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MODELING AND IMPLEMENTATION OF A TELE-DIAGNOSIS AND DRUG PRESCRIPTION SYSTEM (TeleDPS) FOR MALARIA

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Abstract

Efforts have been put in place by organizations and government, including World Health Organization to curb the menace of the world most delicate and deadly disease called malaria. Lack of trained medical personnel, incessant industrial disputes in the medical sector leading to prolong strike actions, and improper management of patients records in most medical outfit have contributed to the fail attempt in the fight against malaria. Make progress, a readily accessible but cost effective self support diagnosis system is essential. This paper proposed development of a mobile-based Expert system (Telediagnosis and drug prescription system) that would be available to all and sundry, with the capability to augment the human expertise in the diagnosis and prescription of drugs for patients with malaria. The intention is to develop a (self-support) decision support system that will assist patients in the diagnosis of malaria in the absence of a doctor, make the system a mobile-based in other to be accessible to patients no matter their locality, cultural background and level of IT literacy. Object oriented analysis and design (OOAD) was used in the design of this work. Unified Modeling Language was used as a graphical language to specify the behavior of the system. Acquisition of knowledge from expert was through interview with stakeholders and major actors in the medical sector. The proposed system was implemented using Java in android studio programming platform. MYSQL was used as the database engine in WAMP server. The system was tested using several test data.

Keywords: Malaria, Expert System, Artificial Intelligence, Knowledge Representation.

1.0 Introduction

Malaria is a deadly disease that is prevalent in Africa and some other parts of the world (Asia, Central and South America). Research shows that more than 3 billion people are at risk of being infected by this disease and this people settle across 99 countries in the world, while millions of them die annually of this disease [1].. History also reveals that the disease have been in existence since ancient times but there was no success in discovering the cause of the disease

until 1880 when Alphonse Laveran [2] discovered the single-celled parasite called plasmodium as the cause of the disease. Some years later female Anopheles mosquitoes were discovered as the carrier of this disease and that the parasite is capable of living partly in man as the secondary host. There are over a hundred species of plasmodium in existence but four of this species commonly infect human beings. [1].

Since the cause of malaria has been discovered, all efforts have been put by organizations, government and individuals to ensure that this deadly disease is eradicated. Some of these efforts most especially by the World Health Organization [3] include; distribution of mosquito nets, anti-malaria drugs, insect repellent and enlightenment to people that resides in malaria prone countries. The general symptoms associated with malaria are: fever, sweating, high body temperature, chills, headache, malaise, muscular pains, nausea, vomiting and diarrhea [2].

Despite these efforts, projects and programmes by NGOs, individuals, governments, international organizations to curb the menace of this subtle but deadly disease, several factors have hampered these programmes from yielding tangible fruits. First, our hospitals are characteristically under staffed with medical doctors, a situation that has resulted to endless queues in the hospitals and inadequate attention to patients. Secondly, there is high rate of infant and adult mobility and mortality due to lack of early and accurate diagnosis of malaria to provide effective and life-saving treatment. Thirdly, of course there is the problem of delay in obtaining medical cards, registering with the hospital, and retrieval of patient's medical information or medical history. These factors have contributed greatly to the shoddier progress to the fight against malaria parasites and infection.

The aim of this research work is to develop a mobile-based Expert system with the capability to augment the human expertise in the diagnosis of malaria and prescription of drugs to patients. The intention is to develop a (self-support) decision support system that will assist patients in the diagnosis of malaria in the absence of a doctor, which will reduce the pressure on the few medical doctors in the hospitals; Make the system a mobile-based in other to be accessible to patients no matter their locality and level of IT literacy. This will help provide early and accurate diagnosis of malaria, and prescribe drug for effective and life-saving treatment; and to automate the hospital registration process and patient's medical information and medical history retrieval process.

2.0 **Review of Literature**

Artificial Intelligence is the area of computer science focusing on creating machines that can engage on behaviors that humans consider intelligent [4]. Serious research in artificial intelligence actually began in 1950s. This was of course heralded by Dr. Allen Turin's article which asked "can the machine think?" Researchers went agog. Why because they wanted to build this "human intelligence" machine. High expectation was also conceived [5].

Right from the inception of Artificial Intelligence, doctors and scientists had always wanted to exploit this technology (Artificial Intelligence) to make computer store and process a volume of knowledge and consequently become 'doctors in box', assisting or even outclassing clinicians in diagnosis [6]. [7] Says "medical artificial intelligence is primarily concerned with the construction of Artificial Intelligence programs that perform diagnosis and make therapy recommendations". Expert System is now used in intensive care, patient's record keeping, medical education etc.

