact and the virus has been traced in semen for up to seven weeks after recovery. It is recommended to control and use condoms during intercourse, and to avoid breast feeding for at least three months after recovery as to prevent secondary cases. The Center for Disease Control and Prevention (CDC) has clearly outlined isolation procedures. The spread of infections are also the product of nosocomial or occupational transmission.

## III. THE CONTROL OF EVD

According to the available data, barriers to preventing and controlling the EVD in affected countries include irresolute and disorganized health systems, substandard sanitary conditions, poor personal hygiene practices, and false beliefs and stigma related to EVD, [17]. There are further hindrances due to the unavailability of electricity, water, adequate communication services between health officials, and poor facilities for transportation of patients and specimens, [10]. The public health sector along with the respective chief authorities in developing countries must devise strategies, keeping the available resources in mind, to deal with the outbreak before it occurs.

As a first step, communities should be educated on EVD's symptoms, history, mode of transmission, and methods of protection, including the importance of personal hygiene practices, via seminars, newspapers, and other social media. A Popular Opinion Leader (POL) giving this information would further help to remove the misconception about the nature of the disease and indirectly improve the quality of life of affected patients and their families, [7,13].

In addition, health systems should formulate proper plans for emergency care, ensuring adequate quarantine facilities, proper surveillance, case management, and contact tracing. Training should be given to healthcare providers in areas such as prompt diagnosis and isolation of a suspected patient, the importance of wearing personal protective equipment, and safe burial techniques [17]. There should be adequate distribution of gloves, gowns, masks, soaps, and disinfectants to healthcare facilities, and safety precautions should be devised especially for laboratory personnel including pretransfusion testing, [9]. The CDC guidelines for monitoring patients (including symptomatic and asymptomatic), and precautions for healthcare professionals (including wearing personal protective equipment, practicing personal hygiene, use of disposable medical instruments, minimizing pricking and aerosol producing procedures, monitoring exposed staff, and adequate environment control) should be practiced, [8]. Special ambulances should also be reserved to enable the safe transport of EVD patients. Incident Management Systems (IMSs), such as the one adopted by the CDC for the control of the current epidemics, has proven efficacious in preventing the spread and adequately controlling the disease [18,16]. A report about the employment of an IMS divulged that Nigeria has successfully limited the outbreak and no further cases have been reported since 19th October, 2014, see [19]. The employment of such a system has resulted in a decrease of EVD patients in Liberia, see [16]. Many drugs are being probed as preventive medications for EVD, such as amiodarone, chloroquine, and clomiphene [7]. An effective vaccine is also being devised; recombinant vesicular stomatitis virus vaccine has been the most promising, yet its efficacy has so far not been tested in humans, [15]. Another study found that Virus-Like Particles (VLPs) can provide postexposure protection by amplifying Type 1 interferon signaling in macrophages and dendritic cells, which are thought to be the initial Ebola virus infection sites, [3]. Thus, taking these preventive measures will drastically reduce the outbreak of the EVD.

### 3.1 Neural Network Learning and GRNN Architecture

The network touches "learning" through the mathematical process can be disregarded by the final user mainly. This is the way of viewing the network as "gloomy case". The gloomy case receives a vector with "n" inputs and provides a vector with "m" outputs. The network studies from a sequence of examples that form the training database. See figure 1 below.

