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Back Cover
Enhancing Online Expert System Consultation Service with Short Message Service Interface

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Abstract— Short message service (SMS) that has been widely used in various fields could potentially utilized for problem-solving consulting services that are based on expert system, so it takes a kind of application platform to implement this service. This paper proposes an expansion of online expert system services (web and wap based) by adding an application use SMS interface. Knowledge base of the expert system, which employs a decision tree approach, is expressed in the form of a database that can be accessed by the application interfaces, including SMS interface. According to the experiment results, the decision tree has been able to play a role directing the consultation mechanism from an initial question to reach a conclusion interactively. Thus, a problem-solving case that can be expressed in the decision tree allows the implementation of this system.

Keywords— expert system; database; SMS; decision tree

I. INTRODUCTION

SMS is basically a text-exchanging feature between mobile subscribers with a limited amount of characters [1]. Although the message is limited, SMS has been a communication media of public service, especially in developing countries, such as the disease prevention services [2], m-banking services [3,5,4,6], and the field of agriculture [7,8,9]. Compatibility of SMS service to various types device of mobile phones which continues to grow, making this service as one of more accessible communication media. Advantages of these services can be used for consulting services regarding the problems in the community which aided by computing technologies such as expert systems.

Expert System (ES) is a particular media that provides problem-solving service within a specific problem domain [10]. When problem domain involves people’s need, then this ES is supposed to be capable to reach wider targeted users. The ES that have been developed utilizing web interface has been successfully giving several service access [11], however the existence of SMS feature in common mobile phone to be another potential alternative for ES implementation.

SMS is initially aimed for person-to-person messaging; this service has been widely used for consulting services that are based on expert system, so it takes a kind of application platform to implement this service. This paper proposes an expansion of online expert system services (web and wap based) by adding an application use SMS interface. Knowledge base of the expert system, which employs a decision tree approach, is expressed in the form of a database that can be accessed by the application interfaces, including SMS interface. According to the experiment results, the decision tree has been able to play a role directing the consultation mechanism from an initial question to reach a conclusion interactively. Thus, a problem-solving case that can be expressed in the decision tree allows the implementation of this system.

This paper proposes the development of SMS interface application that refers to a particular ES’ knowledge base, which is represented in a database system in the previous work [2]. This service development is based on application interaction concept that employs question and answer (as request-response mechanism in client-server system) in an ES, which refers to a particular knowledge base. The SMS application software will be developed for handling message processing and replaying user’s request automatically.

II. RELATED WORK

An ES is basically a form of computing application, which works based on facts any rules accommodated on a knowledge base. The knowledge base mainly acts for representing knowledge extracted from experts and allows particular computer to do reasoning process in a particular problem domain [10].

Evolution communication technology allows a particular computer system to work from a local scale network to an Internet, which is highly potential for implementing ES. Like an online ES, for instance, web usage that allows an ES to be accessible by more users. However, this system costs more complex development [14]. An ES as online consultation media has to pay attention to the interaction aspects. The systems are supposed to be capable for dynamically generating interface for the users, including from consultation process until inference process [15].

The development of an ES using multiple online services requires several media to present knowledge representation, which is accessible by each interface applications. In [3],
knowledge base is accommodated by using a database that will be accessed by web and WAP applications. This approach is likely to be carried out as this implements server side method, which is suitable for SMS.

A SMS based ES has been developed in [12] and [13], although those works are only specified for specific cases. In [12], expert system applications using SMS for fish disease cases with a case-based reasoning approach. While in [13], SMS based expert system use fuzzy approach to case of crops field. Both of these applications require particular design for the implementation because it uses some parameters that need to be considered analytically. While at the other cases it may take more general representation such as with decision tree approach. So the chances of its use will be more flexible.

As SMS offers a wide range for implementation, a SMS based ES is also applicable to be implemented for other particular cases. This paper proposes a general ES model, thus this model is applicable for any particular cases that are able to be represented using decision tree approach.

III. SYSTEM DESIGN

The system design is designed based on our previous work in [11], that was developing a web-based ES with web and WAP application for consultation application. The system was utilizing an arbitrary database for holding knowledge base representation. Therefore the system is accessible through web and WAP interfaces. The usage of the database also allows experts or knowledge engineers to carry out data entry or editing process through web interface. An expansion for SMS based consulting application is done by adding a software that will act as SMS server and gateway. Furthermore, explanations regarding system design will be divided into knowledge base representation and system architecture, which is expanded using SMS, based consulting application.

A. Database of Knowledge Base Representation

This ES will employ decision tree approach in knowledge base representation [11]. The decision tree approach itself is basically a collection of nodes that are connected each other. These nodes are categorized as root node, decision node, and leaf node. The root node represents first fact that will be an initial point where seeking process for identifying emerging symptoms is started. This identification will provide options to walk through other branches into other nodes, either decision node or leaf node. The decision node owns identical purposes with root node, but it is not located in the initial position. Leaf node is particularly a node that marks the ending position of a tree. This leaf node must be a decision that points to a particular solution.

Fig. 1. Example of a decision tree [16].

Representing knowledge base by using decision tree approach basically requires several definition processes. Firstly, defining a problem domain will be the main concern. Secondly, defining facts or symptoms that are probably appear in identification process as a decision node. Thirdly, defining inference as the diagnosis result of several facts or symptoms that appears as a leaf node. Fourthly, defining basic rule elements that are illustrate the relation between nodes as a decision tree representation.

