

Mobile Expert System on Febrile Diseases

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Abstract

It is obvious that in most developing countries patients lack access to good medical services and facilities; the long queues of patients in the hospitals waiting to be attended to cannot be avoided leading to waste of time and worsening of patient's ailment. Febrile diseases have been considered as one of the dangerous diseases which kills more people more than the dreaded Acquired Immune Deficiency Syndrome(AIDS) not because it is not curable but because of the similarities in signs and symptoms that makes it difficult for health workers and the general public to easily identify their variations and administer proper medication. This paper Mobile Expert system on Fevers, is a mobile expert app developed for use in the diagnosis of many febrile diseases which includes malaria, scarlet, typhoid, chikungunya, rheumatic, dengue, lassa, meningitis, filariasis and influenza fevers. The software was implemented using Android SDK programming language and SQLite as the database containing experts' knowledge. It is accessible via mobile devices running on Android operating system platform, and as a data-driven app, the data supplied as symptoms by the user leads to conclusion on any of the diseases within its domain. It also provided general information to people about the ten types of fevers covered in this work. The app does not need any special requirement for its operation.

Keyword: Artificial Intelligence, Expert System, Acute, Chronic, Bio-information, Pyrexia, Diagnoses

I. INTRODUCTION

Health problems have been in existence since the creation of man on planet earth and may likely last as long as man is not extinct from the earth. Several diseases that proliferate on humans are enormous and their hold on man has invariably reduced his lifespan. Amongst these diseases are the febrile diseases which have been considered as one of the dangerous diseases that has led to the death of many and still stand as a great peril to human existence. Some of the febrile diseases are said to be the most common cause of mortality in the tropics [1].

Adehor and Burell [2] stated that one of the febrile diseases kills more people more than the dreaded Acquired Immune Deficiency Syndrome(AIDS) not because it is not curable but because it has signs that are very similar to those of other notable febrile disease.

Information technology plays an important role in the fields of bio-medical area and is used widely for diagnosis and treatment of illnesses[3] The advancement in computing technology especially in the area of artificial intelligence which is a branch of computer science that is concerned with the design analysis and implementation of sophisticated or intelligent programs that can mimic the behavior of human experts in a given domain man has been able to develop computer programs that can help in reducing the scourge of some preventable diseases.

Expert system is an applied area of artificial intelligence that deals with developing computer system that emulates the decision-making ability of a human expert. It is a software that uses a knowledge base of human expertise for problem solving, or to clarify uncertainties where normally one or more human experts need to be consulted [4].

In recent times, expert systems have been widely used in almost all the fields of man's expertise to assist the users in taking decision; where human expertise and multifaceted decision making is required, like medical diagnosis, expert decision making, policy making, estimating strategies, analysis and soon [5]

Expert system may not have learning components but a third common element is that once the system is developed it is proven by being placed in the same real world problem solving situation like an expert, typically as an aid to human workers or a supplement to some information system. In like manner, developing one of such system to represent the repository of the knowledge of medical doctor is as essential as any other system.

This research work presented the mobile expert system on fevers which is meant to carry out diagnosis and prescription for some fevers through interactive response with the user of the system. The fevers under study are malaria, scarlet, typhoid, chikungunya, rheumatic, dengue, lassa, meningitis, filariasis and influenza fevers. The app is mobile in

nature due to the proliferation of mobile devices which invariably provides ease of access to the users.

A. Aim and Objectives of the Study

The Research work aimed at delivering an Expert System on the Diagnosis and prescription of some fever types. The objectives of the system are as follows:

- a) To diagnose the different kinds of fevers based on the simple clinical sign and symptoms from the client.
- b) Serves as a prescription system for the treatment of the different fevers diagnosed.
- c) To provide information to the general public on different kinds of fevers available.

B. Significance of the Study

The significance of this study is to introduce a knowledge base system (i.e. an expert system) that employs the knowledge of humans captured to solve problems that ordinarily human expertise is required in order to improve the quality of our medical services. Also, it is aimed at enlightening the general society on fevers. The products of this research will assist the medical practitioners in delivering quality health services to patients at a faster rate than in the current practice thus improving on the facelift of health services in the country.

II. LITERATURE REVIEW

A. Expert System

Expert System (ES) is an intelligent computer program which has a wide base of knowledge in a restricted domain which has been provided by human experts and it uses complex inference reasoning to perform tasks which human experts can do [6]. It is software that uses a knowledge base of human expertise for problem solving, or to clarify uncertainties where normally one or more human experts would need to be consulted. An expert system can also be defined as computer applications which embody some non-algorithmic expertise for solving certain problems.

Factual knowledge and reasoning ability are used by human experts in problem solving. In an expert system, these two essentials are contained in two separate but related components: a knowledge base and an inference engine. The knowledge-base provides specific facts and rules about the subject and the inference engine provides the reasoning ability that enables the expert system to form conclusions.

Steps in the expert systems development process include determining the actual requirements, knowledge acquisition, constructing expert system components, implementing results, and formulating a procedure for maintenance and review. Knowledge acquisition is the most important element in the development of expert system [7]. An inference engine fits the user's problems into the knowledge

base and derives a conclusion from the rules and facts it contains [8].

Other facilities or tools obtainable in an expert system are user interface and explanation subsystem. User interfaces, as with any application, enable people to form queries, provide information and interact with the system. Explanation subsystem enables the systems to explain or justify their conclusions, and they enable developers to check on the operation of the system themselves.