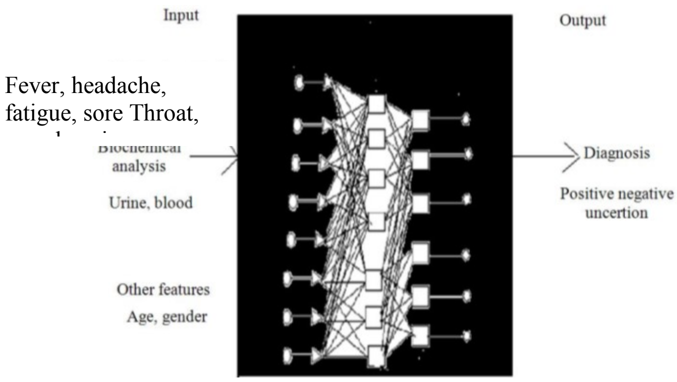



**Figure 3.1:** ANNs-based Prognosis using inputs and outputs

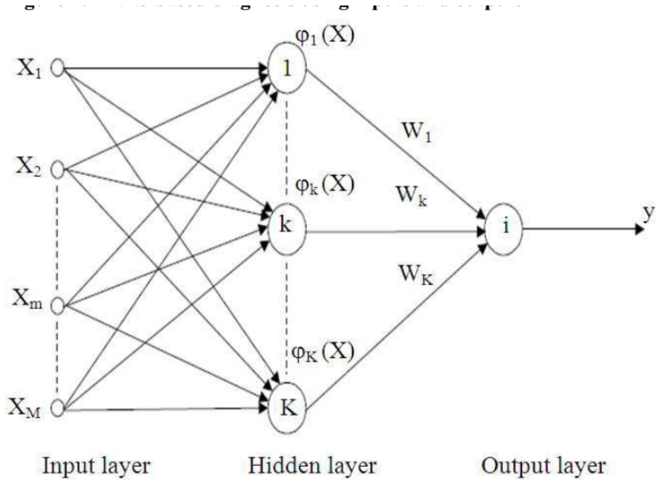



**Figure 3.2 :** ANNs-based Prognosis using inputs and outputs

### 3.2 Generalized regression neural network architecture

The generalized regression neural network was originally proposed for system modeling and prediction. It has been used to learn the same problems as the back-propagation network, the radial basis function network, the probabilistic neural network, and the modular neural network. The network has a relationship to the probabilistic neural network and has sometimes been used in place of it for taxonomy problems.

This network according to [14] has certain features:

i. Speedy learning
ii. Good convergence with a large number of training examples
iii. Control of sparse data well
iv. Possible memory control
v. Conceivable computing time issues

GRNN falls into the category of probabilistic neural networks. This neural network like other probabilistic neural networks needs only a fraction of the training samples a back propagation neural network would need. The data available from measurements of an operating system is generally never enough for a back propagation neural network [11]. Therefore the use of a probabilistic neural network is especially advantageous due to its ability to converge to the underlying function of the data with only few training samples existing. The additional knowledge needed to get the fit in a sustaining way is relatively small and can be done without additional input by the user. This makes GRNN a very useful tool to make predictions and comparisons of system performance in practice [14].

## IV. METHODOLOGY

The methodology used for this research is the Structural System Analysis and Design Methodology (SSADM) since it is acceptable software engineering principle for the design of software. A feasibility study of the conventional method of Ebola Virus Prognosis was taken. Analysis was made to discover area of weakness and the objectives of the proposed system and its design specifications implemented.
SSADM: Structural System Analysis and Design Methodology (SSADM) is a widely used computer application developed in a System. Due to the nature of this research, SSADM is used. This is because SSADM enables projects to be supported by computer-based tools such as computer aided software engineering system so as to establish a frame work to capture basic functionalities for good communication between participants in a project. For each stage SSADM sets out a series of techniques and procedures and conventions for recording and communicating information which pertains to both texture and diagrammatic forms.

### 4.1 Design Model

Design model is a diagram that shows a practical representation of the steps taken to process a given set of data and the relationship between them. It can therefore be defined as the diagrammatic representation of the steps required in solving problems. The model used is here iterative waterfall model.

#### 4.1.1 UML Use Case Diagrams

A Use Case is made up of a set of Scenarios (Such as: About Ebola, Update Info, Preventive Measure) Each Scenario is a sequence of steps that encompass an interaction between a user and a system.

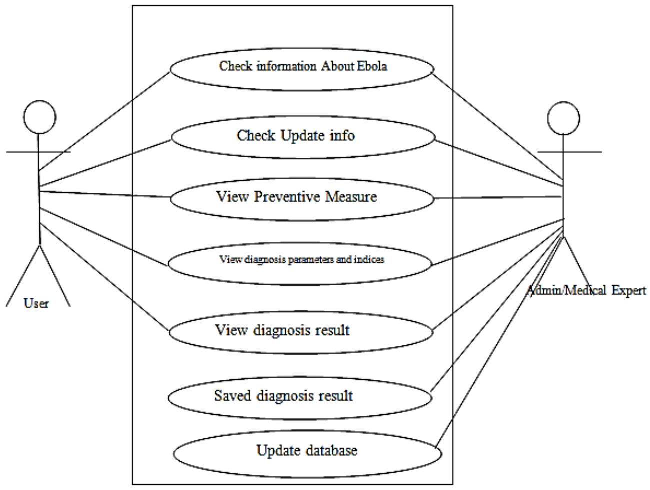



**Fig. 4.1:** UML Use Case diagram for diagnosis of Ebola Virus disease

#### 4.1.2 File Design

The new system comprises of a database for the diagnosis and control of Ebola Virus Disease Database. The database was designed using Access Database. The structure for the tables in the database file includes:

