

A Mobile Expert System Utilizing Fuzzy Logic for Venereal and Sexually Transmitted Diseases

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Abstract—According to American Social Health Association, more than half of all people in the world will have Sexually Transmitted Infection (STI) or popularly known as STD at some point in their lifetime. This paper presents the work of developing a mobile expert system to provide information about the most common venereal and sexually transmitted diseases in the Philippines. The mobile application developed is capable of diagnosing the user based from the different physical manifestations of symptoms and usual signs that occur in their body. The source of data used to build the expert system was collected from various related literature studies and interviews with experts in venereology. The information provided by the application will help users in identifying early signs and symptoms of VD/STD and will also improve their knowledge regarding these infectious diseases. Detection of the VD/STD at a primary stage is essential as to increase people's survival rate. A fuzzy logic algorithm was utilized to filter different symptoms and provide an accurate result of the diagnostic testing. The system was evaluated by venereal disease expert, venereal disease/ sexually transmitted disease patients and IT Professionals through its functionality, efficiency, and portability. The results of the evaluation showed that the application was able achieved the defined objectives from the outcome of the survey given to the experts and other evaluators.

Index Terms—expert system, venereal and sexually transmitted disease, fuzzy logic algorithm

I. INTRODUCTION

Sexually transmitted diseases (STDs) are the most common infectious diseases that plague men and women in different parts of the world. In the United States alone, about 19 million new infections occur each year [1].

Infectious diseases such as STI and VD contribute to the 60% of deaths worldwide [2]. These are the type of diseases transmitted through sex, especially vaginal intercourse, anal sex and oral sex [3]. Most STIs initially do not cause symptoms [4] which results in a higher risk of passing the disease to others [5]-[7]. On the other hand, in STD active symptoms of the disease can be observed as a result of an infection which can be passed through sexual contact [7].

As the innovation in technology grows, mobile platforms became more accessible to the developers and innovators. This advancement has begun the development

of various applications to provide solutions for raising demands and changing trends in business, education, security, and health, to name a few. Health education and awareness is an essential part of the health care of children and adult. Several mobile applications aim to help healthcare providers improve and manage the delivery of patient care and give knowledge to users.

Expert systems are application-specific computer programs that mimic human problem-solving expertise [8]. It is a branch of artificial intelligence [8] where the intelligent activity done by experts systems is problem-solving. An application-specific program is capable of helping users in decision making because expert systems are built based on human experience in a particular field. Expert systems are deployed to aid non-specialists or less experience people in solving problems and making decisions [8]. These applications are made up of a sensible combination of knowledge acquired from human experts. While expert systems efficiently used in many applications in general, its benefits specifically for medicine is more significant and effective compared to other fields. This significance is due to the diagnostic nature of medical applications, which goes along with the effectiveness of expert systems in solving diagnosis problems [8].

WebMD by CDC [9] is a mobile application that provides knowledge and information about the different diseases. The National HIV, STD, and Viral Hepatitis Testing Resources Web site is a service of the Centers for Disease Control and Prevention (CDC) [9]. These tools/applications provide users the locations of HIV, STD, and hepatitis testing and STD and hepatitis vaccines around the United States [9]. Likewise, STD Tx Guide was developed which serves as a quick reference guide for doctors and related parties on the identification and of STDs. This mobile application also provides information and treatment to a person who has or is at risk of STD. Although there are existing applications for providing knowledge, diagnosis and informing the user about their sexual health, the features, scope, and factors to be considered are still limited.

This paper presents the work of developing a mobile expert system to provide information and diagnosis of sixteen most common venereal and sexually transmitted diseases in the Philippines. The researchers conducted knowledge acquisition to collect data from human experts, which was analyzed and formatted as a set of rules to reach the final decision or recommendation. The

inference engine, on the other hand, will obtain information from the profile of the user, by asking various questions including the different signs and symptoms that occur in their body. The user interacts directly with the system through its user interface, with dialog boxes, forms and other input and non-input objects. The mobile application content includes information, treatment, and visual illustration of the diseases. Fuzzy Logic Algorithm was implemented to filter the different symptoms provided by the users and provide a diagnosis.

