ISSN 1512-1232

WEB-BASED MEDICAL ASSISTANT SYSTEM FOR MALARIA DIAGNOSIS AND THERAPY

Adetunmbi A.O, Oguntimilehin A, Falaki S.O

Department of Computer Science
Federal University of Technology, Akure. Nigeria
ebenabiodun2@yahoo.com , bayoadetumbi@yahoo.com

Abstract
Malaria is a deadly disease killing millions of people every year. Different countries of the world, governmental and non-governmental organizations including World Health Organization have taken it as a challenge to address the issue of deaths associated with malaria. Prompt and accurate diagnosis is a major key in medical field. This prompts for the need to develop a diagnosis and therapy system that could be accessed anywhere, anytime taking the advantage of the fast growing internet technology. A machine learning technique rough set was used on labelled sets of malaria fever symptoms collected to generate explainable rules for each level of severity and appropriate therapy is provided. The labelled database was divided into five cases of malaria and the classification accuracy on training dataset is 100% while that of testing data set is 94%. The web based system for malaria diagnosis and therapy was developed using HTML and PHP as front end and MYSQL as backend.

Keywords: *Malaria, Symptoms, Diagnosis, Therapy, Rough Set*

1. Corresponding Author

1.1. Introduction

Telemedicine is a way of delivering health information across distances. Telecommunication devices such as internet and telephone help lines are mainly used to break the barrier of distance. Though telemedicine has been regarded as one solution by which necessary health care services can be provided to everybody at a reasonable cost, the practice should be treated with caution so that the quality of treatment is not compromised. Economic savings alone should not be a justification for the use of telemedicine if the quality of health care provided deteriorates [9]**.** The telephoned countries as leading countries in technological advancement have exploited these ICT potentials in bringing hospital to homes [2].

Diagnosis is the identification of abnormal condition that afflicts a specific patient, based on manifested clinical data or lesions. If the final diagnosis agrees with a disease that afflicts a patient, the diagnostic process is correct; otherwise, a misdiagnosis occurred [14]. Medical diagnosis is a categorization task that allows physicians to make prediction about features of clinical situations and to determine appropriate course of action. It involves a complex decision process that involves a lot of vagueness and uncertainty management, especially when the disease has multiple symptoms [13]. Medical diagnosis has undergone different phases of research from statistical methods, which saw the application of Bayesian inference, utility theory, Boolean logic and discriminant analysis. When it was evident that statistical tools could not deal with most complex medical problems, Artificial Intelligence (AI) principles were applied [9].

Therapy is the attempted remediation of a health problem, usually following a diagnosis. In the medical field, it is synonymous with the word "treatment". Preventive therapy or prophylactic therapy is a treatment that is intended to prevent a medical condition from occurring. For example, many vaccines prevent infectious diseases. An abortive therapy is a treatment that is intended to stop a medical condition from progressing any further. A medication taken at the earliest signs of a disease, such as at the very symptoms of a migraine headache, is an abortive therapy. A supportive

ISSN 1512-1232

therapy is one that does not treat or improve the underlying condition, but instead increases the patient's comfort. Supportive treatment may be palliative care [11].

Malaria is a mosquito borne infectious diseases caused by a eukaryotic protist of the genus plasmodium. It is wide spread in tropical and subtropical regions, including parts of the American, Asia and African. Five species of the plasmodium parasite can infect humans, the most serious form of the disease are caused by plasmodium falciparum. Malaria caused by plasmodium vivax, plasmodium ovale and plasmodium malariae causes milder disease in humans that is not generally fatal. A fifth species, plasmodium Knowlesi, is a zoonosis that causes malaria in macaques but can also effect humans [5].

Malaria deaths are frequently the result of delay in the diagnosis and treatment of the infection. Fever and septic shock are commonly misdiagnosed as severe malaria in Africa leading to failure to treat other life threatening illness [7]. Each year there are approximately 350-500 million cases of malaria, killing between one and three million people, the majority of whom are young children in Sub–Sahara African. Ninety percent of malaria –related deaths occurs in Sub-Sahara African [5]. Half of the world's population is at risk of malaria, and an estimated 243 million cases led to an estimated 863,000 deaths in 2008. Once a person develops malaria, the only means of reducing suffering and preventing death is by diagnosing and treating the disease [6].

This study attempts to build a classification model for malaria diagnosis using rough set and develop a web-based medical diagnosis and therapy system for malaria based on classification model generated by rough set.

2. Review of Related Literature

Due to the adverse effect of malaria on people and economy, researchers had undergone series of researches to develop systems that could diagnose or diagnose as well provide therapy.

In [14], Decision Tree Analysis is used to diagnose malaria using the basic symptoms for malaria which include, fever, loss of appetite, bitter taste, body and joint pains and headache. The system fails to present ranked list of symptoms according to severity of malaria and it only carries out diagnosis without therapy.

In [12], Medical decision support system using analytic hierarchy process was used to diagnose malaria. The system was designed to overcome the conventional method of malaria diagnosis. Knowledge components used include: patient information, patient characteristics, medical history, patient examination, chemotherapy and symptom intensity. The system is able to diagnose and determine the priority order (ranking) of basic malaria diagnosis criteria. Apart from the fact that the system fails to provide therapy for the diagnosed malaria case, it is not generally accessible for people.