The first medical diagnosis Expert System is MYCIN. Other medical diagnosis Expert Systems after MYCIN according to [5] include: HEADMAN, which was developed by [8] and is used in diagnosing psychiatric disorders and recommending treatment; PIP, developed by Pauker and Svolovits at the Massachusetts institute of Technology for diagnosing and treating kidney disorder; CASNET that Diagnosis and recommends treatments for eye disorders such as glaucoma. It was developed by Kulikowski and Weiss starting in the early 1970s at Rutgers University; QMR-Quick Medical Reference, developed out of INTERNIST-I, which is an in-depth information resource that helps physicians to diagnose adult diseases, as the list continues.

2.1 Component of the Expert System

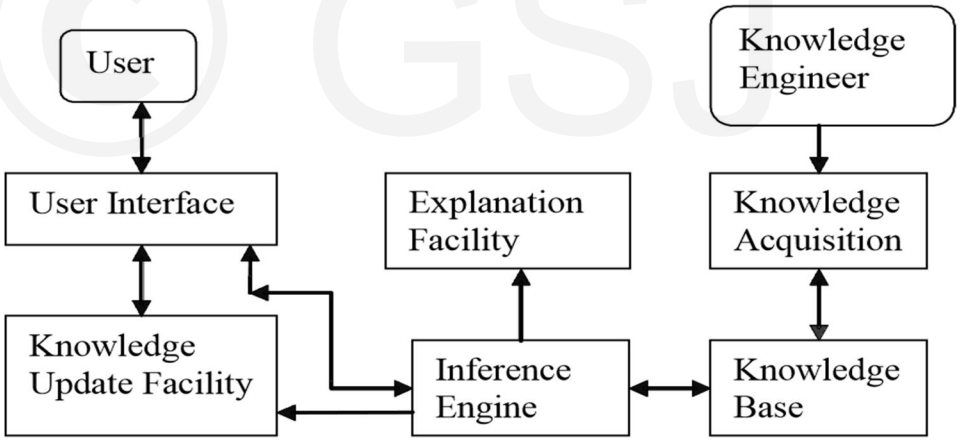

Figure 1: Schematic diagram of An Expert System. [5]

2.2 Knowledge Representation in Expert System

Expert System can be typified based on the way knowledge is represented in that system. These include the following [4]:

2.2.1 Production Rule

1. **Rule-based Representation**:- knowledge is represented through a series of rules. These rules are usually in the form:

IF (condition) THEN (action).

MYCIN uses this representation. One of the rules runs thus:

IF { a) the stain of the organism is gramney AND
b) The morphology of the organism is rod AND
c) The patient is compromised}
THEN {there is suggestive evidence that the identity of the organism is pseudomonas}

A series of IF-THEN rules used to arrive at a given conclusion in interface chain. If the knowledge available is less certain, then the rules could use probabilities. Medical diagnosis Expert System is noted for uncertainty. That is why MYCIN uses probability in its reasoning. The most common probabilistic reasoning used is Bayes' theorem.

2. **First Order logic**:- In this case, the word is seen as objects and predicates on the objects or the relations between the objects. Use is made of logical connectors and quantifiers. With this scheme, it is possible to generate sentences about everything (object) in the world [9].

Example: Objects: Books, people, Numbers, Knowledge
Relations: Contain, Loves, greater than
Properties: Big, good, prime

We can form as many sentences (facts) as we want from the above e.g.

(i) Glory loves Aniekan and Udeme
Relation: Loves
The book contains good information

(ii) Object: Book, information
Relation: contains
Property: Good.

Thus, it can be seen that with this argument, objects can be talked about in many different ways.

2.2.2 Frame-Based Representation

The idea of this representation is reportedly attributed to minsky [10]. In this representation, knowledge is grouped in pieces called frames. Each piece is made up of knowledge, which may help in understanding a certain concept. A frame is basically a network of nodes and relations. A combination of these attributes and their associated instances helps to represent an entity in the world. It rarely happens for a single frame to be useful. Thus a collection of related frames (frame-system) is built. Transformation between the frames depend on values in the slots

Example: TREE frame
IS-A: plant

Trunk type: large, small, medium
Leaf type: coniferous, deciduous
Leaf shape: simple, lobed, compound

One advantage of frame is that different objects may share the same frame. Also a natural hierarchy is provided (e.g. leaf shape can contain sub-frames) [11], [12].