According to Seghal [9], expert systems are used in diagnostic applications, making financial planning decisions, configuring computers, monitoring real time systems, underwriting insurance policies and performing many services which previously required human expertise

B. Computerized Medical Diagnosis

Diagnosis is used in many different disciplines like in computing, tools, logic and experience to determine the cause and effect relationships. The word diagnosis comes from the medical context which is the process of identifying a disease by analyzing its symptoms and signs. Medical diagnosis refers both to the process of attempting to determine the identity of a possible disease or disorder and to the opinion reached by this process. There are a number of techniques used by providers to obtain a correct diagnosis namely: Exhaustive Method, Algorithm Method, Pattern-Recognition Method and Differential Diagnosis.

Shortlife [10] explained that medical diagnosis is the identification of the nature of disease by means of observations recorded from the manifestation of symptoms. This is achieved by examining the use the clinical features and investigation associated with the disease. In severe cases, diagnosis may require confirmation from microbiological, immunological and homological or histopathological examination. Physical investigation involved thorough examination of patients before examination for diagnosis can fully be analyzed. Some disease can be acute, severe or chronic. But in whatever nature diseases appears, diagnosis can still be achieved through clinical manifestation of its symptoms.

C. Fevers

A fever or pyrexia is a rise in internal body temperature to levels that are considered to be above normal. Average body temperature is about 98.6°F or 37°C and temperature above 104° F or 38°C are generally considered to be febrile.

Body temperature is determined by the body's thermoregulatory set-point. The body increases this set-point in response to threats such as bacterial or viral infections. When this set-point rises, a fever occurs and the body perceives itself as suffering from hypothermia (colder than it should be). Brief summary on the fevers under study and their symptoms is shown in Table I.

S/No.	Fever Type	Brief Description and Causes	Symptoms
1	Malaria	Transmitted by the bite of a female anopheles' mosquito. When a mosquito bites an infected person, a small amount of blood is taken, which contains malaria parasites. These develop within the mosquito, and about one week later, when the mosquito takes its next blood meal, the parasites are injected with the mosquito's saliva into the person being bitten. After a period of between two weeks and several months (occasionally years) spent in the liver, the malaria parasites start to multiply within red blood cells, causing symptoms that includes fever and headache. In severe cases, the disease worsens, leading to coma and death.	Rise in temperature accompanied by chills, headache, shivering. Nausea, abdominal cramps, dry cough, tiredness, myalgia (limbs and back pain), loss of appetite, sweating, fatigue, dizziness, fever, shivering, arthralgia (joint pain), vomiting, anemia (caused by hemolysis), hemoglobinuria, retinal damage, and convulsions.
2	Scarlet	Scarlet fever is a disease caused by exotoxin released by streptococcus pyogenes.	They include: abdominal, bright red color in the crease of the underarm and elbow, chills, fever, general discomfort (malaise), headache, muscle aches, sore throat, swollen red tongue (strawberry tongue), vomiting and nausea, very sore and red throat, sometimes with white or yellowish patches, difficulty in swallowing. The rashes usually begin by looking like a bad sunburn with tiny bumps, and it may itch.
3	Typhoid	Also known as salmonella typhi or commonly just typhoid. Is a common worldwide illness, transmitted by the ingestion of food or water contaminated with the feces of an infected person? The bacteria then perforate through the intestinal wall and are phagocytosed by macrophages. The organism is a gram-negative short bacillus that is motile due to its peritrichous flagella. The bacterium grows best 37°C/99°F- human body temperature.	rise in temperature often as high as 103° or 104° (39 or 40C), headache, weakness and fatigue, sore throat abdominal pain, diarrhea or severe constipation, rash, weight loss, profuse sweating, gastroenteritis, delirium, lethargic and thirst.
4	Chikungunya	Chikungunya (in the makonde language that means "bends up") virus (CHIKV) is an insect-borne virus, of the genus alphavirus, that is transmitted to humans by virus-carrying aedes mosquito.	The incubation period of chikungunya disease is from two to four days. Fever up to 40°C(104°F), maculopapular or petechial rash (a unique type of rash with spots and bumps), other non-specific symptoms can include, headache, inflammation of conjunctiva of the eye, joint pain, muscular pain, fatigue (weakness, nausea, vomiting and rash), vomiting and rash.
5	Rheumatic	Rheumatic fever is an inflammatory disease that may develop two to three weeks after a group of streptococcal infection (such as strep throat or scarlet fever). It is believed to be caused by antibody cross reactivity and can involve the heart, joints, skin, and brain. Rheumatic fever is an inflammable disease that can develop as a complication of untreated or poorly treated strep throat. Strep throat is caused by infection with group of streptococcus bacteria	: Heart inflammation (carditis), fever, painful and tender joints, pain in one, joint that migrates to another joint, red, hot or swollen joints, small, painless nodules beneath the skin, chest pain, sensation of rapid fluttering or pounding heartbeats (palpitation), fatigue, shortness of breath, jerky, uncontrollable body movement.
6	Filariasis	Filariasis or filarial is caused by the bite of an infected mosquito belonging to species called culex	The spectacular symptom of lymphatic filariasis is elephantiasis. The early symptoms are fever accompanied by pain and redness along the affected lymphatic vessels.
7	Dengue	Dengue fever and dengue hemorrhagic fever (DHF) are acute febrile disease which occur in the tropics, can be life-threatening and are caused by four closely related virus serotypes of the genus flavivirus, family flaviviridae	High fever up to 105°F (40.6°C), a rash over most of your body, severe headache, backache or both, pain behind your eyes, severe joint and muscle pain. Nausea and vomiting, abdominal pain, rash, drop in blood pressure (shock), bleeding from the nose and mouth.
8	Meningitis	It is an infection of the lining (meninges) and the fluid that cover the outside of the brain and spinal cord. The infection can spread into tissue and cause brain damage.	High rise in temperature, severe headache, vomiting, nausea with headache, confusion or difficulty concentrating, seizures, sleepiness or difficulty waking up, stiff necks, photophobia, lack of interest in drinking and eating and skin rash in some cases.
9	Influenza	Influenza, commonly refer to as the flu, is an infectious disease caused by RNA viruses, of the family orthomyxoviridae (the influenza viruses), that affects birds and mammals.	Rise in temperature and extreme coldness (chills shivering, shaking, rigor), cough, nasal congestion, body aches especially joint and throat, fatigue, headache, easily irritated, watering eyes, reddened eyes, skin (especially face), mouth, throat and nose, in children gastrointestinal symptoms such as diarrhea and abdominal pain.
10	Lassa	Lassa fever is an acute viral hemorrhage fever first described in 1969 in the town of Lassa, Borno state, Nigeria located in the yedseram river valley at the south end of lake chad.	Rise in temperature, which may be constant or intermittent, pain behind the chest wall and at the back, a sore and inflamed throat with white patches on your tonsil, cough and abdominal pain, vomiting (bloody), diarrhea (bloody), facial swollen, temporary or permanent hearing loss Dysphasia, Hepatitis, pericarditis, hypertension, hypotension.