Obot and Uzoka in [10] presented a fuzzy rule-base framework for the management of tropical diseases with main focus on malaria. The system involves fuzzification, inference and defuzzification. The system is able to diagnose malaria case as either mild, moderate several or very several. The symptoms and signs of the diseases were fuzzified based on recommendation of some medical personnel; the fuzzified variables were composed, inferred and later defuzzified to give final diagnosis. However, to further optimize the system, they emphasized the need of a hybrid comprising neural networks and fuzzy logic, or fuzzy logic and case-based reasoning paradigm. The system also lacks therapy, besides is a stand alone system .

In [8], an automated image processing method for the diagnosis and classification of malaria on thin blood smears was developed. The image classification system is designed to positively identify malaria parasites present in thin blood smears, and differentiate the species of malaria. Features based on image characteristics such as colour, texture and geometry as well as original features that mimic the qualities used by microscopists when diagnosing malaria are generated from the erythrocytes which are candidates for infection. A tree classifier with two nodes using BFF a neural network is used to determine whether or not a cell is infected, and if so, the species of the malaria. The limitations of this system include inherent limitations of microscopy such as the

ISSN 1512-1232

degradation of slide quality with time apart from the fact that the system is too expensive. It is exclusively reserve for medical experts to aid in the identification of malaria fever.

Kamukama in [14], developed a clinical protocol-based decision support system for malaria treatment. The system is able to provide treatment of malaria according to the level of severity of the malaria case. The system is only useful after diagnosis which it fails to provide.

All the researchers emphasized the need for further research on the subject matter.

The systems reviewed above have limitations ranging from diagnosis without therapy, therapy without diagnosis and poor accessibility. Since internet is now the major means of effective communication in the whole world, people can make use of internet enabled phone and other internet facilities like GSM data link, Cybercafés etc to get diagnosed and get treatment for malaria provided there is a web-based system that can carry out diagnosis as well provide therapy, then the need for this study arises.

3. Description of Datasets

The data were collected from a reputable hospital in Ado-Ekiti, Ekiti State, Nigeria under the supervision of the Chief Medical Director of the hospital. The data collected were mainly records of patients with malaria cases comprising the symptoms observed by the medical practitioner and complaints made by the patients. The data were collected in two phases, the first set of data was ninety nine in number and it was used as training set. The second phase consists of fifty sets of data and was used as testing set. The two sets of data were collected at different time. The training set was collected in June, 2010 while the testing set was collected in December, 2010.

All the data were assigned classes by a medical practitioner and the medical expert grouped the malaria cases into five classes according to the level of severity- Very High, High, Moderate, Low and Very Low using the symptoms of malaria of each patient. There are nineteen conditional attributes (symptoms) and one decision attribute, shown in the table1 below.

Table 1: Attributes of malaria fever

S/N	ABREVIATION	ATTRIBUTE	ATTRIBUTE TYPE
A1	WKN	Weakness	Discrete
A2	APB	Abdominal Pain	Discrete
A3	COH	Cough	Discrete
A4	BOP	Body Pain	Discrete
A5	FVR	Fever	Discrete
A6	RGR	Rigour	Discrete
A7	COD	Cold	Discrete
A8	ANR	Anorexia	Discrete
A9	HEC	Headache	Discrete
A10	CAH	Catarrh	Discrete
A11	INS	Insomnia	Discrete
A12	YEU	Yellow Urine	Discrete
A13	VOM	Vomiting	Discrete
A14	JOP	Joint pain	Discrete
A15	DSN	Dizziness	Discrete
A16	ILL	Ill-looking	Discrete
A17	COV	Convulsion	Discrete
A18	BOT	Body Temperature	Discrete
A19	DIA	Diarrhea	Discrete
A20	MAL DIAG	Malaria Diagnosed	Discrete

ISSN 1512-1232

4. Rough Set

4.1. Basic Concept of Rough Set

Rough set theory (RST) is a useful mathematical tool to deal with imprecise and insufficient knowledge, find hidden patterns in data, and reduce dataset size. Also, it is used for evaluation of significance of data and easy interpretation of result. RST contributes immensely to the concept of reducts. Reducts is the minimal subset of attributes with the most predictive outcome [1]. Rough Set is a machine learning method which generates rules based on examples contained within an information table. Rough set theory has become well established as a mechanism for solving the problem of how to understand and manipulate imprecise and insufficient knowledge in a wide variety of applications related to artificial intelligence.

Let = (U,C) be an appropriate space, where U is a non-empty , finite set called the universe; A subset of attributes $R \subseteq C$ defines an equivalent on U. Let $[\mathrm{X}]_{\mathrm{R}}$ $(\mathrm{X} \in \mathrm{U})$ denote the equivalence class containing x.

Given $R \subseteq \mathrm{C}$ and $\mathrm{X} \subseteq \mathrm{U}$. X can be approximated using only the information contained within R by constructing the R-lower and R-upper approximations of set X defined as:

$$\underline{R}X = \{x \in X | [x]_R \subseteq X\}$$

$$\overline{R}X = \{x \in X | [x]_R \cap X \neq 0\}$$

Where $\underline{R}X$ is the set of objects that belong to X with certainty, and $\overline{R}X$ is the set of objects that possibly belong to X. The R-positive region of X is $\mathrm{POS_R(X)} = \underline{R}X$, the R-negative region of X is $\mathrm{NEG_R(X)} = \mathrm{U}\text{-}\overline{R}X$, and the boundary or R-borderline region of X is $BN_R(X) = \overline{R}X - \underline{R}X$. X is called R-definable if and only if $\overline{R}X = \underline{R}X$. Otherwise $\overline{R}X \neq \underline{R}X$ and X is rough with respect to R iff $\underline{R}X \neq \overline{R}X$.