**Table 1:** Database table 1 structure (About Ebola)

| Field Name | Data Type | Field Size | Index |
|---|---|---|---|
| ID | Integer | 1 | Primary |
| AboutEbola | Text | 25,000 | Null |

**Table 2:** Database table 2 structure ( Patient Data)

| Field Name | Data Type | Field Size | Index |
|---|---|---|---|
| PatientCode | Integer | 10 | Primary |
| PatientName | Text | 100 | Null |
| PatientSymptoms | Text | 100 | Null |
| PatientQuarantine | Text | 100 | Null |
| PatientResult | Text | 100 | Null |

### 4.1.3 Logical Model (Flow Chart)

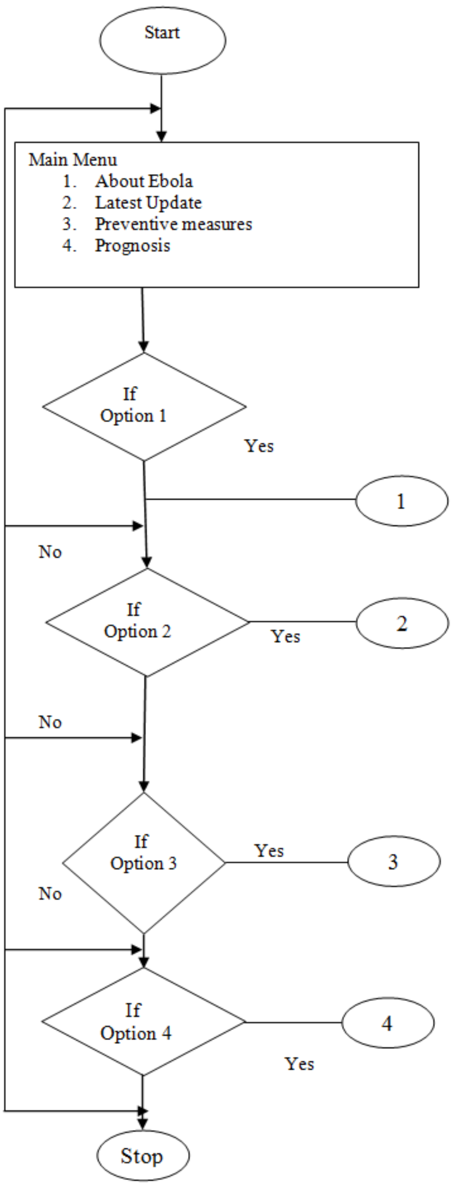



**Fig. 4.2:** System Main Flow chart

Fig. 4.3 shows the logical flow of events in the system, it caters for the time when the user logs in and signs out of the system