The general objective of the study is to develop a mobile expert system that would give a reliable diagnosis for Venereal Disease/ Sexually Transmitted Disease (VD/STD).

(1) Implement Fuzzy Logic Algorithm to provide a diagnosis to patients of VD/STD; (2) Apply the different Human-Computer Interaction (HCI) design principles in creating the user interface; (3) Provide information, treatment, and visual illustration of the disease; and (5) Evaluate the application using ISO 9126 measuring the quality standard in terms of functionality, efficiency, and portability.

The medication and treatment provided by the application may or may not be followed by the users since the disease still requires further consultation with an expert. The developed application is only compatible with Android mobile devices with version 4.1.3 and higher.

The study would contribute to the innovation of mobile health applications by developing an expert system which leads to better awareness of individuals regarding their sexual health. The developed application provides relevant information, appropriate and correct knowledge validated by the experts hence, reduces misconceptions about VD and STD. The application could serve as a model and reference for future developers who are interested in developing a mobile health expert system.

II. ALGORITHM

There have been much research related to the fuzzy logic expert system since few decade ago [10]. There are various works done which implement the fuzzy logic algorithm in the medical expert system. By using the expert medical knowledge fuzzy rules are developed that can be used in decision making. Detection of the VD/STD at a primary stage is essential as to increase people's survival rate.

The medical industry using the field of artificial intelligence has successfully moved from clinical laboratory to real-time applications [10]. The fuzzy expert system can be applied as a decision-making tool for monitoring VD/STD using fuzzy relationships. Designing and implementing results for the diagnosis of VD/STD using fuzzy logic was designed as shown in Fig. 1. The fuzzy rule-based system utilizes the expert medical knowledge to understand the patient's symptoms and provide accurate decision according to fuzzy rules constructed.

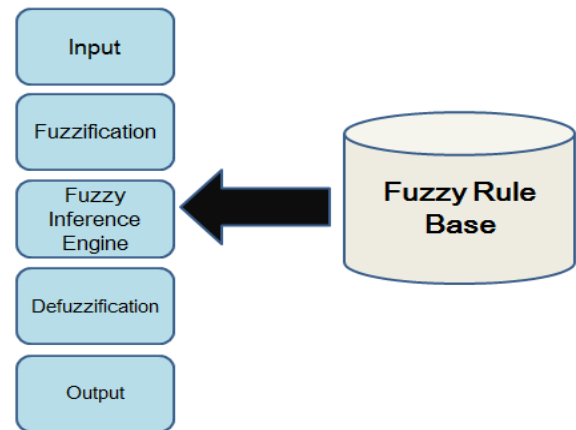


Figure 1. Fuzzy logic system

III. RESEARCH METHODOLOGY

The system architecture of the mobile application developed mainly consists of the following components as shown in Fig. 2.

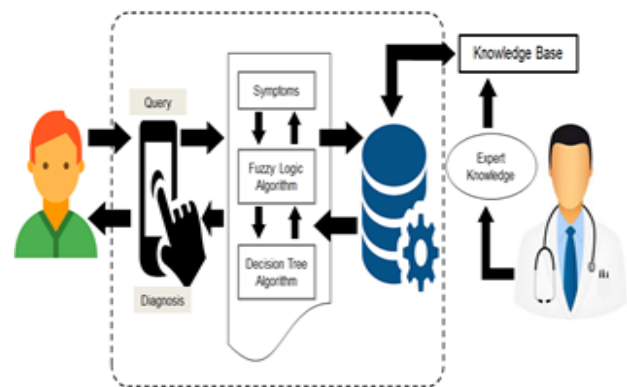


Figure 2. System architecture

The database serves as the data connection of other components which contains expert knowledge and diagnosis data. The knowledge base stores information obtained by summarizing experts' experiences. This information was processed to create valuable knowledge behind diagnosis data. The Fuzzy Logic Algorithm was applied to generate a diagnosis based on the rules created from the list of signs and symptoms of the different VD/STD. These rules were collected from an expert's knowledge which has the form of if-then statements [11]. The user will be asked of various questions including the different signs and symptoms that occur in their body. Then the application will display the condition of the user's sexual health and provide information, medication, and treatment for the identified disease. For knowledge-based systems, the decision tree has the advantage of being comprehensible by human experts and directly convertible into production rules [12]. The study applied the decision support tool to generate an enhanced and comprehensible diagnosis based on the signs and symptoms occur in the body of the user. Furthermore, to achieve the objectives, a thorough knowledge of the

application, software, and hardware requirements were required.

