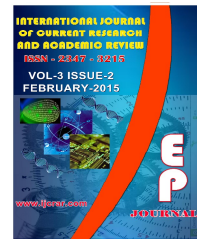




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### Web based expert system for diagnosis and management of kidney diseases

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#### KEYWORDS

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WEB,  
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Disease,  
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#### A B S T R A C T

This paper presents a web-based expert system for diagnosis and management of kidney disease. Along with the explosive increase of information services using World Wide Web (WWW), the practical application of web-based expert system has shown tremendous growth. One of the most important branches of Artificial Intelligence is the expert systems. Expert systems are application oriented. An expert system is a computer application that solves complicated problems that would otherwise require extensive human expertise. Kidneys are two bean shaped organs in the body situated at the back on either side of the spine. They are essentially responsible for removing toxins and other waste products from the body through urine. When these kidneys cease to working appropriately due to any reason, the body become incompetent of getting rid of wastes and excess water. Kidney failure is a world- wide health problem, kidney diseases is a complicated process and require high level of expertise. The aim of this work is to design and implement a web based expert system for diagnosis and management of kidney diseases. For the development of expert system, free e2gLite expert system building tool (shell) implemented as a Java applet was applied which is equipped with an inference mechanism and a knowledge base, and the web interface was developed with the use of HTML. The system asks questions of the user to elicit the information needed in order to recommend or give final result based on the user input and uses IF-THEN rules to represent knowledge. The system has been tested with domain dataset, and results given by the system have been validated with domain experts.

#### Introduction

A web based application is an application that is accessed by users over a network such as the Internet or an intranet. The term may also mean a computer software application that is coded in a browser-supported programming language (such as

JavaScript, combined with a browser-rendered markup language like HTML) and reliant on a common web browser to render the application executable. Web applications are popular due to the ubiquity of web browsers, and the convenience of using web

browser as a client (Harmon & David, 1995).

Expert Systems (ES) is a computer-based systems that emulate the reasoning process of a human expert and serve different purposes like Consulting Diagnosis, Learning, Decision support, Designing and planning, etc. An expert system is a system that can reason about facts about the world using rules, and take appropriate actions as a result (Hill, 2006).

Kidneys are two bean shaped organs in the body situated at the back on either side of the spine. They are essentially responsible for removing toxins and other waste products from the body through urine. When these kidneys cease to working appropriately due to any reason, the body become incompetent of getting rid of wastes and excess water (Smith, 2006).

A primary function of kidneys is the removal of poisonous wastes from the blood. Chief among these wastes are the nitrogen-containing compounds urea and uric acid, which result from the breakdown of proteins and nucleic acids. Life-threatening illnesses occur when too many of these waste products accumulate in the bloodstream (Remuzzi *et al.*, 2002). Fortunately, a healthy kidney can easily rid the body of these substances. Guidelines for early identification and management of patients are now a priority.

### **Research motivation**

The main reason for this research work is to Implement and design an expert system which is able to diagnose kidney diseases, due to wrong kidney diseases diagnosis and treatment given to patients, now that Kidney disease mortality is a growing public health problem it is based on this that I can see

what has been done as far as kidney disease is concerned. It prompts the design of this system to eliminate the above problem, due to its characteristics such as quick, effective and accurate diagnosis and treatment of kidney diseases. This system is designed to give help to a medical expert (doctor) in making the appropriate diagnosis of a patient. The kidney diseases have a lot of common symptoms and many of them are very much alike, and that makes it very difficult even for a kidney doctor (specialist) to put a right diagnosis.

By definition Expert Systems are knowledge-based systems that contain expert knowledge; they are programs that can provide expertise for solving problems in a defined application domain (Kasabov *et al.*, 1996). They have been applied successfully in almost every field of human activities due to their abilities to represent, accommodate and learn knowledge; they are capable of taking decisions and communicating with their users in a friendly way (Wielinga *et al.*, 1997). The system will therefore provide a web based application with simple and easy to use graphical user interface.