2.2.3 Predicate Logic

Predicate logic, involves using standard forms of logical symbolism which have been familiar to philosophers and mathematicians for many decades.

In this work, production rule was employed for the development of the Mobile-Based Expert System. Sample rules in the rule base are shown below.

IF patient have fever
AND patient have headache
AND patient has nausea
AND patient has abdominal pain
AND patient feels feverish
AND patient feels dizzy
AND patient feels body weakness
THEN Patient has malaria

3.0 System Design and Methodology

The Structured system analysis and design method (SSADM) was adopted in this research work and the unified modeling language was adopted as a tool to design the system. The method of extracting knowledge from the expert was through interviewing with stakeholders and major actors of the system (Doctors, Nurses, patients and hospital administrators. Although, there are two conventional programming languages used in artificial intelligence for expert system development, list processing (LISP) and logic programming (PROLOG). The proposed system was implemented using Java in android studio programming platform. MYSQL was used as the database engine using WAMP server.

3.1 System Design

In developing the proposed system, we employed the Unified Modeling Language (UML) as the graphical language to specify the behavior of the system. In this case we used the Use Case and activity diagram as the tools to model the behavior of our system.

3.1.1 Use Case Diagram

The Use Case graphically depicts the interactions between the system and the users. Use case diagrams play a major role in system design because it acts as a roadmap in constructing the structure of the system. The use case diagrams for the actors identified in this system are presented in figures 3.1.1 and 3.1.2 below.