Table I: Summary of Fever Types Under Study

D. Related Work

So many researchers over time have designed and developed different types of expert systems which have been used for the diagnosis and treatment of some diseases. Some of these work were done by ([11]; [12]; [13]; [14]; [15]; [16]; [17]).

[15]and [16]both developed expert systems for the diagnosis of Malaria fever the major difference in their works is that former applied fuzzy logic in their developmental process. The two work focused on only one type of fever.

[17]developed a rule-based expert system that can be used in diagnosis of five diseases namely: Malaria, Typhoid Fever, Cholera, Tuberculosis, and Breast Cancer. They incorporated only two fevers and three other diseases.

The expert system for diagnosis of fevers in this work takes in to consideration ten types of fevers (malaria, scarlet, typhoid, chikungunya, rheumatic, dengue, lassa, meningitis, filariasis and influenza) which has subsumed all the other ones developed by the earlier mentioned researchers. It is installable on mobile devices like Phones, tablets, iPad, etc. that operates on the android platform.

III. RESEARCH METHODOLOGY

A. Problem of the Existing System

The problems that are common with the manual system include the following:

- i. Absence of medical personnel lead to deteriorated cases of patients.

- ii. Retrieval of information is not quick and accurate.
- iii. Problem of inefficiency in the manual diagnosis system.
- iv. High cost of medical diagnosis in the manual system.

B. Advantages of the Developed System

The proposed system has the following advantages:

- The system can store knowledge more than Human Doctors and do not forget it.
- The system can access specialist knowledge that a doctor may not have.
- The system also has increased distribution of expertise.
- It will also reduce the number of patients in waiting queue for minor cases of fever diagnosis.
- The system will reduce the time required for medical diagnosis.

C. System Modeling

The developed system was modeled using Use Case diagram which is a type of Universal Modelling Language (UML). It provides a way for your developers to come to a common understanding with your system’s end users and domain experts [18].Figure 1 shows use case diagram of the proposed system