### **What is renal failure?**

Smith (2006) stated that renal failure refers to temporary or permanent damage to the kidneys that result in loss of normal kidney function. There are two different types of renal failure - acute and chronic. Acute renal failure has an abrupt onset and is potentially reversible. Chronic failure progresses slowly over at least three months and can lead to permanent renal failure. According to Sarnak and Levey (2000), the causes, symptoms, treatments, and outcomes of acute and chronic are different.

### **What are the symptoms of renal failure?**

National Kidney Foundation (2004), says the symptoms of kidney failure or kidney problems appears slowly over a long period of time, so they can easily go unnoticed or thought to be normal stress. Knowing the symptoms of kidney failure can help you recognize the problems and then get proper treatment. If you experience any symptom of kidney failure, you should at once discuss it with your doctor and not ignore it. The symptoms for acute and chronic renal failure may be different.

The aim of this paper is to design and implement a web-based expert system for diagnosis and management of renal diseases, which possesses the following objectives;

- a. To know the various causes of kidney or renal failure and to enhance early diagnosis and treatment of kidney disease.
- b. To serve as temporary assistance to those who are in need of instant help when expert consultant is not readily available due to time and distance.
- c. To design a system where the user can interact with the system website anywhere, anytime to manage or diagnosis various kidney diseases.

The rest of the paper is organized as follows. In section 2, literature review is presented; this is followed by the description of the expert system development in section 3 and the developed system structure in section 4. Section 5 presents the discussion, and the conclusion is presented in section 6.

### **Literature review**

#### **a. Artificial Intelligence**

Artificial intelligence (AI) is the part of computer science concerned with designing

intelligent computer systems, that is, system that exhibit the characteristics that is associated with intelligence in human behavior –understanding language, learning reasoning, solving problems and so on (Barr and Feigenbaum, 1981).

Artificial intelligence (AI) is technology and a branch of computer science that studies and develops intelligent machines and software. AI textbooks define the field as "the study and design of intelligent agents", (Poole *et al.*, 1998), where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success. John McCarthy, who coined the term in 1955, defines it as "the science and engineering of making intelligent machines".

#### **b. Expert Systems**

An Expert system is defined as a computer program that reason using human knowledge to solve complex problems (Feigenbaum, 1992). An Expert system is an interactive computer- based decision tool that uses both facts and heuristics to solve difficult decision problems based on knowledge acquired from an expert (Penta, 2002).

An Expert system is a computer system that attempts to replicate specific human expert intelligent activities (Mockler and Dologite, 1992).

An Expert (Knowledge Based) system is a problem solving and decision making system based on knowledge of its task and logical rules or procedures for using knowledge. Both the knowledge and the logical are obtained from the experience of a specialist in the area (Armstrong Walker, 2002). Folorunso *et al.*, (2012) An Expert System is computer program that emulates

the behavior of human expert to solve problems which are real word problems associated with a particular domain of knowledge. An Expert System which is sometimes called an Intelligent Knowledge Base System (IKBS) is essentially a computer system containing expertise in a particular area. The primary goal of an Expert System is to make expertise available to decision makers and technicians who read answers quickly (Keller, 1988).

### **Medical Expert Systems (MESs)**

Since the 1980s, development of expert systems, both in theory and practice has gained tremendous success and development, and demonstrated its great vitality and value (Ignizio, 1991). But it also shows it's obvious shortcomings and deficiencies, such as the system's vulnerabilities, limitations and inability to share the knowledge content the unity of solution strategy, lack of uniformity for the system interfaces, difficulties of system development and maintenance and so on, especially in the medical expert system that relates to a wide range and whose categories are very numerous, the performance becomes more apparent (Zhongzheng, 1994). The medical field may make more use of the expert systems than any other field. Series of advisory programs have been developed to help physicians diagnose a particular illness and in some cases, to prescribe treatment. The oldest medical expert system is called MYCIN. MYCIN is an expert system developed at Stanford for diagnosing blood diseases. It is one of the widely studied expert systems because of its success. MYCIN was one of the first expert systems to use production rules and to employ the backward-chaining inference method (Frenzel, 1987). Production rules are IF-THEN statements that express chunks of knowledge that are readily applied to problem solving. Backward-Chaining refers

to the search method used by the computer to look through the production rules and find the appropriate solution (Frenzel, 1987).