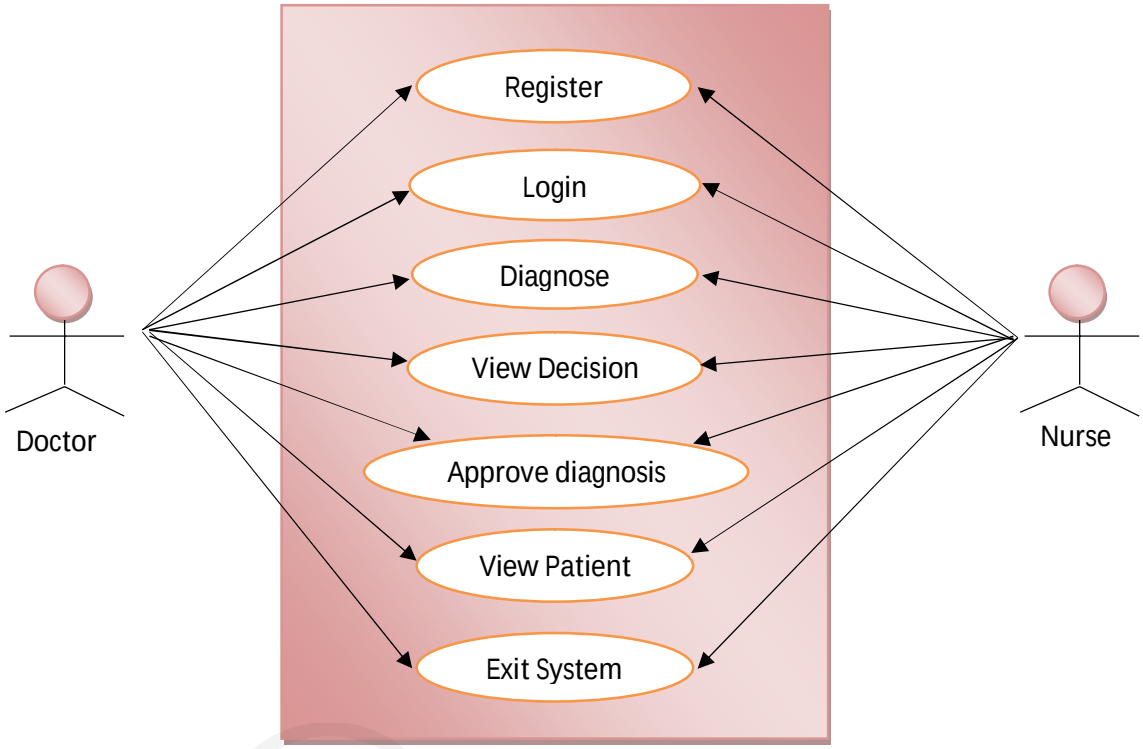

Figure 3.1 Use case diagram for Doctor and Nurse

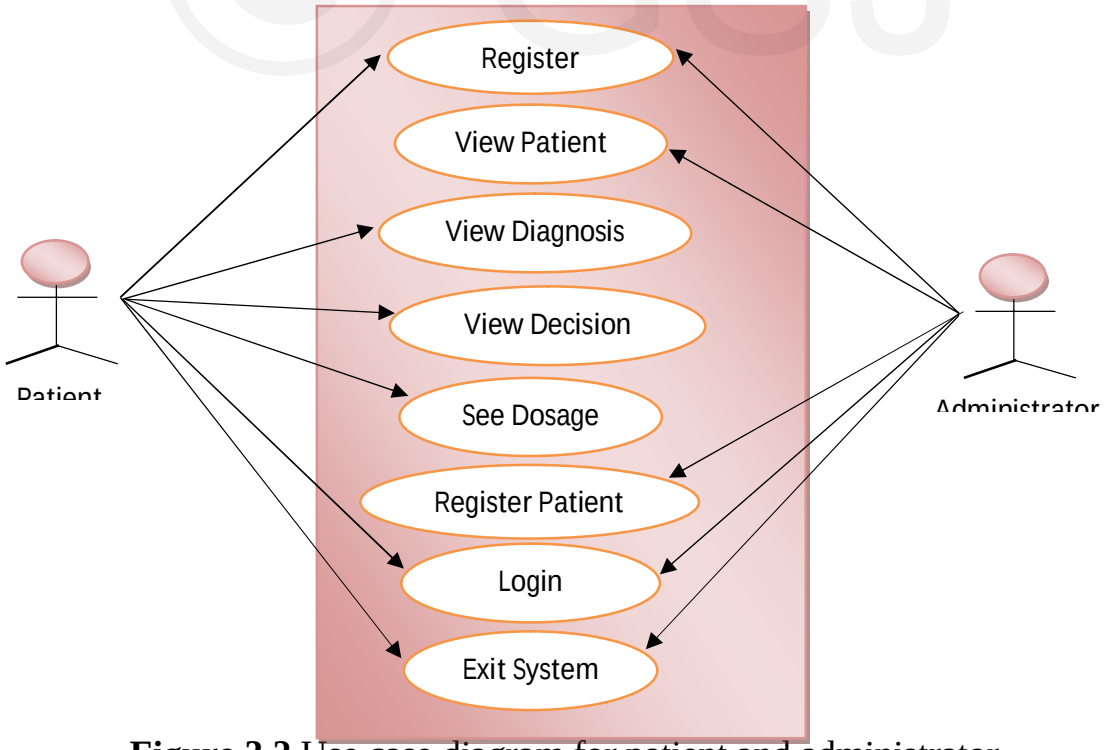

Figure 3.2 Use case diagram for patient and administrator.

3.1.2 **Activity Diagram**

Activity diagrams graphically show the performance of actions or sub activities and the transaction that are triggered by the completion of the actions or sub actions. It is a means of describing the workflow of activities**.** The activity for this system is shown in figure 3.3 below.