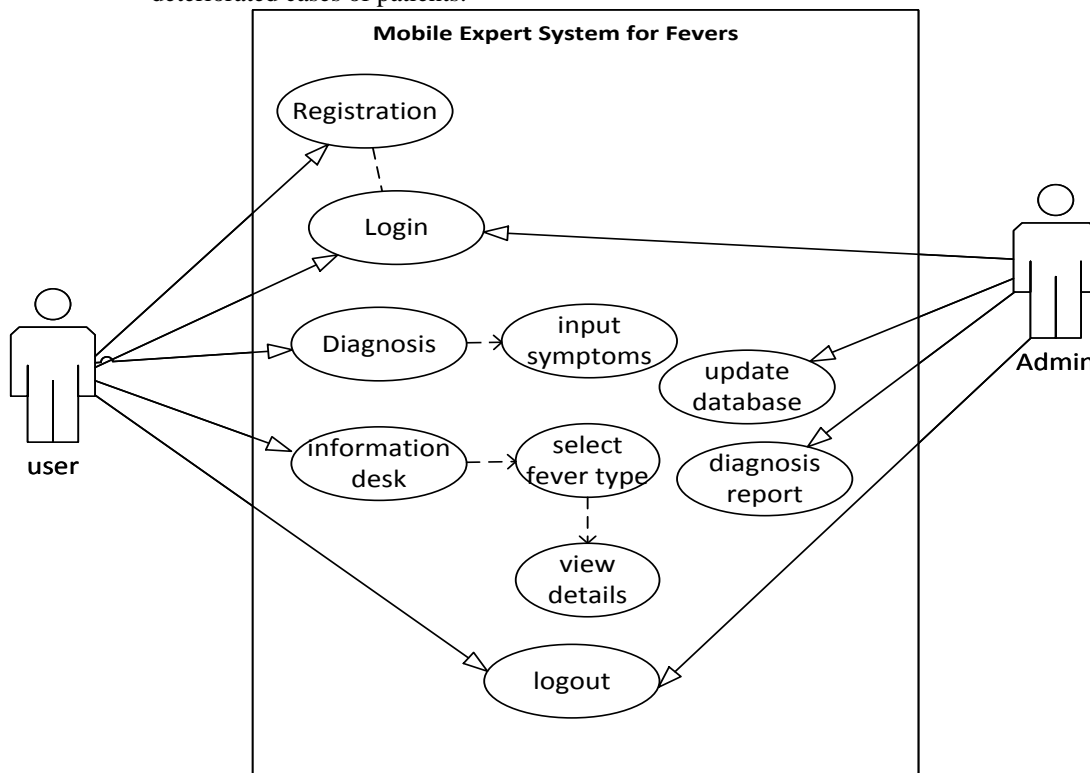


Figure 1: Developed System Use case

D. System Design

System design is an organized scheme or method or plan produced to show the look and function of something before it is built or made. It is based on analysis carried out in the requirement definition and specification phase. The system design can be carried out in terms of input, output and database design.

1) Input Design and Output Design:

Input design facilitates the entry of the data into the computer system. Input design involves the selection of the best strategy for getting data into the computer system as accurate as possible. It must capture all the data that the computer needs without introducing any errors. Table II is a sample input design.

Table II: Fever Diagnosis Input Design

Field name	Data type
High_fever	Boolean
Shivering	Boolean
Fatigue	Boolean
Myalgie	Boolean
Arthralgie	Boolean
Hemoglobinuria	Boolean
Retina_damage_convulsion.	Boolean
:	:
symptomN	Boolean

The output designs are the reports or products of what is yielded by the system. Table III shows a sample output design for the proposed system.

Table III: Sample Output Design

Field name	Data type	Description
result	Varchar	it displays fever type, drug prescription and advice

E. Flowchart

Program flowchart of the developed system is shown figure 2.

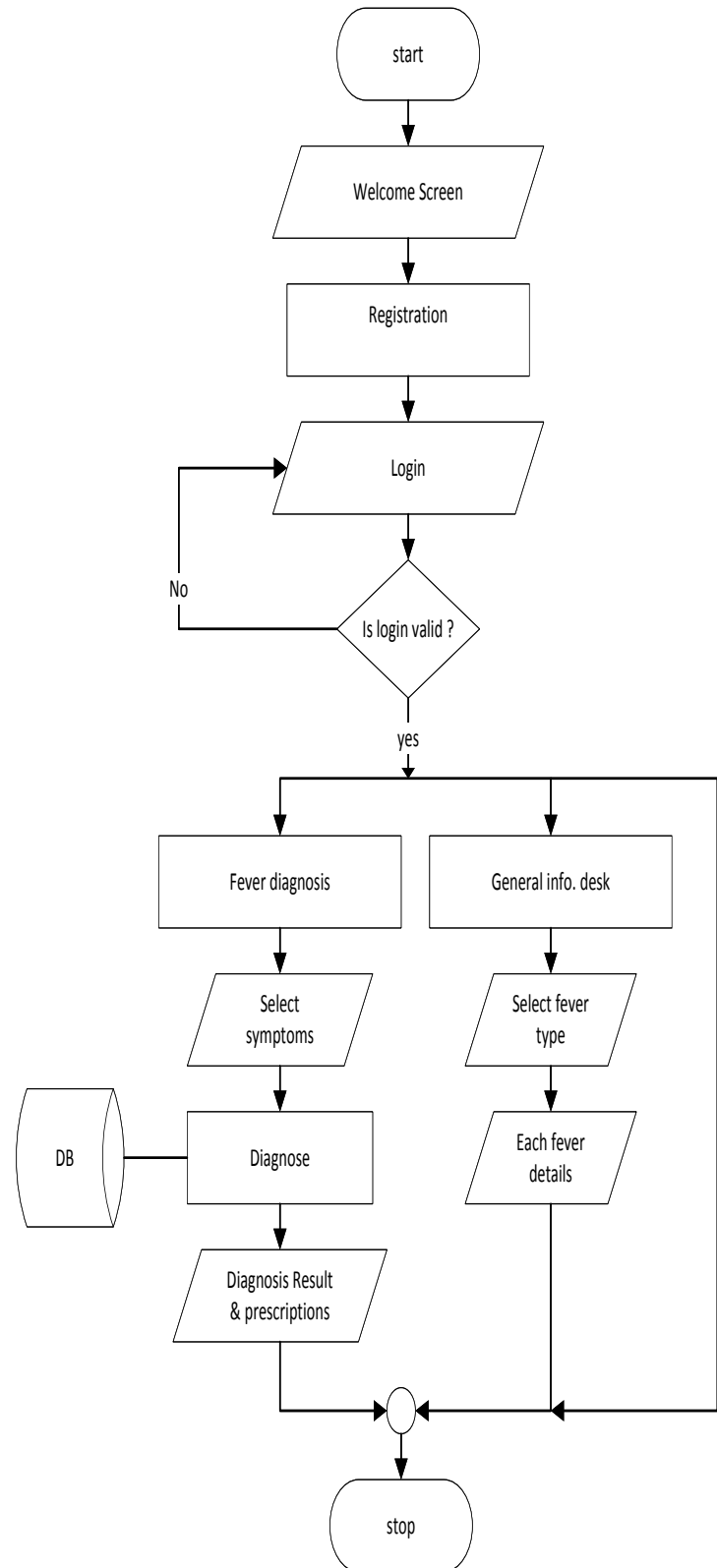


Figure 2: Proposed System Program Flowchart

F. Program Architecture

The class diagram in figure 3 shows the program architecture of the proposed system.