The approximation measure $\alpha_R(X)$ is defined as

$$\alpha_R(X) = \frac{|\underline{R}X|}{|\overline{R}X|}$$

where $\mathrm{X} \neq \phi$, and $|X|$ denotes the cardinality of set X.

Algorithm LEM2 below developed by Grzymala-Busse in 1997 [1] was used in building the classification model for malaria diagnosis classes.

Figure 1. LEM2 Algorithm

Input: k set of objects
Output: R set of rules
begin
G=K;
$\mathrm{R} = \phi$;
While $\mathrm{G} \neq \phi$ do
begin
$\mathrm{C} \neq \phi$
$\mathrm{C(G)} = \{c : [c] \cap G \neq \phi\}$;
While $(C \neq \phi)$ or $(!([C] \subseteq K))$ do
begin
select a pair $\mathrm{c} \in C(G)$ such that $|[c] \cap G|$ is maximum;
if ties, select a pair $\mathrm{c} \in C(G)$ with the smallest cardinality $|[c]|$;
if further ties occur, select the first pair from the list;

ISSN 1512-1232

$C = C \cup \{c\}; G = [c] \cap G;$
$C(G) = \{C : [c] \cap G \neq \phi\};$
C(G)=C(G)-C;
end;
for each elementary condition c $\in C$ do
if $|C - c| \subseteq K$ then $C = C - \{c\}$;
create rule r basing the conjuction C and add it to R;
$G = K - \bigcup_{r \in R} |R|$
end;
for each $r \in R$ do
if $\bigcup_{s \in R-r} |S| = K$ then R = R-r
end

5. Experimental Set Up and Results

Rough Set used the training data set to build a classification model. For easier programming, it is easier to work around with numbers since the number of bytes that will be reserved for integer numbers will be smaller. For the decision attribute, the data Very Low, Low, Moderate, High and Very High are thus converted to integer numbers 1,2,3,4 and 5 respectively. For the conditional attributes (symptoms) A1 to A19, each symptom is classified as either high or low. Value high is converted to integer 1; Value Low is converted to integer 2 while default exists for symptom not applicable and takes a value of 0.

Rough Set was then used on the training set to give a diagnosis classification model for the five labels (five cases of malaria) which is in form of explainable rules displayed in the table2 below.

Table 2. Generated rules of the five cases of malaria by rough set

Rule No	Rule in details
Rule1	(A2=2)&(A5=2)&(A7=2)&(A9=2)&(A11=2)&(A13=2)&(A17=2) => (Dec=1)
Rule2	(A1=2)&(A2=2)&(A3=2)&(A4=2)&(A5=1)&(A9=2) => (Dec=1)
Rule3	(A3=1)&(A8=2)&(A9=2)&(A11=2)&(A12=2)=> (Dec=2)
Rule4	(A6=1) => (Dec=2)
Rule5	(A1=1)&(A2=2)&(A5=1)&(A9=2) => (Dec=2)
Rule6	(A1=2)&(A2=2)&(A8=2)&(A13=1)&(A15=2) => (Dec=2)
Rule7	(A3=2)&(A5=2)&(A8=2)&(A9=1)&(A11=2) => (Dec=2)
Rule8	(A1=2)&(A5=1)&(A8=2)&(A9=1)&(A10=1)&(A11=2)&(A15=2) => (Dec=3)
Rule9	(A4=2)&(A5=1)&(A9=1)&(A11=2)&(A15=2)&(A16=2)=> (Dec=3)
Rule10	(A5=1)&(A9=1)&(A13=1)&(A15=2)&(A19=2) => (Dec=3)
Rule11	(A3=1)&(A4=2)&(A9=1)&(A10=2)&(A12=2) => (Dec=3)
Rule12	(A2=2)&(A4=1)&(A5=1)&(A7=2)&(A8=2)&(A10=2)&(A13=2) => (Dec=3)
Rule13	(A1=2)&(A11=1)&(A15=2) => (Dec=4)
Rule14	(A1=2)&(A8=1)&(A15=2)&(A17=2) => (Dec=4)
Rule15	(A5=2)&(A8=1)&(A10=2) => (Dec=4)
Rule16	(A1=1)&(A2=2)&(A5=2)&(A9=1)&(A18=2) => (Dec=4)
Rule17	(A8=1)&(A9=1)&(A13=2)&(A19=2) => (Dec=4)
Rule18	(A1=2)&(A2=1)&(A4=1)&(A13=2)&(A15=2) => (Dec=4)

ISSN 1512-1232

Rule19	(A5=2)&(A10=1)&(A11=2) => (Dec=4)
Rule20	(A1=1)&(A2=1)&(A10=1) => (Dec=5)
Rule21	(A17=1) => (Dec=5)
Rule22	(A15=1) => (Dec=5)
Rule23	(A1=1)&(A9=2)&(A11=1) => (Dec=5)

5.1. evelopment of Website for Malaria Diagnosis and Therapy

The website for malaria diagnosis and therapy was developed using HTML and PHP as front end and MySQL as the backend.