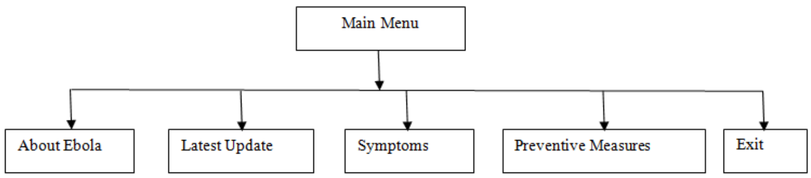



**Fig. 4.3:** Main Menu flow chart

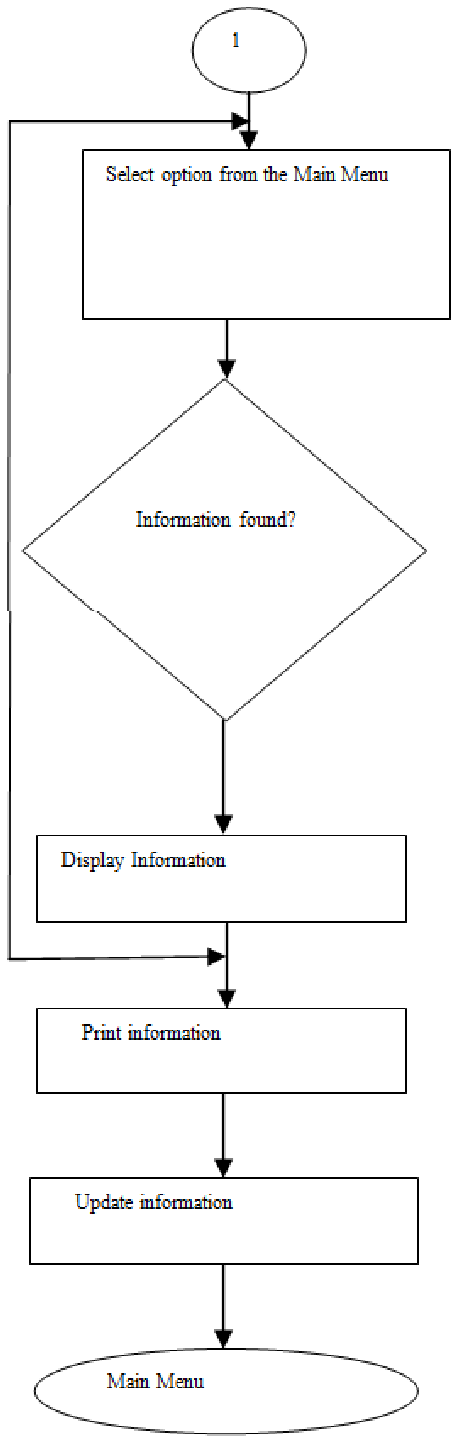



**Fig. 4.4:** System flowchart for Awareness

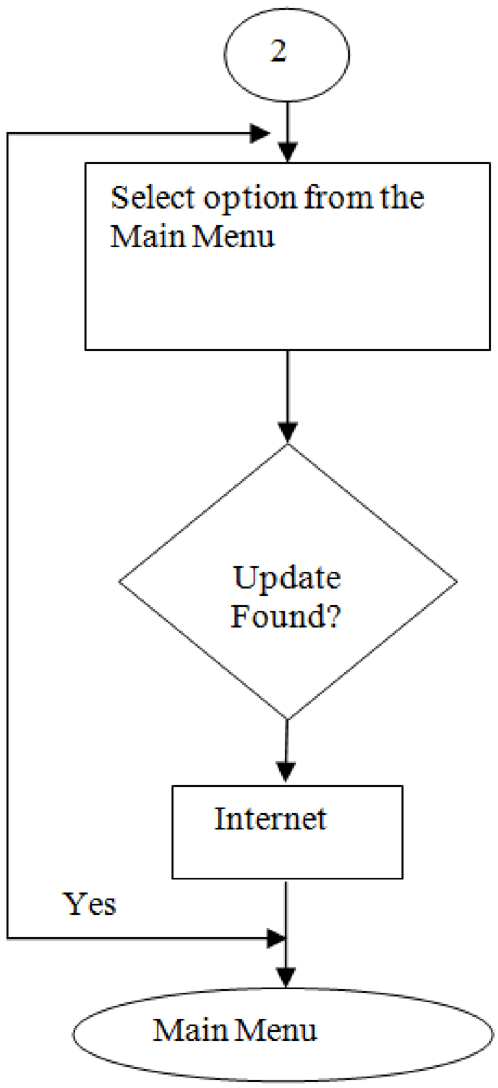



**Fig. 4.5:** System flowchart Latest Update

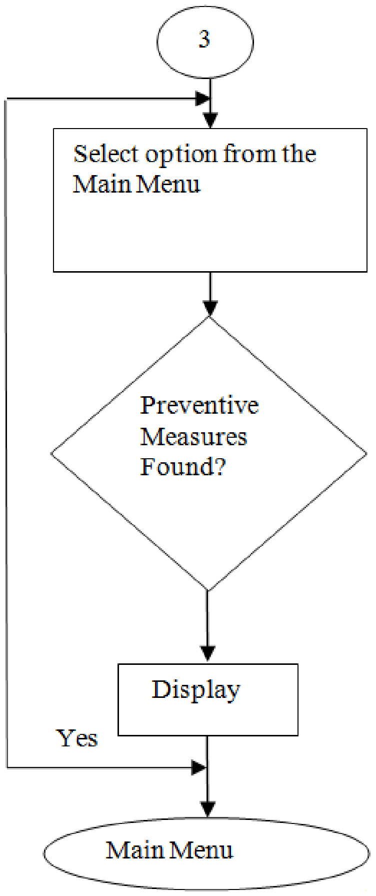



**Fig. 4.6:** System flowchart Preventive Measures

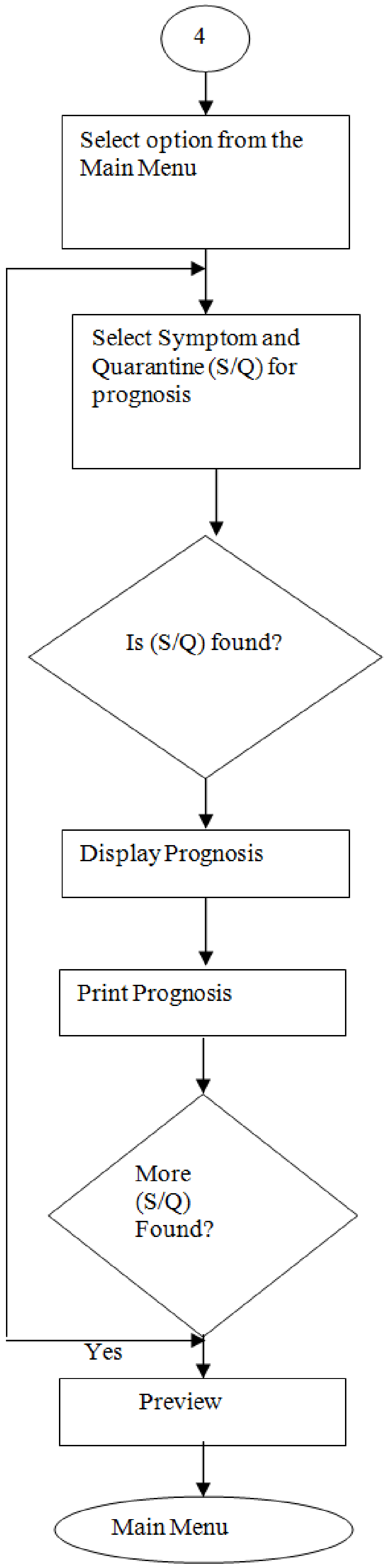



**Fig. 4.7:** System flowchart for Symptoms and Quarantine

### 4.1.4 Designing the New System

It is expected that with the introduction of this new system, tremendous changes will be noticed. In the design of the diagnosis system, conscientious effort was made to create an effective knowledge based system which would be successfully implemented into the workflow, providing users with the necessary tools to enhance their decision making abilities.

The system is able to give useful diagnosis and control strategies based on the selected symptoms and Quarantine (S/Q) submitted by the user. It does this by querying a pool of diagnosis parameters in the database record and selects the parameters that matches the selected symptoms and Quarantine (S/Q). The system proves to be helpful by providing useful diagnosis and control techniques to the user. It does this because the backend record is dynamic. The goal is simple and feasible because the technologies have been tested and found to resolve all constraints.

The system, design provides a friendly interface. The symptoms windows displays a checkbox function that allows the user to select the suggested symptoms and Quarantine (S/Q) if there is any relating to his/her condition. The system now uses the query function; thus sends a query to the backend.

### 4.1.5 Analysis of New System

To provide efficient and accurate automated diagnosis and control information quality system that will help in facilitating the treatment and prevention of Ebola Virus Disease. The new system will give information about EVD. It will also help in giving an update on the Ebola Virus Disease. The new system will be providing user with Symptoms and Quarantine (S/Q) to be selected for the diagnosis of EVD and also help in giving the desired control measure of the disease.

### 4.1.6 System Design Philosophy

The main standard for this design is that, the users will be provided with the different symptom and quarantine to be selected for diagnosis.

**(A) Input Design:**

Data input is generally done through the keyboard terminals. Screen buttons are designed such that the user will tick the appropriate option for the diagnosis.