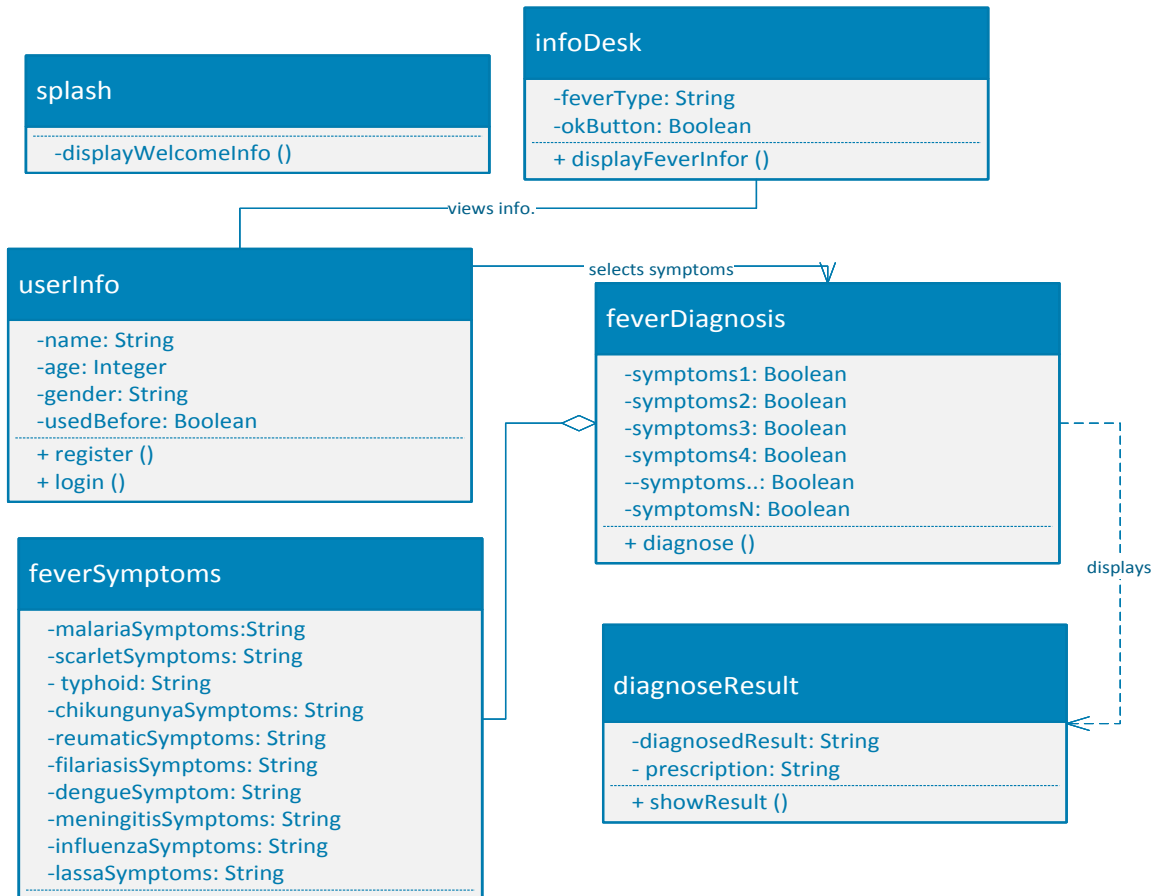


Figure 3: Proposed System Class diagram

G. Choice of Programming Language

The software was implemented in Android SDK with SQLite for data storage purpose. It is an open source integrated software platform.

IV. TESTING, RESULT AND DISCUSSION

A. Software Testing

Test techniques includes, but are not limited to the process of executing a program or application with the intent of finding software bugs (errors or

other faults). Table IV shows system testing that was carried out on the developed app.

Table IIV: System Testing Test cases

Test case id	Objectives	Description	Expected result
TC1	To check if malaria fever can be diagnosed	Select symptoms common to malaria fever	The user should see malaria fever as result, drug prescription and advice
TC2	To check if scarlet fever can be diagnosed	Select scarlet symptoms	The user should see scarlet as result, drug prescription and advice
TC3	To check if typhoid fever can be diagnosed	Select typhoid symptoms	The user should see typhoid as result, drug prescription and advice
TC4	To check if Chikungunya fever can be diagnosed	Select Chikungunya symptoms	The user should see malaria as result, drug prescription and advice
TC5	To check if Rheumatic can be diagnosed	Select Rheumatic symptoms	The user should see Rheumatic as result, drug prescription and advice

TC6	To check if Filariasis fever can be diagnosed	Select Filariasis symptoms	The user should see Filariasis result, drug prescription and advice
TC7	To check if Dengue fever can be diagnosed	Select Dengue symptoms	The user should see Dengue as result, drug prescription and advice
TC8	To check if Meningitis fever can be diagnosed	Select Meningitis symptoms	The user should see Meningitis as result, drug prescription and advice
TC9	To check if Influenza fever can be diagnosed	Select Influenza symptoms	The user should see Influenza as result, drug prescription and advice
TC10	To check if Lassa fever can be diagnosed	Select Lassa symptoms	The user should see Lassa as result, drug prescription and advice
TC11	To test if general information on different fever types can be accessed	Select different fever types to access info about each	Ease of access to info on the different fever types selected

B. Result

Based on the test carried out, the system was able to satisfactorily meet the expected requirement as shown in Table V which gives the

summary of the result obtained from the testing. Figures 4 to 19 showed some sample result interface obtained.