### **Review of Previous Work**

Dada *et al.* (2011) developed a web-based expert system for classification of industrial and commercial waste products for the classification of wastes to overcome the difficulty, The main objective of the system is to join the expert system intelligent knowledge and the capability of the Web to put the knowledge of experts anywhere the expert can't go, and also to obtain facts and rules from the experts that will allow the system to draw expert level conclusions. The method used in actualizing the objective stated above was IF-THEN styles for the representation of the knowledge. Object oriented approach using Universal Modeling Language (UML) can be applied to the rule-based expert system. The Rule Compiler (RC) then takes the rules from the experts and automatically generates each rule as Java source code. The source code is then compiled into Java Byte Code using Java compiler.

Akanbi and Odejebi (2009) design a web based expert systems for management of pests diseases of cassava, the work was aimed at developing an expert system that could used by farmers and by the experts to train their students cassava was referred to as a very important plant that if properly managed could enhance the foreign exchange earning of the country that have it However, there are little number of experts that can handle the pests and diseases of cassava. the knowledge was represented using rule based approach i.e. IF...THEN rules and unified modeling language (UML) which is an object oriented programming tool for modeling objects and the relationships between object and classes in the design phase of the program was

employed in designing the system. Visual prolog 7.0 was used to develop the expert system and the web interface was developed with the use of macromedia Dreamweaver,

Prasad *et al.* (2010) developed a web based tomato crop expert information system based on artificial intelligence said tomato is one of the most important "protective foods" both because of its special nutritive value and also because of its wide spread production. The knowledge collected through experts is stored as a database (Knowledge Base) that serves as a repository for quick processing and future retrieval. The system stores the information in html files.

A set of rules, which constitute the program, stored in a rule memory of production memory and on an inference engine required to execute the rules. The monitoring data is in the MySQL database. It can be used as any other data stored in a database. It was latter concluded that a web-enabled application developed using java server pages (jsp) and MySql database was used

The work presented by Abd Wahab *et al.* (2009), design a web base network troubleshooting expert system. The work is aimed to developed an expert system for troubleshooting the network problems, the system is intended to be used by the network administrators to quickly troubleshoot the network hardware problems and solve the problem optimally and systematically. Though there are many types of network problems but the work was only focus on the hardware components. The tools used to develop the system is ASP (Active server pages) it was chosen due to its easy-to understand code for web based applications and Microsoft access is used to store the production rules. ASP pages are file that contains HTML tags, text and script

command, ASP lets developers add interactive content to web pages or build an entire web application that uses HTML pages as user interface.

Fahad *et al.* (2008) proposed a web based expert system for wheat diseases and pests. The work presents the use of expert systems in the agriculture domain in Pakistan. Wheat is one of the major grain crops in Pakistan. It is cultivated in vast areas of Punjab followed by Sindh and ranked first as a cereal crop in the country. The rapid development of internet technology has changed the way of expert system development. It is easy to access the system via the internet

The work was aimed at developing an expert system that will help the farmers, researchers and students and provides an efficient goal-oriented approach for solving common problems of wheat.

The expert system is constructed using e2gLite™ expert system shell available freely on the internet. This web-based expert system shell allows a JAVA interface to process its input and output sets. Java has been to process input and output sets. The knowledge base for e2glite expert system shell consists of simple if-then rules. The rules are usually fired on the basis of internal logic of inference engine. Forward chaining and backward chaining techniques are used.