**(B) Output Design**:

This is the sole aim of the design. The output design of the system is the printed report. Some outputs of the system include:

i. Information on Ebola virus
ii. Control measures of Ebola Virus Disease (EVD)
iii. Numbers of symptoms ticked or selected by the user
iv. Number of the quarantine
v. The diagnosis result

### 4.1.7 Program Design

The design is made in form of modules, which are collectively five modules in number. The entire problems are splitted into smaller units, then; these units are coded into computer understandable GUI form. The individual units are later combined to form a system. The modules include:-

I. Awareness module
II. Update module
III. Symptoms module
IV. Preventive Measures module
V. Exit module

**Awareness Module**

This module holds information about Ebola with the aim of sensitizing the user on the deadliness of Ebola Virus Disease (EVD).

**Update Module**

This module links the user to the Internet for updates on Ebola Virus Disease (EVD) when connected to the network.

**Symptoms Module**

This module contains symptoms and quarantine (S/Q) for the diagnosis.

**Preventive Measures Module**

This module holds Preventive measures of Ebola Virus Disease (EVD).

**Exit Module**

This module enables the user to go out of the program after working on it.

### 4.1.8 Choice of Programming Language

The programming language chosen is Java (Netbean 6.9.1) for designing of the front-end and SQlite for the back-end.

#### 4.1.9 System Requirement

Both software and hardware are required for the system to run correctly and efficiently.

##### 4.1.9.1 Software Requirements

Windows, Linux
Java Netbean 6.9.1
SQlite Database

##### 4.1.9.2 Hardware Requirements

Pentium VI and Above
256MB Ram and above
320GB HD
Printer

## V. RESULTS

As GUI is the main entry point to any software application, the Diagnosis Support System is designed in an easy to interact with anybody due to its user friendly environment. The front-end of Ebola Diagnosis Support System (EDSS) is designed in Java to make the interface simpler and easier.

The following Figure, Fig. 4.1 shows Home Screen which is the gateway point to the EDSS Application.

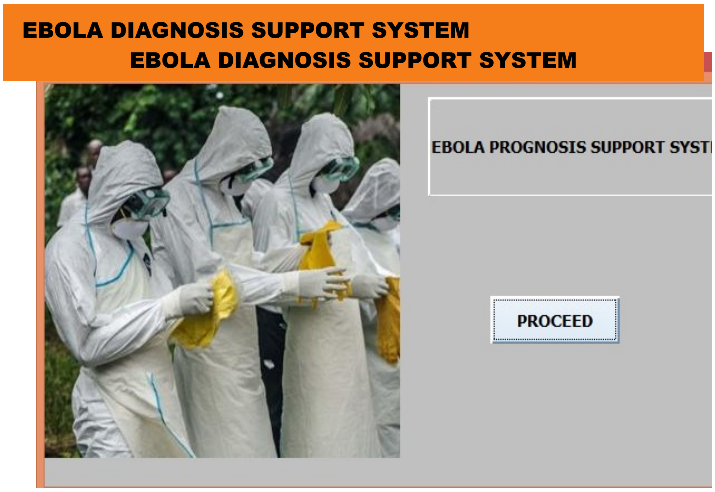



**Fig. 5.1** Home Screen

The Figure shows Login Screen which allow access to EPSS Application


**Fig. 5.2 Login Screen**

Fig. 5.2 displays the Login Screen which allows a user easy access to EDSS application.


Fig. 5.3 above shows the form that displays and prints information on Ebola Virus Disease and allows an administrator to login and update information in the database.