Table V: System Testing Result

Test cases	Objectives	Result	References
TC1	To check if malaria fever can be diagnosed	Malaria fever was diagnosed, treatment prescriptions and advice also displayed	See figures 4 to 19 for sample result obtained
TC2	To check if scarlet fever can be diagnosed	Scarlet fever was diagnosed, treatment prescriptions and advice also displayed	
TC3	To check if typhoid fever can be diagnosed	Typhoid fever was diagnosed, treatment prescriptions and advice also displayed	
TC4	To check if Chikungunya fever can be diagnosed	Chikungunya fever was diagnosed, treatment prescriptions and advice also displayed	
TC5	To check if Rheumatic can be diagnosed	Rheumatic fever was diagnosed, treatment prescriptions and advice also displayed	
TC6	To check if Filariasis fever can be diagnosed	Filariasis fever was diagnosed, treatment prescriptions and advice also displayed	
TC7	To check if Dengue fever can be diagnosed	Dengue fever was diagnosed, treatment prescriptions and advice also displayed	
TC8	To check if Meningitis fever can be diagnosed	Meningitis fever was diagnosed, treatment prescriptions and advice also displayed	
TC9	To check if Influenza fever can be diagnosed	Influenza fever was diagnosed, treatment prescriptions and advice also displayed	
TC10	To check if Lassa fever can be diagnosed	Lassa fever was diagnosed, treatment prescriptions and advice also displayed	
TC11	To test if general information on different fever types can be accessed.	Information desk provides info on different fever types.	