The first interface is a user interface which allows users to create a new account by supplying username and password of interest. The created password and username are then used on the same interface to login into the next interface which is diagnosis interface. This phase contains the personal details of the patient (user), the patient's select symptoms table and command button to check malaria status. The personal details section contains name, age, sex, occupation, address, phone number and e-mail. The patient's symptom select table contains nineteen symptoms (conditional attributes), each of which has the value high, low and default in which a patient must select one depending on the feelings of the patient (user). There is a space for a patient to type in any other perceived symptom not identified in the patient's symptoms select table for future consideration of medical experts, however, this is optional.

After all the perceived symptoms are selected, a check me button is clicked to take the user to the next phase where the patient views the result of the diagnosis and the appropriate therapy. The rules generated by rough set forms the engine room of the diagnosis. The earlier created username and password are both used at this phase to view medical report and therapy. If these are both correct, the system displays patient's diagnosis and treatment report sheet where a patient knows if he or she has malaria or not. If malaria is detected, the degree of severity is shown and the appropriate treatment is made available. This page also allows a patient who wishes to print the whole report sheet to do so and when a patient is through with the system, he or she clicks on logout to logout.

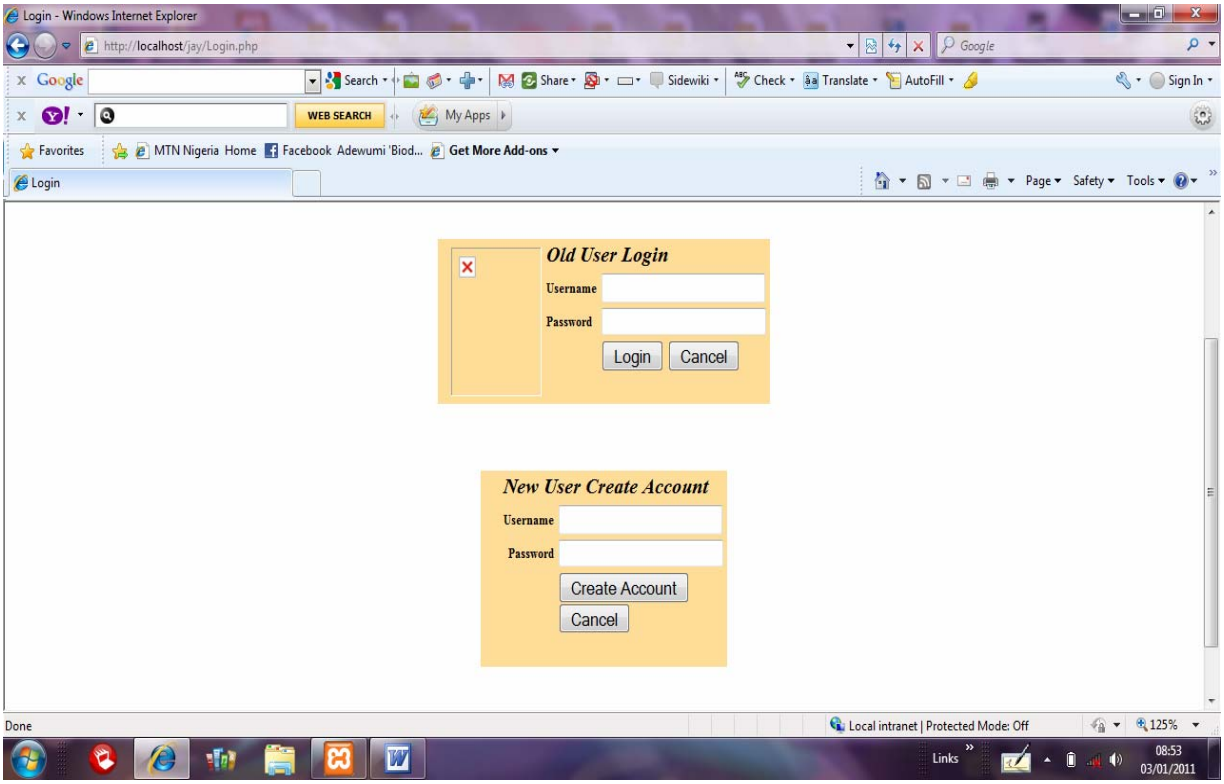

Figure 2. First Interface

ISSN 1512-1232

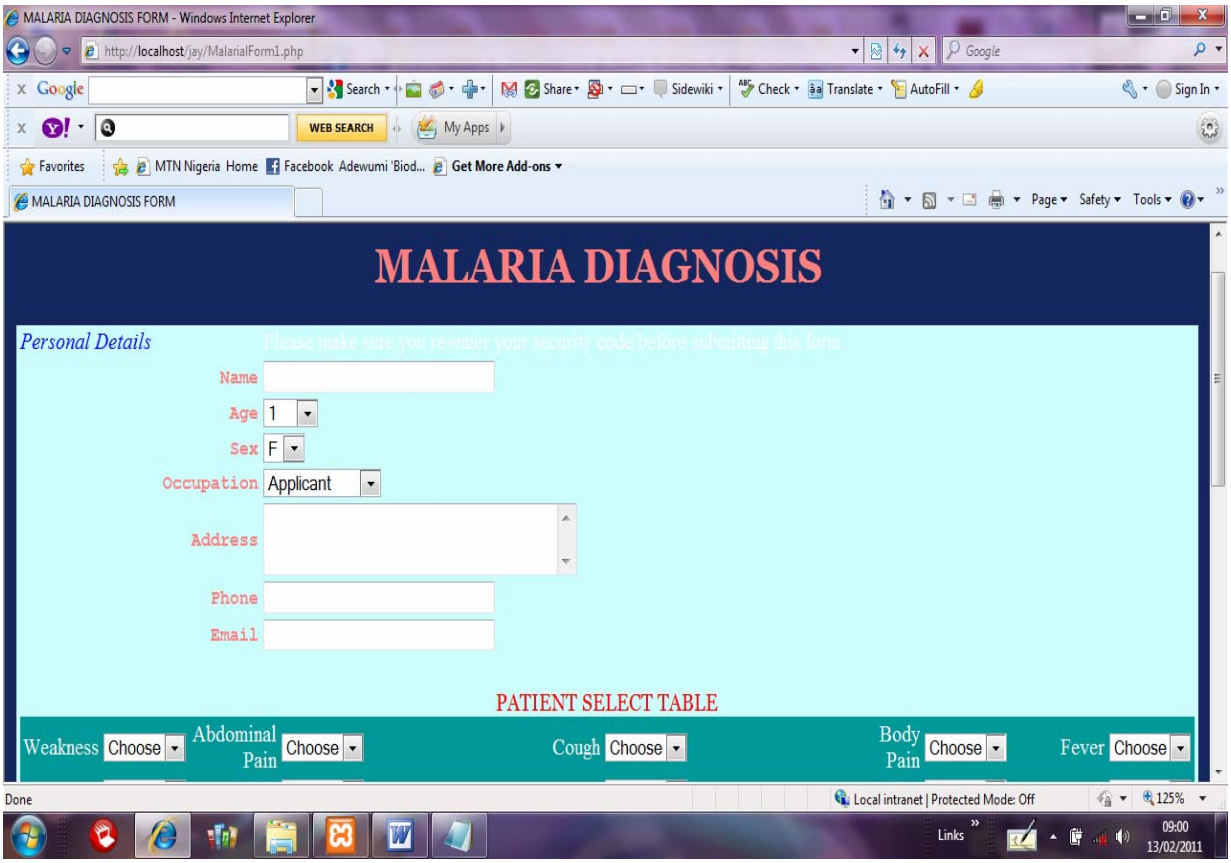

Figure 3. Patient Symptom Select Interface

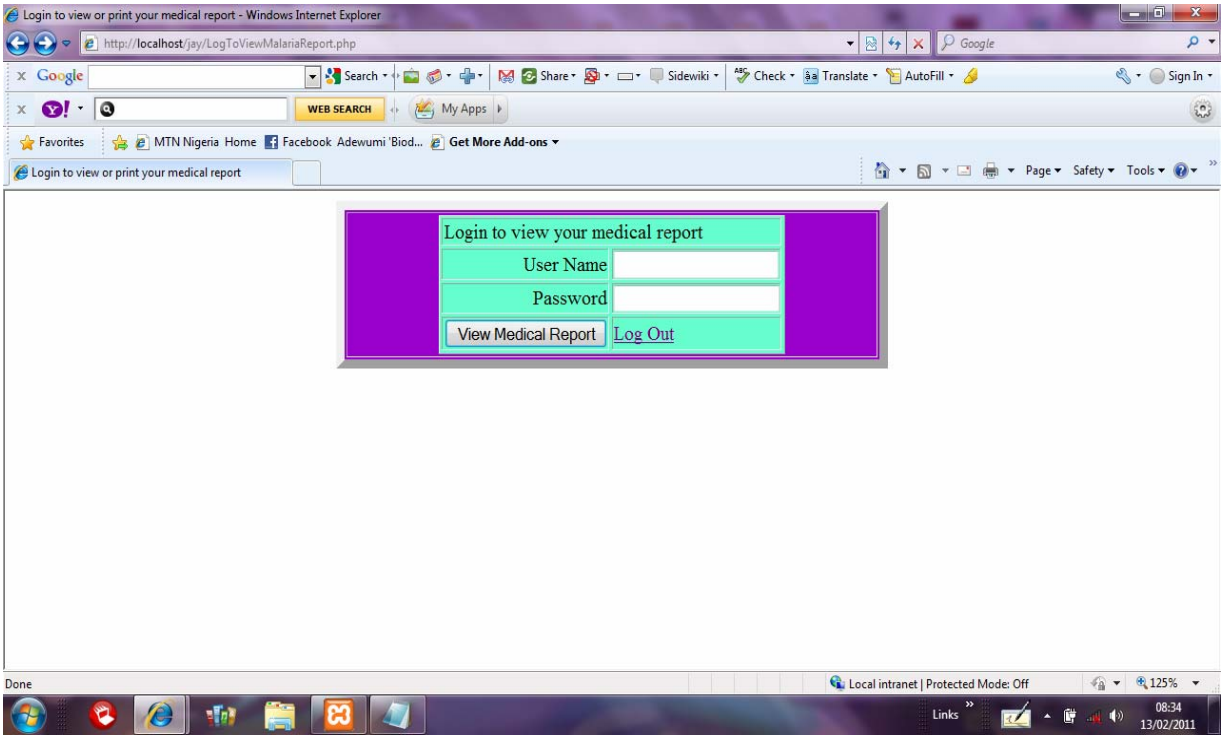

Figure 4. Log in to view medical report interface

ISSN 1512-1232

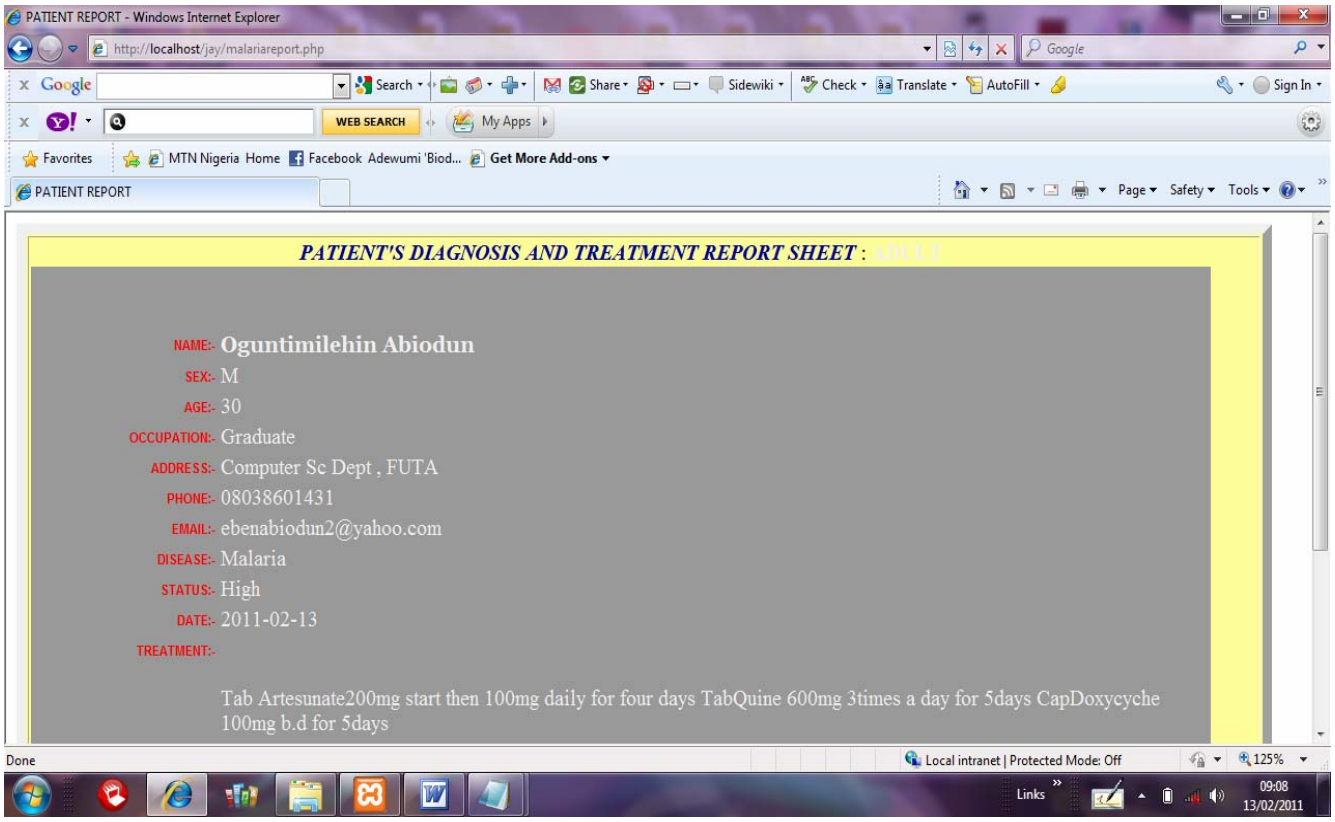

Figure 5. Patient Medical Report Interface

5.2. Discussion of Results

The performance of the system were measured base on two results generated from the system, one on training set and the other on testing set. The first result was obtained from the training set. All the ninety nine (99) data sets were tested, using the designed web based system according to the twenty three rules generated from rough set and the confusion matrix of the result is given in the table 3 below

Table 3. Confusion matrix for the Training Set

Predicted as Actual	Very Low	Low	Moderate	High	Very High
Very Low (6)	6 (100%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Low (11)	0 (0.00%)	11 (100%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Moderate (20)	0 (0.00%)	0 (0.00%)	20 (100%)	0 (0.00%)	0 (0.00%)
High (52)	0 (0.00%)	0 (0.00%)	0 (0.00%)	52 (100%)	0 (0.00%)
Very High (10)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	10 (100%)

TP = Class group correctly classified
TN = Class group wrongly classified

$$\text{Detection Rate} = \frac{TP}{TP + TN} = \frac{6+11+20+52+10}{99 + 0} = \frac{99}{99} = 100\%$$

All the six labels classified as Very Low were correctly predicted by the system which gives 100% prediction. All the 11 labels classified as low were also actually predicted, given 100%. There are twenty labels classified as moderate and all were correctly predicted, given 100%. The fifty two

ISSN 1512-1232

labels classified as High were all correctly predicted and likewise the ten labels classified as Very High. The confusion matrix thus gives 100% Detection Rate.