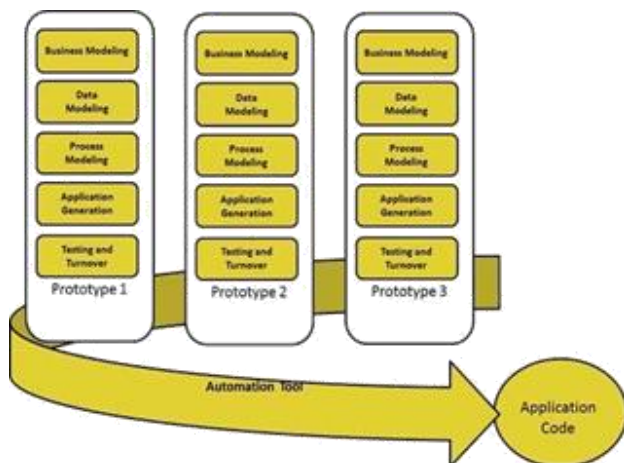


Figure 3. Adaptation of rapid application development

The study implemented the Rapid Application Development (RAD) a methodology which uses minimal planning for rapid prototyping represented in Fig. 3. It allows the software to be written faster and to incorporate changes easier. During the development, the application goes through various changes in its features and functionalities. The application was also deployed and tested on Android devices with a version 4.1.3 or higher to ensure that all functions are properly operational and compatible with the operating system. RAD methodology was applied in order for the development to adapt to the sudden changes from the results of the evaluation and testing.

IV. RESULTS AND DISCUSSIONS

The data collected were processed to address the problems presented in this study.

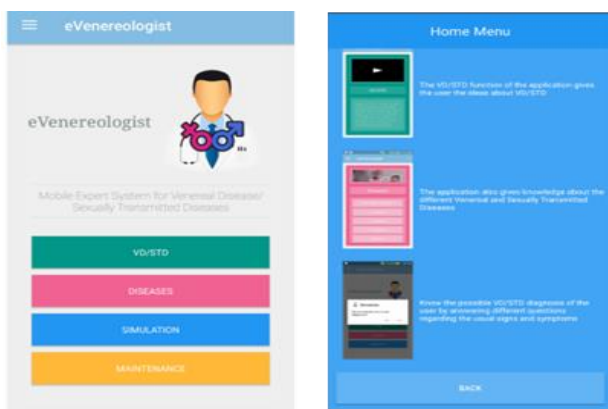


Figure 4. Main module

The mobile application allows the user to select a specific action to perform as shown in Fig. 4.

The questions were generated using the Fuzzy Logic Algorithm as shown in Fig. 5. These are based on the collected expert's knowledge. On the other hand, the Decision Tree Algorithm to be able to generate a diagnosis based on the rules created from the list of signs and symptoms of the different VD/STD.