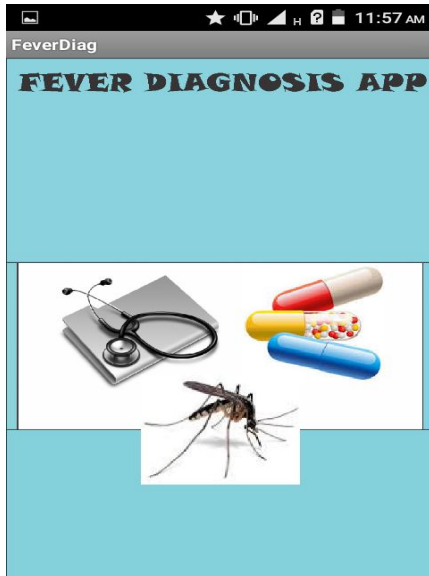


Figure 4: Start Page

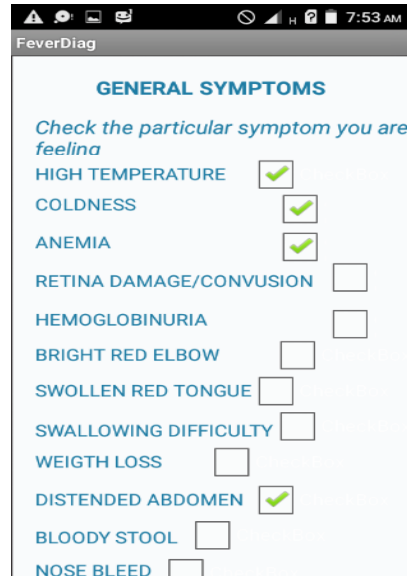


Figure 7: General Symptoms 1

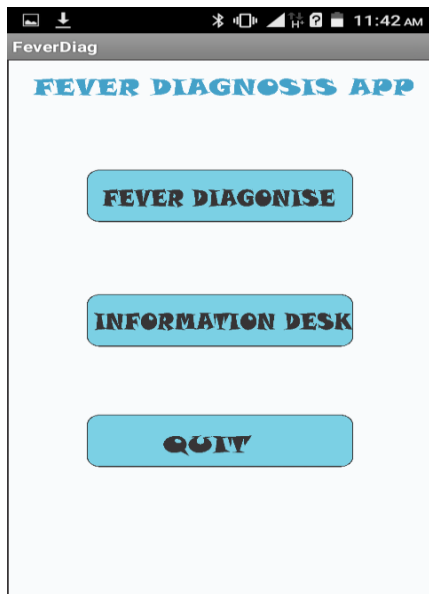


Figure 5: Option Interface

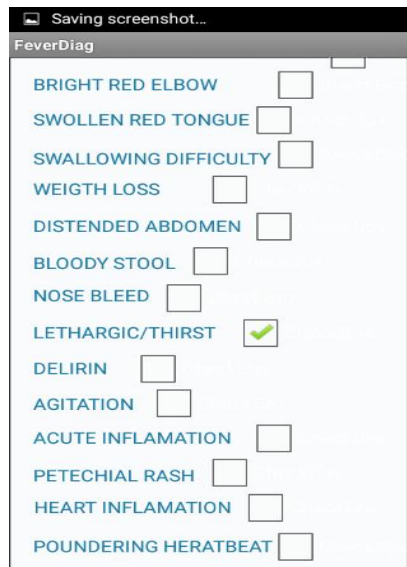


Figure 8: General Symptoms 2



Figure 6: Introduction Interface



Figure 9: General Symptoms 3

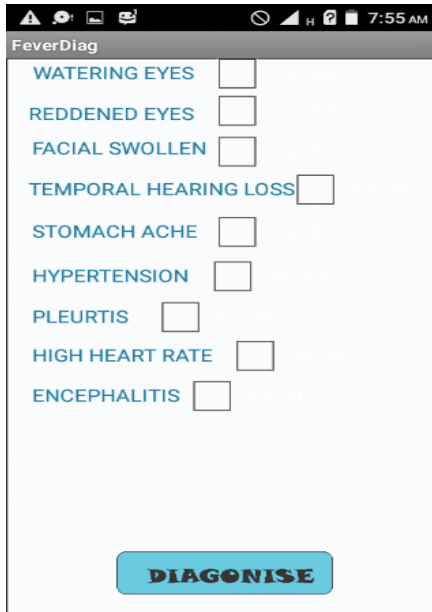


Figure 10: General Symptoms 4

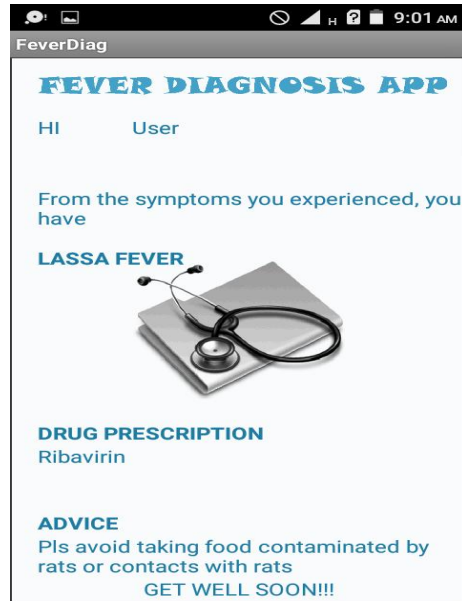


Figure 13: Lassa Fever Diagnosed



Figure 11: Malaria Fever Diagnosed

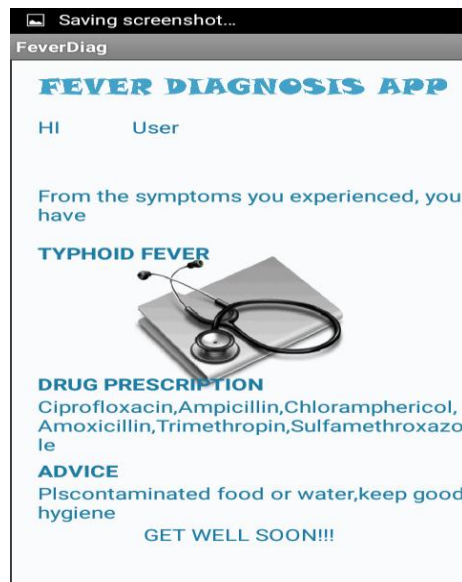


Figure 14: Typhoid Fever Diagnosed

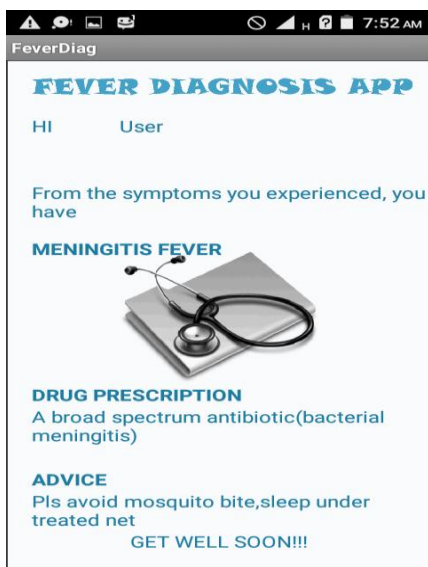


Figure 12: Meningitis Fever Diagnosed

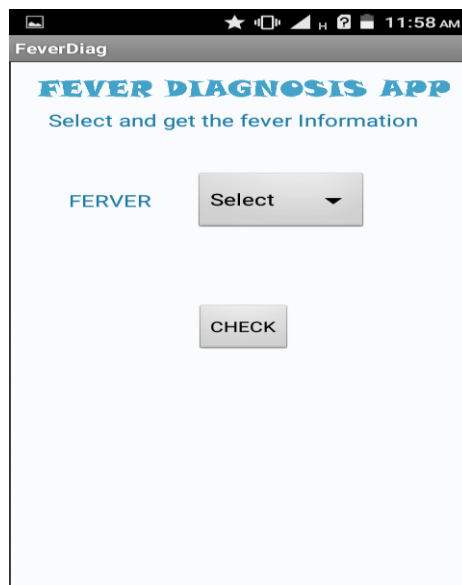


Figure 15: Information Desk Dashboard

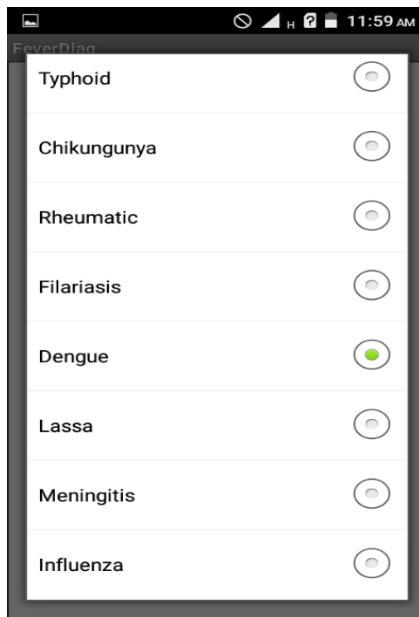


Figure 16: Info. Desk Fever Type Selection

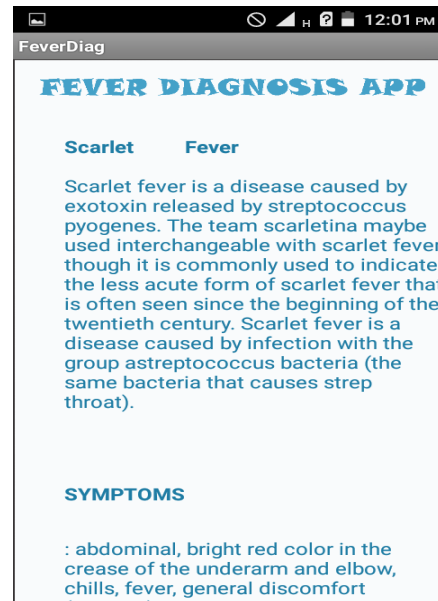


Figure 18: Info on Selected Fever Type1

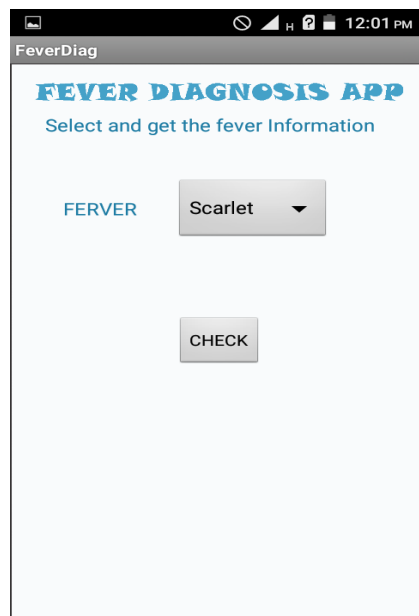


Figure 17: Scarlet Fever Selected

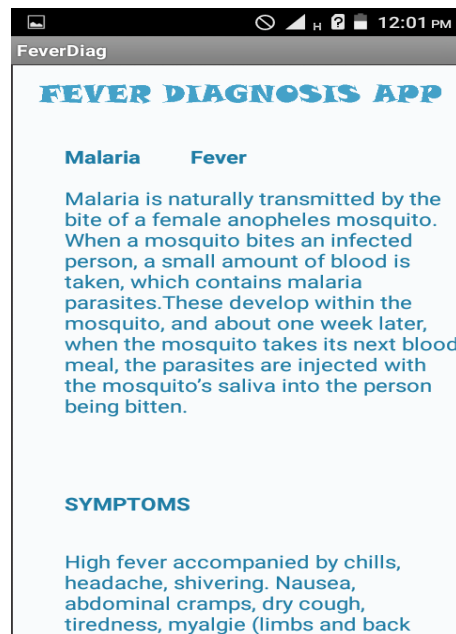


Figure 19: Info on Selected Fever Type2

C. Discussion

Based on the result obtained from the testing carried out, the application successfully diagnosed all the different types of fevers within the domain of influence namely; malaria, scarlet, typhoid, chikungunya, rheumatic, dengue, lassa, meningitis, filariasis and influenza fevers as indicated in TC1 to TC10, it also showed that users were able to access information on the different types of fevers as stipulated in TC11(general information desk). With the obtained results, we conclude that the app met the requirement specification of the system.

D. System Requirement

Hardware Requirements: A compatible mobile device (Android devices) with the following configurations and devices are required for this application software to function efficiently. Memory: 1GB RAM and above, Processor: 800HMZ or 1.5

GHz and above, Hard Disk(HDD): 5GB and above, Android devices

Software Requirement: The software requirement for this system includes is any Android OS based tablets, phones, etc.

E. User Documentation