### **Expert system design and development**

A precise domain is required by an expert system. The domain must be compact and well organized. The quality of knowledge highly influences the quality of expert system. The first step in the development of any expert system is problem identification. The problem here is a diagnostic problem aimed to identify kidney failure and causes.

The problems occur frequently and the consequences on the human expert. The demand for help is increasing rapidly. Experts are there to help but sometimes they are not readily available, especially in rural areas due to distance and time availability. Therefore expert systems are needed in those areas where the help to human expertise is not readily available.

### **Knowledge acquisition**

Knowledge acquisition is the process of collecting data from the domain expert. This stage involves the consultation of domain experts which are the most important individual in an expert system design process. In this work knowledge is acquired by consulting an expert in the medical field i.e. this is direct contact with human expert in nephrology at LAUTECH TEACHING HOSPITAL OSOGBO, this involves constant interaction with the expert and elicitation of relevant information such as signs, symptoms, causes, diseases, kidney etc. Expert knowledge is also acquired from literatures related to kidney diseases. Most of the common problems related to the kidney diseases are described in “Diagnosis of common diseases of kidney”, by (Francisco and Zahirul, 2003). The knowledge acquired from the domain expert was represented in simple production rule.

### **Representation of Knowledge**

In the representation of knowledge into knowledge base, the knowledge acquired from knowledge acquisition process is represented into structured form. This involves encoding and representation of the facts and relationships that constitutes the knowledge. As mentioned earlier, I used *IF-THEN* styles for the representation of the knowledge. In this case, I developed a Web-based user interface module for the domain

experts to allow them enter rules and basic facts about the kidney. The rules and facts are based on the consultation process, with specific information on the stages of kidney disease. The domain experts can monitor and automatically test the execution of the expert system in Web browser before deployment for the users and this is achieved with the help of E2glite a rule-based expert system shell. E2gLite which comprises of Java applet and is a development toolkit (a 'shell') developed by eXpertise2GO which was developed with Java. The other development tools include;

HTML (Hyper Text Mark-up Language), JQuery, Cascading Style Sheet (CSS).

### **Working with E2glite**

The e2glite shell is implemented as a Java *applet*. An applet is a form of Java program that can be embedded into a web page via a special HTML tag just like any compiled Java program (Khaled *et al.*, 2004). The e2glite consists of a set of class files. These class files have all been packaged together as a Java Archive file, e2glite.jar. The most common way to run a Java applet is to invoke it from a web page via an HTML applet tag.

### **Developed System**

The system, “a web based expert system for diagnosis and management of kidney diseases”, is a rule based medical system for diagnosis of renal failure using E2glite as the knowledge base. Forward chaining inference mechanism is used, this method involves checking the condition part of a rule to determine whether it is true or false. If it the condition is true, then the action part of the rule is true. This procedure continues until a solution if found or a dead end is reached. Forward chaining is commonly

referred to as data-driven reasoning; it begins with known facts and an attempt to moves towards the desired goal.

### **How to manage from web based to expert system**

To manage from the web-based to expert system, the .jar file which is an executable file must be embedded in the html page in order to run on the web. To use the expert system, a Web page that loads the applet and identifies the knowledge base is needed. The e2glite consist of 3 main components which are;

- a. E2glite .jar file
- b. The .KB files
- c. The .HTML file

### **Expert system for diagnosis of kidney diseases**

For the development of expert system, free e2gLite expert system building tool (shell) implemented as a Java applet was applied. To use the expert system, a Web page that loads the applet and identifies the knowledge base is needed. The system can be used without network connection under the requirement for putting the Web page (knowledge.html), the knowledge base (knowledge.kb) and the e2gLite applet archive (e2glite.jar) in the same subdirectory.