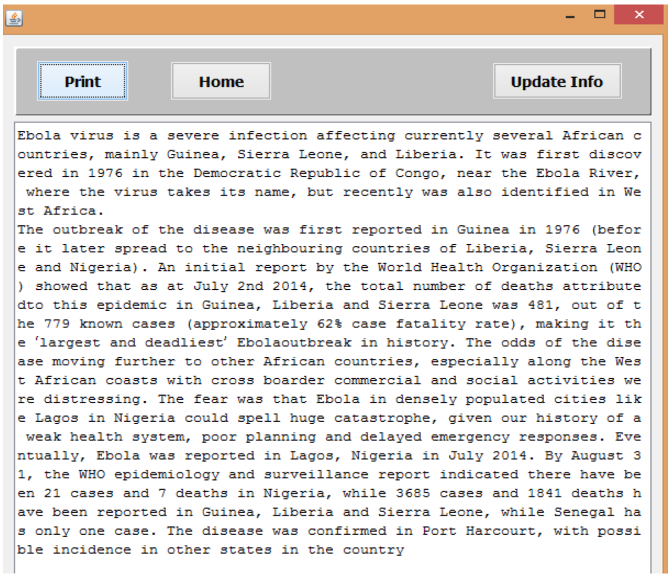



**Fig.5.4** Information Screen

Fig. 5.5 shows Administrator login form for updating information on Ebola Virus Disease in the database.

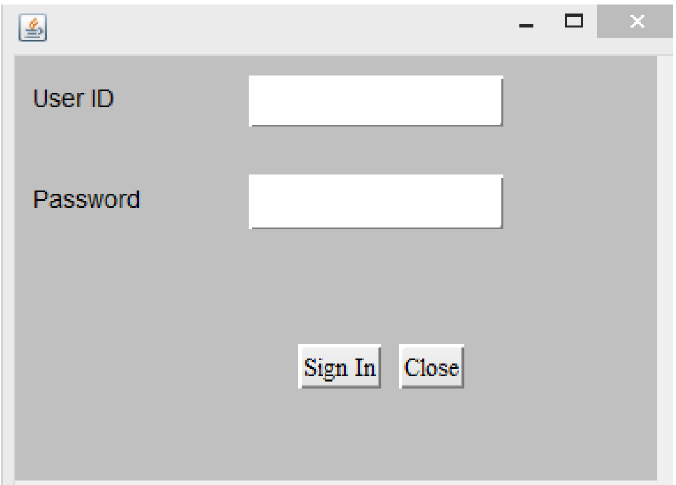
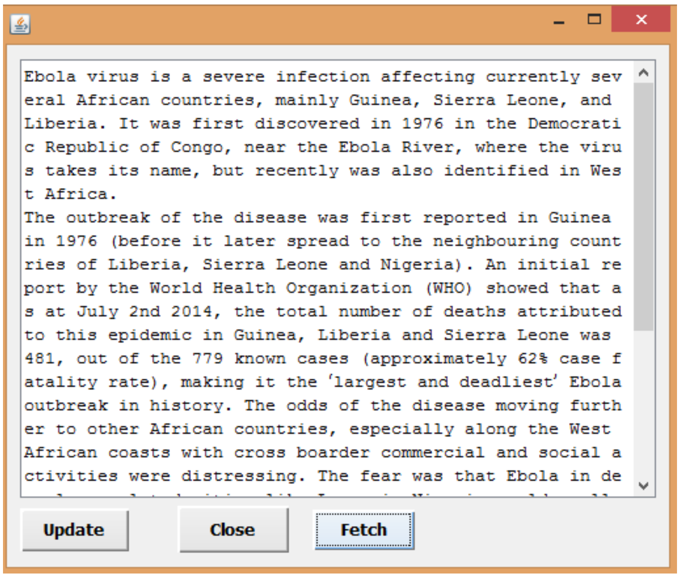



**Fig. 5.5** above shows the Administrators Login Screen

Figure 5.6 shows Administrator's editing and updating form to the database.




.**Fig.5.6** Administrator's Update Screen

Fig. 5.6 above shows the Administrator's EDIT and UPDATE form module to the database. The "Fetch" button is used to fetch data and after any update, the "Close" button is used to exit.

The Fig. 5.7 below shows form that display the control measures of Ebola Virus Disease to the user.