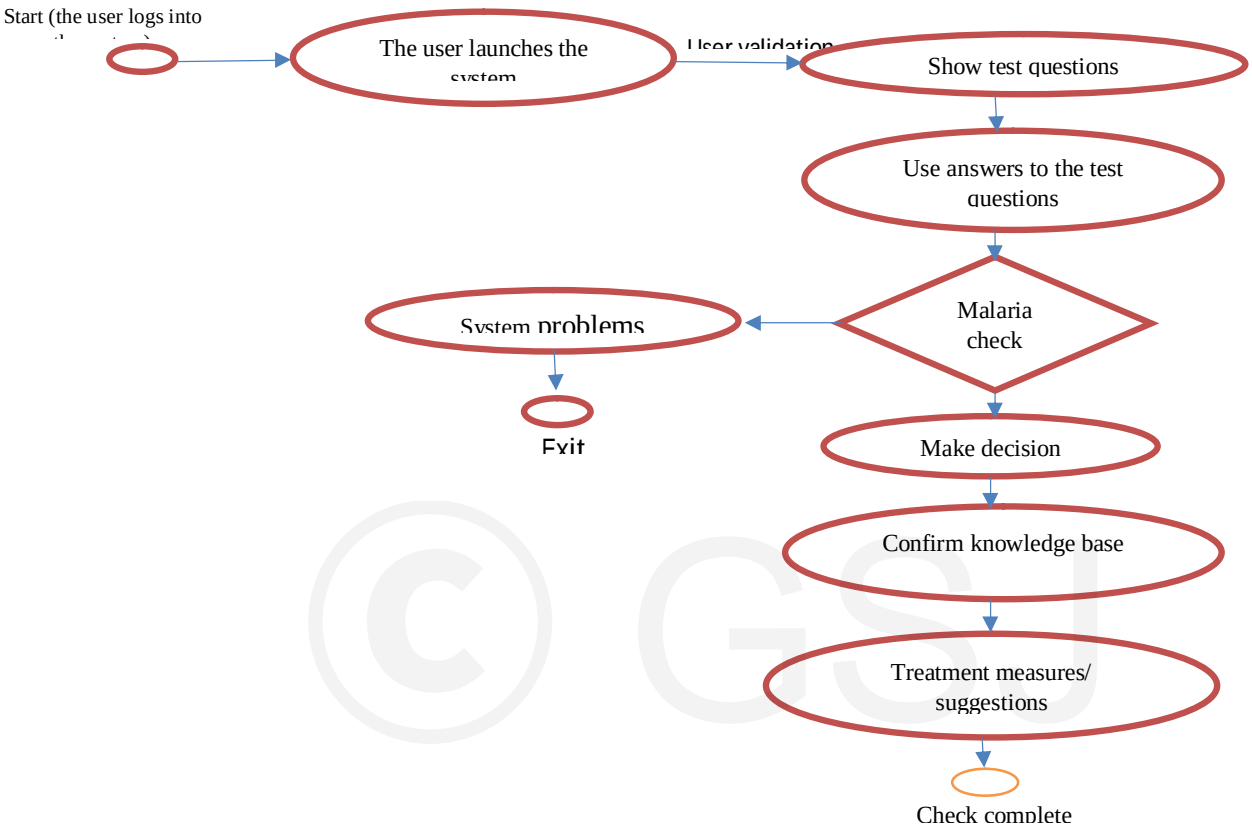

Figure 3.3 Activity diagram of the Proposed Expert System

3.2 System High Level Diagram

A system high level diagram is a graphical representation of the "flow" of data through a system, modeling its process aspects. A system high diagram is often used as a preliminary step to create an overview of the system. The high level diagram for the proposed mobile-based Malaria Expert System is presented below.