For the testing set, fifty set of data were tested against the twenty three rules using the designed system. There is only one very low label and it was correctly predicted by the system, attaining 100% in this case. Out of seven labels classified as Low, only six were correctly predicted while one was predicted as Very Low, which gives 85.71%. Of the seven labels classified as moderate, only five labels were correctly predicted, one was predicted as high while another one was predicted as Very high, given 71.43%. All the thirty one labels classified as high were correctly predicted, attaining 100%. In the case of the four labels classified as Very High, all were correctly predicted, this gives 100%. The confusion matrix for the testing set is given in table 4 below with Detection Rate of 94%.

Table 4. Confusion Matrix for the Testing Set.

Predicted as Actual	Very Low	Low	Moderate	High	Very High
Very Low (1)	1(100%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Low (7)	1 (14.29%)	6(85.71%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Moderate (7)	0 (0.00%)	0 (0.00%)	5 (71.43%)	1(14.29%)	01(14.29%)
High (31)	0 (0.00%)	0 (0.00%)	0 (0.00%)	31 (100%)	0 (0.00%)
Very High (4)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	4 (100%)

TP = Class group correctly classified
TN = Class group wrongly classified

$$\text{Detection Rate} = \frac{TP}{TP + TN} = \frac{47}{47+3} = \frac{47}{50} = 94\%$$

Based on these results, the success rate is considered good if the web based is implemented. However, the effect of dosage on a patient with moderate malaria classified as High or Very High is not put into consideration and likewise Low classified as Very Low.

6. Treatment of malaria

Malaria case management remains a vital component of the malaria control strategies. This entails early diagnosis and prompt treatment with effective antimalarial medicines. Most countries where malaria is epidemic have progressively updated treatment policies from the failing chloroquire(CQ) and snifadoxine – permenthamine (SP) to the recommended artemisinin-based combination therapies (ACTS); this is the best current treatment for uncomplicated malaria cases. While prescribing drugs for the treatment of malaria, the following must be taken into consideration: Body weight or age, Pregnancy status, HIV status and region of the world in which the person was infected [15]

The type of drug to be used depends on the type of malaria and the severity of the case, that is, first line drugs are for uncomplicated malaria and second line drug are for complicated malaria and malaria in pregnancy [15]

In this research work, the two data sets collected and classification reveal both complicated and uncomplicated cases of malaria. Out of the five labels, the first four- Very Low, Low, Moderate and High reveal uncomplicated cases of malaria that can be treated orally. The label Very High reveals a complicated malaria case which cannot be treated orally and in addition a parasitological test is recommended. The oral treatment recommended by both medical doctors and pharmacists in this research work are based on World Health Organization guidelines for malaria treatment (2nd Edition), 2010. Treatments are presented according to the level of severity of malaria. HIV status of

ISSN 1512-1232

patients and pregnancy status are not taken into consideration which means the treatment is not applicable to HIV patients or pregnant women. The treatments are also based on African region, Nigeria in particular. There are five classes of malaria as classified by the system and the recommended treatments are given in table 5 below.

Table 5. Malaria Treatment

LEVEL OF SEVERITY	INFANT	CHILDREN	ADULT
VERY LOW	Syrup Chloroquine 25mg/kg daily for 3 days, Syrup Paracetamol 2ml 3 times daily for 2days	Tab chloroquine 25mg/kg daily for 3days, Tab paracetamol 3times daily for 3days	Tab Paracetamol 500mg 3 times daily for 3days,Tab Sulphadoxie /perimethane III start, then Tab Ibuprofen 400mg b.d for 5days.
LOW	Syrup Chloroquine 25mg/kg daily for 3 days, Syrup Paracetamol 2ml 3 times daily for 2days	Tab chloroquine 25mg/kg daily for 3days, Tab paracetamol 3times daily for 3days	Tab Paracetamol 500mg 3 times daily for 3days, Tab Sulphadoxie /perimethane III start, then Tab Ibuprofen 400mg b.d for 5days.
MODERATE	Suspension Artemether 25mg + Amodiaquine 75mg for 3days OR	Artesunate 4mg/kg+Amodiaquine 10mg/kg for 3days (1 morning, 1 night) OR	Artesunate 100mg b.d for 3days Amodiaquine 200mg daily for 3days Tab Artemether 20mg/kg +Lumefantrine 480mg for 3days.
	4mg/kg Artesunate +10mg/kg Amodiaquine for 3days	Artemether 20mg+Lumetamtine 120mg (2morning, 2night) for 3 days.	
HIGH	Susp Artemether 25mg+Amodiaquine 75mg, Susp Amoxicillin 125mg 3times a day for 5 days, Susp Quine 160mg 3 times for a day , Susp Quine 150mg 3 times for a day	Susp Artemether 4mg/kg, Susp Amoxiallin 250mg 3times a day for 5days	Tab Artesunate200mg start then 100mg daily for four days, TabQuine 600mg 3times a day for 5days, CapDoxycyche 100mg b.d for 5days
VERY HIGH (SEVERE)	*Patient should be on admission* Inj Phenobnibitone 5-10mg/kg every 20-30mins up to plasma concentration of 40mg/litre. OR	*Patient should be on admission* Inj Phenobnibitone 8mg/kg daily Inj Quine 10 mg/kg 8hrly Inj Artemether 3.2mg/kg start then 1.6mg dailyX 6/7 Inj Arteether 3mg/kg for 3days	*Patient should be on admission* Inj Artemether 160mg then 80mg daily x 3/7 Inj (Arteether) E-mal 150mg daily x 3/7 Tab Ciprofloxacin 500mg b.d x 5/7
	Inj Quine 10mg/kg every eight hrs,Inj Artemether 3.2mg 1kg then 1.6mg daily X6/7		