This phase has to with the instructions or manual to users on how to operate the system for its workability. The steps that will enable effective use of this system are as follows:

- Step 1: Launch the application
- Step 2: The welcome or splash screen comes for five seconds
- Step 3: The registration/logging page comes next for the user to fill his/her details
- Step 4: The next page shows fever diagnosis button, information desk and quit button.

Step 5: The user can either click on fever diagnosis, information desk or quit the application.

F. Conclusion

Medical expert system for diagnosis of febrile disease was duly designed and implemented for use on mobile devices. The developed app makes diagnosis faster and less prone to errors. It proved to be more consistent and accurate compared to the old or manual system.

The research work provides adequate solutions to the problem mentioned. It integrates expert systems into healthcare services via the creation of an expert system for fevers diagnosis and management. The full implementation of this project will greatly help the distribution of primary healthcare services around tropical Africa and the whole world at large. The result of this research work has shown that an expert system for diagnosis and treatment/prescription of fevers would be of immense help to medical experts, patients and all who are interested in gaining information about various types of fevers, its treatment/prescription, prevention and advice.

G. Recommendation

After a proper examination of the existing procedure involved in diagnosing fevers, the following recommendation are made:

- a) Since Africa and Nigeria is prone to fevers, every individual is expected to have access to this application in order to effectively diagnose any of the fevers covered in this work.
- b) This application covers only ten types of fevers which includes; malaria, scarlet, typhoid, chikungunya, rheumatic, dengue, lassa, meningitis, filariasis and influenza fevers, so we recommend further researchwork to incorporate more fever types.

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