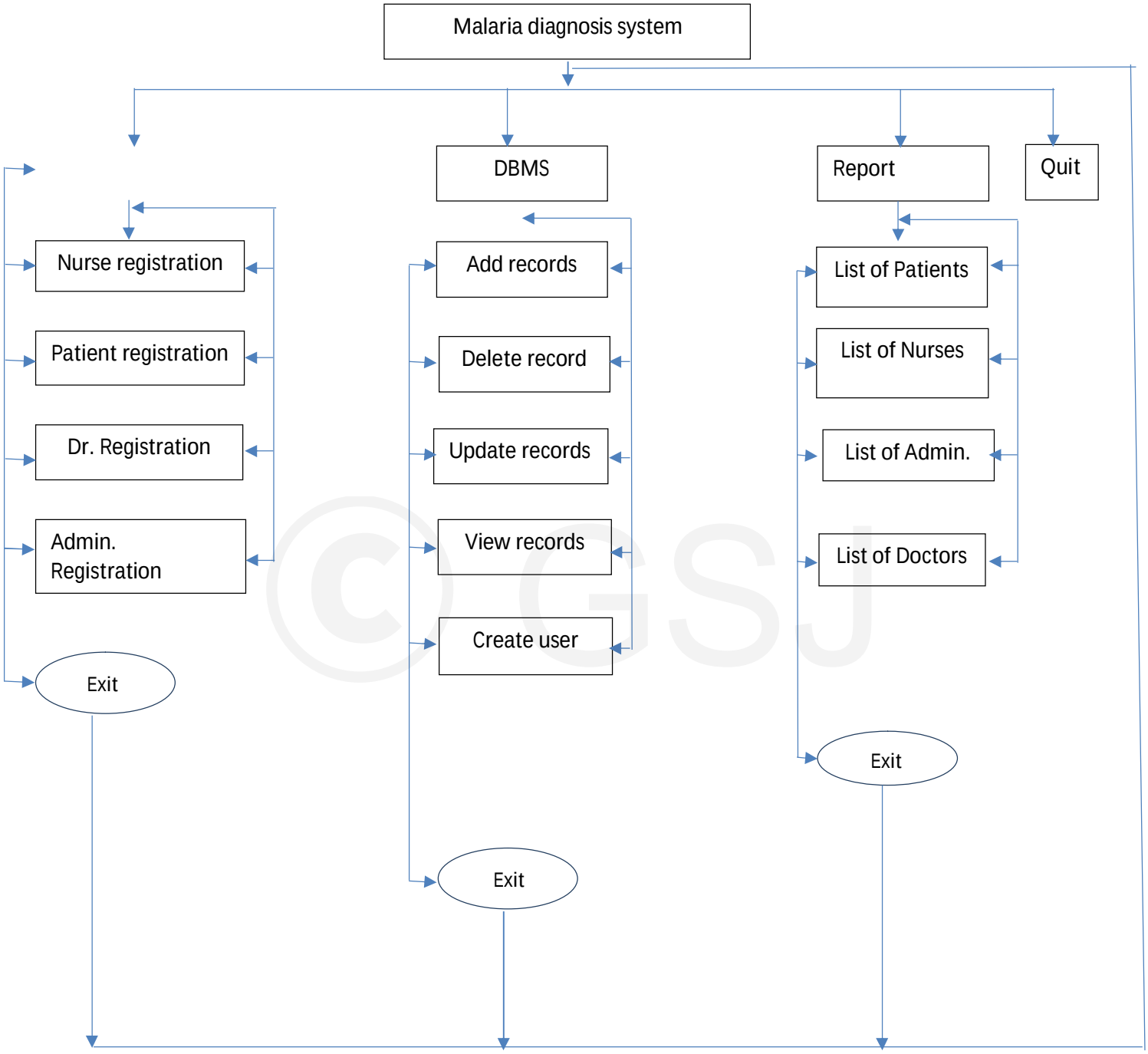

Figure 3.4 System high level diagram

3.3 Database Design

The database serves as the storage facility for storing and maintaining the records of patients. The entities identified in the proposed system are doctor, nurse, patient and administrator. These three entities are grouped under users.The database table of each entity is given below:

Loginrecord_Table

S/N	FIELD	DATA TYPE	WIDTH	FOREIGN KEY
1	SURNAME	TEXT	20	NO
2	PASSWORD	VARCHAR	15	NO

User_Table

S/N	Field	Data type	Width	Foreign key
1	USER_ID	INTEGER	12	YES
2	NAME	Text	20	NO
3	USER_NAME	Text	20	NO
4	PASSWORD	VARCHAR	15	NO
5	DATE_ OF_BIRTH	Date	10	NO
6	CATEGORY	VARCHAR	20	NO
7	ADDRESS	VARCHAR	30	NO
8	GENDER	VARCHAR	10`	NO
9	BLOOD GROUP	VARCHAR	3	NO
10	GSM	INTEGER	12	NO

3.4 System Requirement

The proposed Expert System is mobile-based and requires a smart phone to be able to access the services of the system. The target mobile phone requirements define the resources required by the application that will enable the application to function optimally in its operating environment. This resources covers both hardware on which the application will be deployed and software which the application will interact with.

3.4.1 Software Requirements

- Operating system:- Andriod
- Operating system version:- Andriod version4.0.3

3.4.2 Hardware Requirements

- Memory space:-45 MB
- Input/Output:- phone key pad and phone screen

3.5 System Testing

The system was tested to detect any inconsistencies between software units that make up the system and also between software and hardware on which it will be deployed. Two categories of testing were done, Unit testing and Integration testing. Under unit testing, testing was performed on each module during the program development to ensure that codes are working as expected independent of the rest of the system**.** During our integration testing, sets of test were done before, during and after the integration of new module into our main software package.