**Diseases stage check:** This is the page where proper consultation will start and before the consultation start, the user must have gone for MRI (magnetic resonance image), CT (Computed Tomography) scan, ultrasound or contrast X-ray to know or check whether an individual is at risk of having kidney diseases. When the user click on start consultation, it will link to another page which is figure 4.2 where the user will interact with the system and ask various

question about the GFR(glomerular filtrate rate), when the user input the GFR, the user submit the response. It is the submission of each response to the question that prompt another question, the system provide an interactive way to the user, ask question about personal details and symptoms it is now based on the input provided by the user that the system (Expert system) will now draw out the final conclusion and let the user know the stages he/she belongs to as illustrated in figure 4.1 and 4.2

**Question of expert system:** The system gives questions to a user in (Figure 4.3).

- a. When the user submits his response, he can continue to another question. After clicking the “Why ask?” button, the user can see the inference engine’s explanation of the question. The user can find out the goal or subgoal, the inference engine is currently working on, attribute that is trying to find and the rule that needs the value of this attribute.

#### **b. Explanation of the question:**

After answering the questions, the inference engine has enough information to conclude the interview with high risk of kidney disease: if you are above 60, have a family history, have heart problem, and have high blood pressure, obese and a smoker. The expert system will now give the recommendation that there is high risk of having kidney disease. As illustrated in figure 4.4

### **Discussion**

The developed system “web based expert system for diagnosis and management of kidney disease” is a medical expert system for diagnosing kidney diseases. The system

is a generic tool for renal failure and can be used by all types of people because the symptoms of different types of renal failure are almost similar. Using this system user will be familiar with the symptoms and causes of kidney diseases and give suggestion for a healthy living. It provides a very fast and accurate diagnosis and minimizes the amount of time the medical experts spend in attending to patients suffering from kidney diseases. It is a rule based system that supports forward chaining reasoning. This project work recommends that teaching Hospital and all other public and private Hospitals should develop a web based expert system that will serve as temporary assistance to those who are in

need of instant help when a human expert is not readily available due to time and distance.

The system recommends that the user should be at least computer literate and there should be uninterrupted power supply (UPS) to back up, solar power or standby generator set in case of power failure for an effective use and performance of the system. This project work was achieved with the help of E2glite a rule-based expert system shell. E2gLite which comprises of Java applet and is a development toolkit (a 'shell') developed by eXpertise2GO which was developed with Java.