Database model illustrated in relational diagram (Fig. 2.) is developed to represent above-mentioned knowledge base. The Database design consists of Case Table, Symptom Table, Diagnose Table, and Rule Table.

Fig. 2. Database design to store knowledge base representation.
Case table acts to keep problem domain definition data, which consists of Case Title fields and its explanation. Symptom Table is used for storing fact definitions as an identified symptom. This Symptom table holds question field for symptom identification and description field for the descriptions. Diagnose Table will act to store leaf node representations. That table will also store conclusion definitions or diagnosis results and suggestions data.

The decision tree structure representation will be stored in Rule Table. Several fields that are accommodated by Rule Table covers IsRootNode field as first stage initial identification data (to find out the existence of root or decision nodes), Identification_Question field as a storage for questions data regarding Symptom table, Answer_Description field to store options label data, Answer_Link field to store the link to an answer, either a link to next question or a link to a decision (diagnosis result), and IsANswerLeafNode field to store answer indication data, whether leaf node will stop or no.

B. Design of System Architecture

System architecture design (shown in Fig. 3.), which previously consisted of knowledge representation databases, development application, and consulting application for Web and WAP interfaces, will be expanded by using SMS application. This SMS application will provide a proper access to the data stored in database, accordingly SMS based consultation is possible to be built. The SMS application utilizes request-response communication concept in order to provide consulting application based on the knowledge base stored in database. Thus, this SMS application would be a particular interface for an ES consultation service.

The database, which stores knowledge representation, will act as the center of the proposed system. Knowledge engineers will be able to insert or edit existing knowledge base through Web interface. Furthermore, consulting application can utilize the stored knowledge representation, based on access media type, to provide consultation services to the users. Each type of consulting application is supposed to own similar interpretation to the knowledge base representation. Fig. 4 illustrates the decision tree seeking algorithm as a knowledge base representation in flowchart diagram.

![Diagram](image-url)

**Fig. 3.** An expanded Web and WAP based Expert System architecture using SMS consulting application.

**Fig. 4.** Tracing algorithm in a decision tree.
As seen in Fig. 4, the seeking process is started by choosing appropriate case as the problem domain. Then, identifying process is begun from root node, which contains initial question. Each identification questions contains multiple choices with next node regarding to the selected answer. When the users answer a particular question, a node is obtained. If that is a leaf node, then the identifying process will reach a conclusion. Nevertheless, if the node is a decision node, then the identification process will continue by showing the next question. This identification process will take place step by step between decision node until the process reaches the leaf node. Based on this algorithm, each application can be developed by using its own programming language platform.

This SMS application is developed by using PHP language as the server side application. This application employs Gammu software as the SMS gateway that provides send-receive interface for text messages to the clients. The SMS gateway device will provide communication media to the mobile network that will be forwarded to the mobile subscriber.

IV. CASE EXAMPLE : DENGUE FEVER CONSULTING

Dengue fever disease had been a serious worldwide concern as seen in Dengue Map\(^1\), an effort to keep monitoring these disease incidents globally. Beside preventive efforts to prevent the spread of this disease, an effort to take proper actions when the symptoms occur is also required to be carried out. A well-known and easily accessible communication service like SMS is expected to be an appropriate consultation media to detect initial detection of this disease. Therefore, this paper employs dengue fever as a case example for case study.

Based on World Health Organization (WHO) agreement, the dengue fever levels of severities are classified into dengue without warning sign, dengue with warning sign, and severe dengue [9]. According to the classification, there are several symptoms and actions that are required to be performed. Based on that reference, this ES application is developed as a consultation application by identification process through question and answer regarding the possibly identified symptoms, so that a proper action can be easily determined.

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![Fig. 5. Suggested dengue case classification and levels of severity [9].](image)
by users. Consultation can be performed using available access media, either Web, WAP, or SMS interface.

B. SMS based Consulting Application

This application provides a service for users to perform a consultation using SMS communication. Consultation process will be performed using question and answer mechanism between the service application and users, right after the user has been registered.

Users are able to continue to consultation process immediately after finished the registration process and replied according to the given instruction. This experiment is carried out based on the following decision tree shown in Fig. 7.

Fig. 7. illustrates the decision tree of Dengue Fever consultation process. The model possesses 13 questions and six decisions in total. In this scenario, the experiment will test whether the developed system would give question and decision correctly according to the decision tree model. The desired path is Q1-Q3-Q4-Q6-Q7-Q8-Q9-Q10-D4.

Consultation process will begin with initial question from root node (Q1) as shown in Fig. 8. Each question will always be followed by answer options to reply. Users are required to simply reply the question by replying the message according to the given instruction. Consultation process will continue with appropriate questions according to the constructed decision tree model. The process will end up in a leaf node where a conclusion is drawn; in this case, the experiment reached D4 decision.

VI. CONCLUSION

Knowledge base of the expert system with decision tree approach is accommodated in a database that allows to be accessed by an applications interface, including SMS interface for consultation application. The consultation mechanism, by means question and answer can work as an auto reply system. The decision tree has been able to play a role to direct the consultation mechanism from an initial question on a root node until it finds a conclusion at a leaf node. Thus, this system is also capable in implement any other problem domains, if it can be expressed by a decision tree models.

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