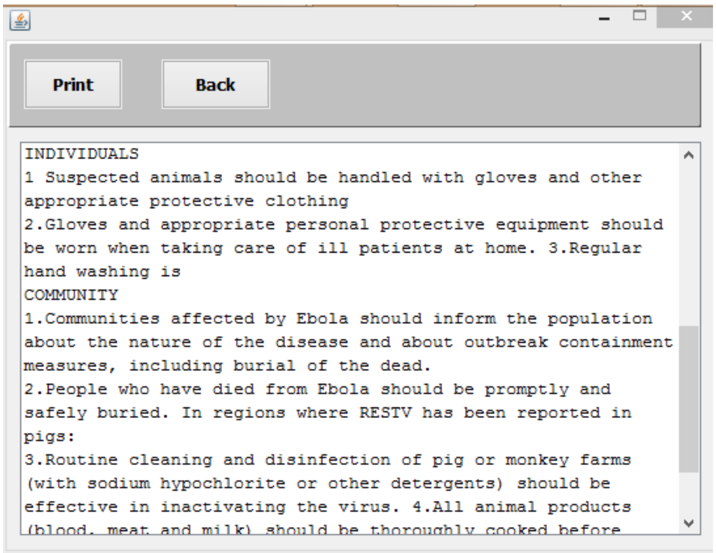



**Fig. 5.8** Prevention and Control Screen

The Figure 5.8 shows the diagnosis form where the user will select the symptoms (such as Fever, sore Throat etc) and quarantine (either the user has suffered with the symptoms for more than or less than 21 Days) for diagnosis of Ebola Virus Disease.

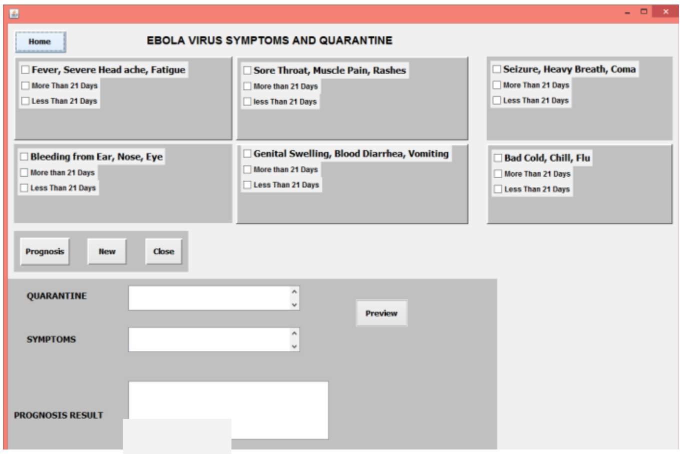


Fig.5.8 Diagnosis Screen

The fig. 5.9 below, shows the form that allow user to review and save diagnosis, indices, parameters and result in the database.

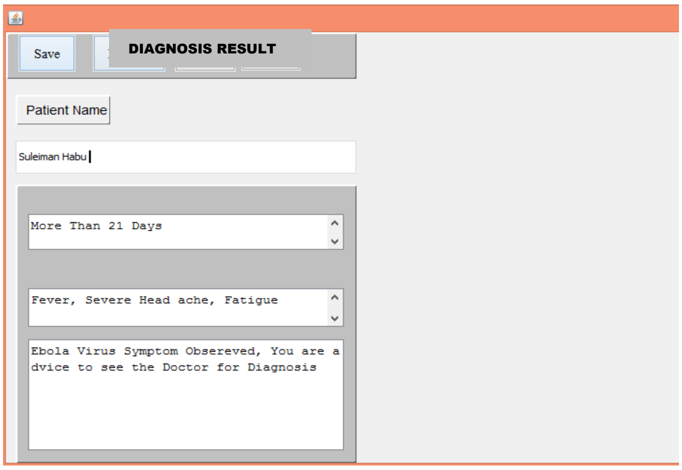


Fig.5.9 Preview Screen

## VI. CONCLUSION

With the rate of the spread of Ebola Virus Disease diseases in Sub-Saharan African region today, medical specialists, and Health agencies find it difficult to handle the prediction, diagnosis and control of Ebola Virus Disease as such, Ebola triggered widespread fear among local populace that leads to the rapid intensification of spread of the disease. This research has presents the application of Ebola Diagnosis Support System for the prediction, diagnosis and control of Ebola Virus with better performance, reliability and increase efficiency and availability. The system, (EDSS) serves as an important supportive tool for the user. It will indeed assist the user or physicians to know whether or not a patient is infected and to predict the chances of possible spread in the community.

The coupling of EDSS technology brings together two potentially powerful methods for improving healthcare quality. To realize the potentials of this synergy, literature-based and practice-based evidence has been captured into computable knowledge bases; technical and methodological foundations for evidence-adaptive EDSS to be developed and maintained.

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