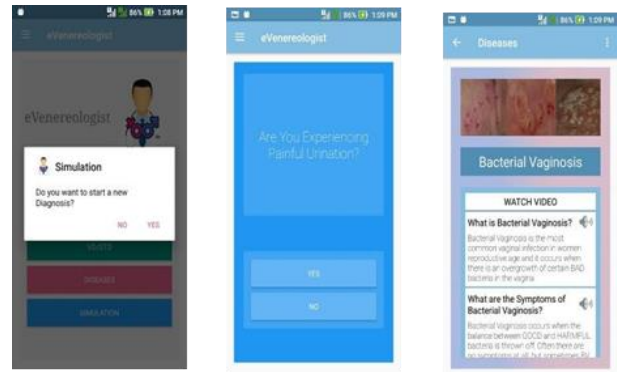


Figure 5. Diagnostic test and result

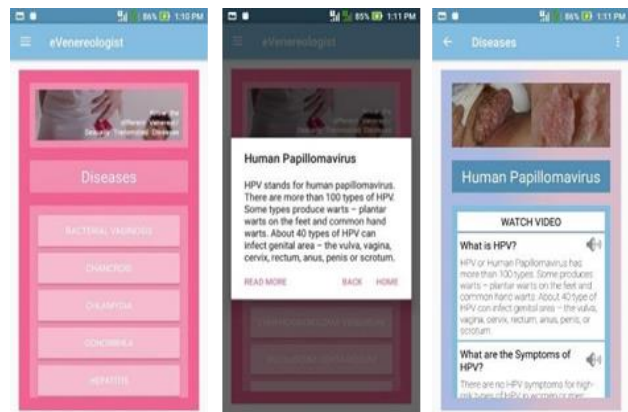


Figure 6. List of diseases and its information

Fig. 6 shows the list of the different Venereal or Sexually Transmitted Diseases together with its corresponding information, such as definition, medication or treatment and visual illustration.

We considered the actual involvement of the user to the application and their requirements. The feedback from the testing and internal evaluation contributed to the improvement of the application and served as further requirements on the actual software development using RAD methodology.

The next phase of the study is the evaluation of application which includes the recording of the feedback on a set of criteria. The data collected has been analyzed to recognize the usefulness of the application and if the users were able to enhance their knowledge about VD/STD patient health.

The application was evaluated regarding its functionality, efficiency, and portability following ISO 9126 Software Quality Characteristics standard. The application was evaluated by getting the frequency distribution of respondents with the use of Likert Scale. Likert Scale is the most likely used rating scales to measure attitudes by asking the respondents to a series of questions [3]. The users scored this mobile application by giving five (5) as the highest and one (1) as the lowest. The developers summarized the evaluation and tabulated the results. Participants of the evaluation are composed of 19 VD/STD patients, 11 venereology experts, and 40 mobile developers. The results were used to measure the reliability of the outcome of the diagnosis on the application.

The Table I shows the result of the evaluation conducted. It shows the respective mean result and the interpretation for each. The computation indicates an overall interpretation that the respondents Agreed with a 4.11 which is equivalent to 82.2% overall result of the system evaluation.

TABLE I. RESULTS OF EVALUATION

Criteria	A	B	C	D	E
Functionality	4.11	4.2	3.88	4.06	Agree
Efficiency	4.18	4.18	3.56	3.97	Neither
Portability	4.42	4.48	4	4.3	Agree
Mean Average				4.11	Agree

Legend:

A - VD/STD Patients

B - Expert in Venereology

C - Mobile Developers

D - Average

E - Interpretation

The validation process based on the ISO 9126 which is intended to address human usability that can affect the delivery and perception of a software development project. Through the compliance to measurable values recognized in this study in order to develop a common understanding of the objectives and goals of the project.

V. CONCLUSION AND FUTURE WORKS

The mobile expert system developed provides accessible information about the sixteen (16) different VD/STD derived from an expert in Venereology. The application applied Decision Tree and Fuzzy Logic Algorithm to provide a diagnosis based on the signs and symptoms observed from the user's body. The study would contribute to the innovation of mobile health applications by developing an expert system which leads to better awareness of individuals regarding their sexual health. Therefore, it is evident that the results of the evaluation showed that experts in venereology, VD/STD patients, and mobile developers agreed that the application achieved its objectives based on the criteria of functionality, efficiency, and portability. The application could also serve as a model and reference for future developers who are interested in developing a mobile health expert system.

Further research on the other sexually transmitted diseases could enhance and update the data provided in the application. Also considering more experts in venereology, will obtain more in-depth understanding and information about the other related sexually transmitted diseases. Identify algorithm that would provide more accurate and reliable diagnosis. Lastly is to improve the design to create an interactive and user-friendly interface for users.

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