ISSN 1512-1232

7. Conclusion and future work

With the detection rate of 100% for the training set and 94% for the dataset and medical experts' provision of therapy for malaria according to World Health Organization Guidelines for the treatment of malaria, it is hopeful that the web based system will go along way to reduce the large deaths being caused by malaria. Apart from reducing the number of patients waiting for doctors for consultation on malaria cases, we also hope that many people will have access to it mostly in rural areas where hospitals are not available or not sufficient; the web-based system is expected to save a lot of lives since people can have access to it through GPRS enabled mobile phones, Cybercafés and telecommunication companies' data link modems.

In the future, there is need of a web-based system that could diagnose malaria in pregnancy and provide treatments in accordance with different stages of pregnancy and also a web-based system that could diagnose malaria and provide treatment for HIV patients according to the level of severity of HIV.

Acknowledgement

We hereby acknowledge the effort of the following medical personnel for their efforts during this research work, Dr Adeife Erinfolami and Pharmacist Oyewo Idris. May God continue to enrich their knowledge.

8. References

[1] Adetunmbi A.O, Falaki S.O, Adewale O.S and Alese B.K(2008) "Network Intrusion Detection Based on Rough Set and K-Nearest Neighbour", International Journal of Computing and ICT Research, Vol.2 No. 1, June 2008 (www.ijcir.org/volume2-number1/article7.pdf, retrieved 24/01/2011)

[2] Agbonifo O.T and Akinyede O.R (2008), "Modelling a framework for telemedicine in transmitting Medical Data for diagnosis Management in Nigeria",Nigeria Computer Society 22nd National Conference pg 325- 332

[3] Bernard C, Jacques T and Henny B (2000), "Script and Medical Diagnostic knowledge: Theory and Applications for Clinical Reasoning Instruction and research", http://www.ncbi.nlm.gov/pubmed/10693854.

[4] Kakukama I (2009), "Clinical Protocol-Based Decision Support System for Malaria Treatment", M.Sc Computer Science Thesis, Makere University, http://dspace.mak.ac.ug/bistream/123456789/628/3/kamukama-ismail-cit-masters-report.pdf, retrieved 4th May 2010.

[5] Malaria, http://en.wikipedia.org/wiki/Malaria, retrieved 4th May 2010.

[6] Malaria-World malaria day 2010, http://www.who.int/malaria/en/, Retrieved 29th May 2010.

[7] Malaria Overview, Prevention and Symptoms, http:www.home-remedies-for-you.com/remedies/malariasymptoms.htm, retrieved 4th May 2010.

[8] Nicholas E.R, Charles J. P, David M.R and Adriano G.D, "Automated image processing method for the diagnosis and classification of malaria on thin blood", http://www.springerlink.com/content/wgh485h218379005 , retrieved 29/05/2010.

[9] Obot O.U., Akinyokun O.C, and Udoh S.S (2008)-Application of Soft Computing Methodologies to the Management of Hypertension, Nigeria Computer Society 22nd National Conference pg 339-348.

[10] Obot O.U. and Uzoka F-M.E. (2008), "Fuzzy-rule based framework for the management of tropical disease",Int. J. Medical Engineering and Informatics. Vol.1. No. 1. http://inderscience.metapress.com /media/acecbdayxq7uyvbwdp4u/contributions15/6/4/0/ 564023q746568m75_html/fulltext. Retrieved 20/05/2010.

[11] Therapy,http://en.wikipedia.org/wiki/Therapy, retrieved 20/05/2010.

ISSN 1512-1232

Uzoka F-M.E(2005), "Medical Decision Support System using Analytic Hierarchy Process: A case study of malaria diagnosis", http://www.medetel.eu/download/2005/parallel_ sessions/presentation/0407/medical_decision. Retrieved 24th May,2010.

[12] Uzoka F-M.E, Obot O and Barker K(2009), "A performance comparison of Fuzzy Logic and AHP as engines for the development of Intelligent Medical Diagnosis Systems",Nigeria Computer Society 23rd National Conference pg 135- 150.

[13] Ugwu C, Onyejegbu N.L and Obagbua I.C (2009), "The Application of Machine Learning Technique for Malaria Diagnosis", Nigeria Computer Society 23rd National Conference pg 151- 158.

[14] World Health Organization, "Guidelines for the treatment of malaria, 2nd Edition", http://whqlibdoc.who.int/publications/2010, Retrieved 06/01/2011.

Article received: 2011-02-14