**Fig.1** Screen shoot of Kidney diseases stage checker





Figure.2 Screen shoot of kidney diseases stage checker 2

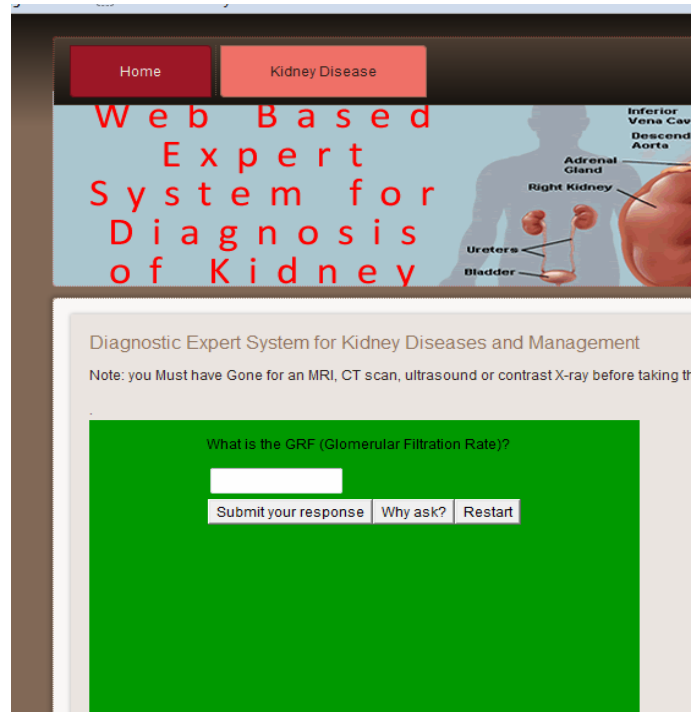


Figure.3 Question of expert system on increased risk of KD

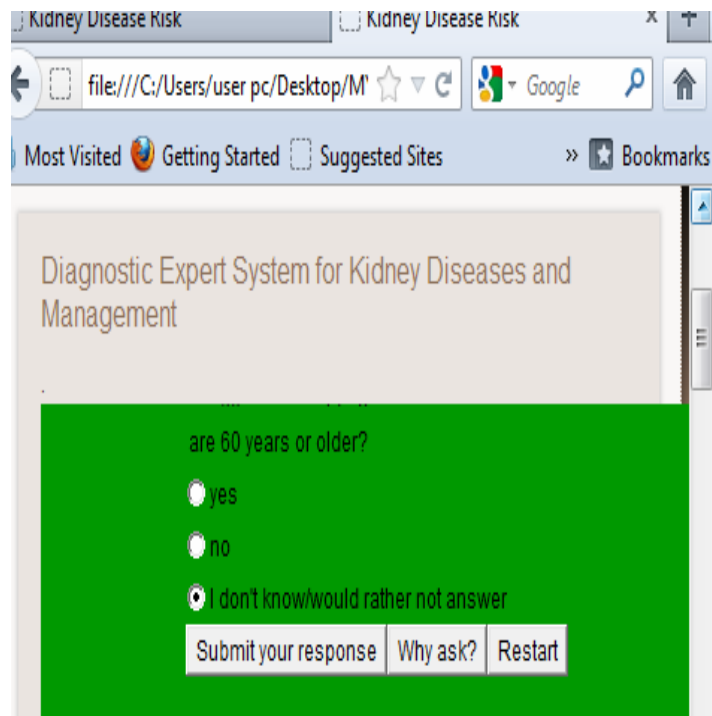
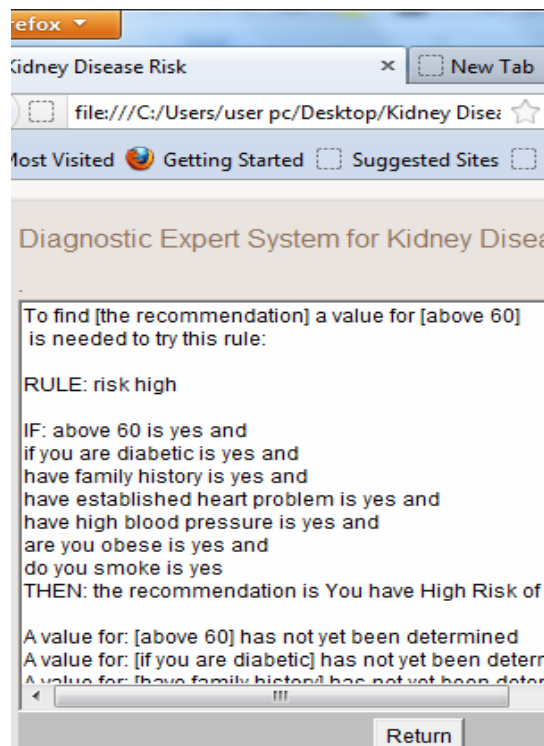


Figure.4 Explanation of the question (Output)



## Conclusion

The proposed system a web based expert system for diagnosis and management of kidney disease has been designed and implemented that can be used to solve problems of too many patients seeking daily medical attention. The system has been able to review various causes of kidney or renal failure and also enhance early diagnosis and proffer a better treatment, it also serves as a temporary assistance to those who are in need of instant help when expert consultant is not readily available.

Furthermore, the system has been carefully designed to be user friendly and accessible to anybody that intends to use it irrespective of their location, a system whereby the user can interact with the website anywhere, anytime to manage or diagnosis various kidney diseases based on user input.

The results given by the system have been validated with domain experts after tested with domain dataset. The knowledge is represented in the form of IF-THEN rules which reasoning by forward chaining, This expert system does not need intensive training to be used, it has simple interface and attractive, it is developed using E2glite a rule-based expert system shell and can be use in DOS/Windows environment.

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