4.0 **Results (Sample Output)**

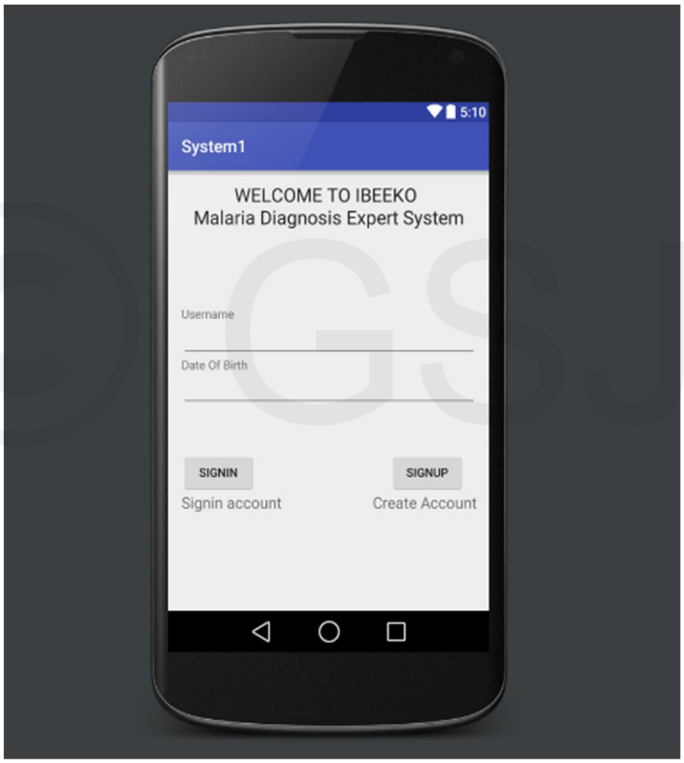

Figure 4.1: The Mobile Expert System Welcome Screen

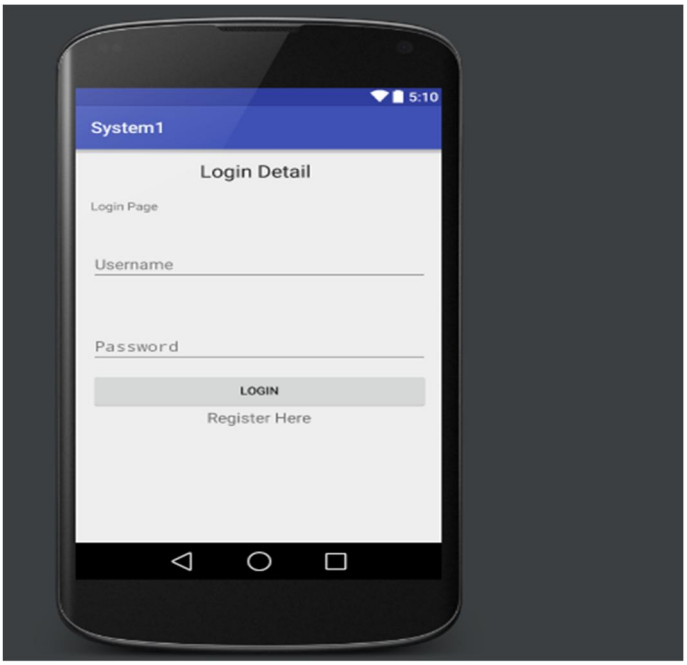

Figure 4.2: Login Page

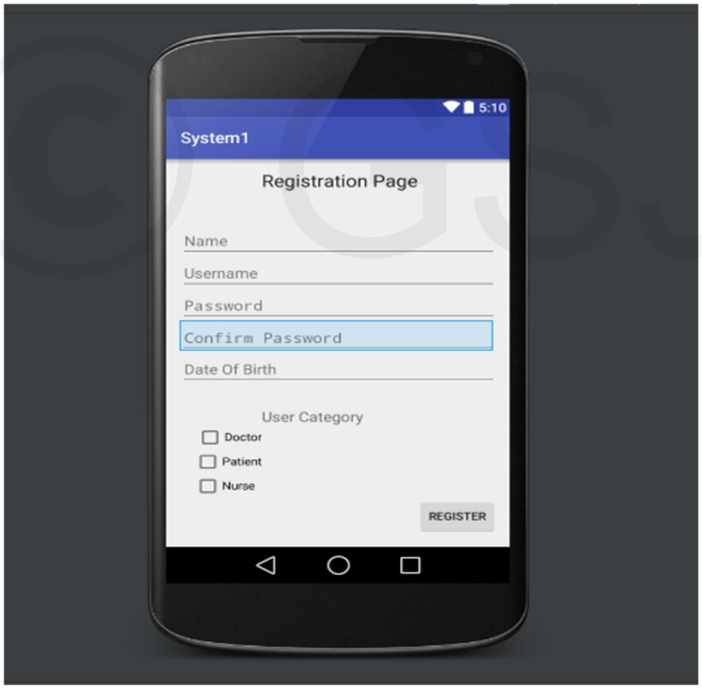

Figure 4.3: User Registration Form

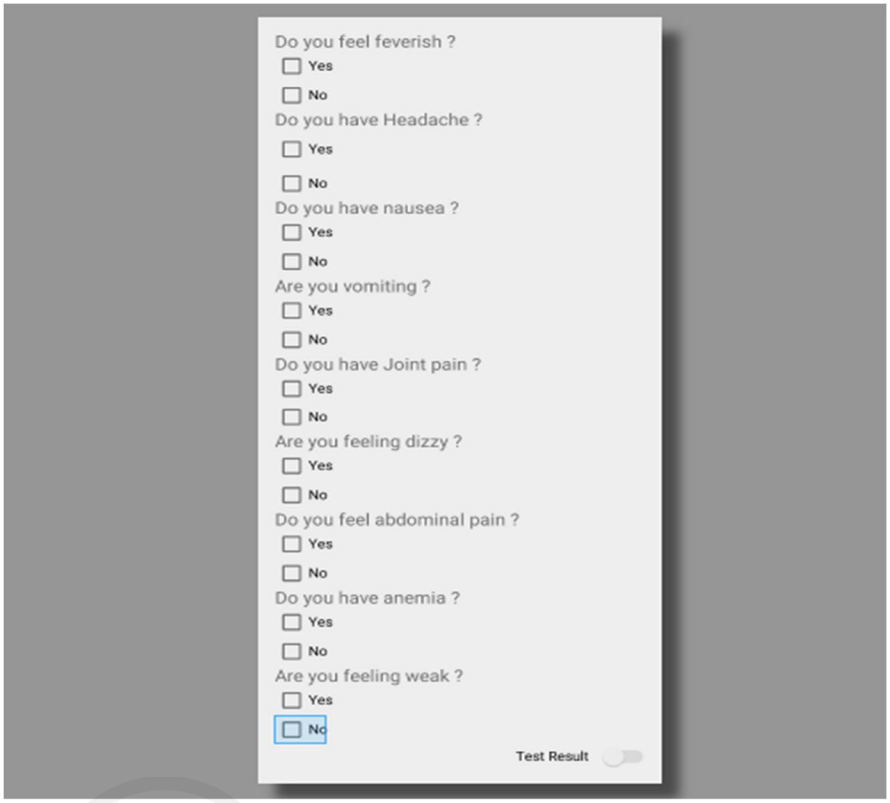

Figure 4.4: Diagnosis Interface

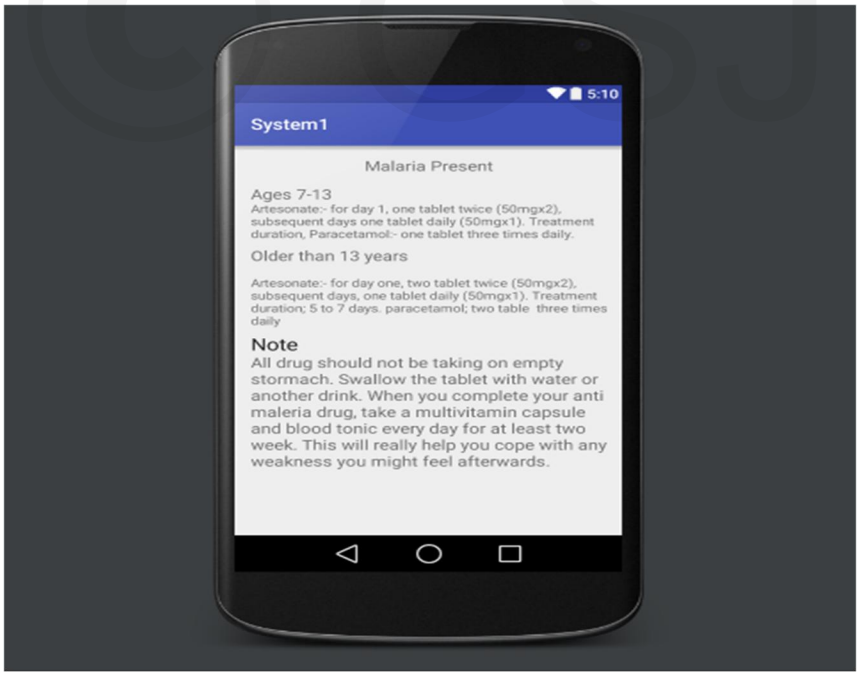

Figure 4.5: Diagnosis Result Page

Figure 4.6: Users' password changed Interface

5.0 **Conclusion**

This proposed Telediagnosis and drug prescription system has been design and implemented in Android Studio. The system has been tested both at unit and integrated levels using several test data and by several stakeholders – Doctors, Nurses Patients and hospital Administrators, and exhibits the expertise of a physician in malaria diagnosis. Object oriented paradigm was employed in the design and implementation of the expert system. This paradigm modules a system as a group of interacting objects and was chosen due to the ease of development and maintenance it affords. The modeling of system was done with the aid of UML diagrams notably the use case diagram, activity diagram as graphical tools to model the system's behavior.

Acknowledgement

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