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AN ONLINE EXPERT SYSTEM FOR CONSULTATION SERVICES USING A MOBILE APPLICATION INTERFACE

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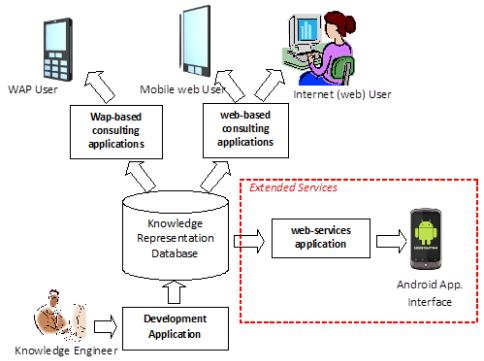
Graphical abstract



Abstract

An expert system service that deals with public problems or wide ranges of users basically requires an alternative medium, which is accessible. This paper proposes interface expansion for Web and WAP based expert system consulting application using an Android application interface. An open and accessible web service is developed to provide an access to the Android application to reach the knowledge base in the form of a decision tree stored in a particular database. The Android application employs HTTP for accessing data in a JSON format through web service. Then, the consultation mechanism would run interactively following an available path in the decision tree model from initial symptom identification to reach a conclusion.

Keywords: Expert system, android, decision tree, web service

1.0 INTRODUCTION

An Expert System is a medium that provides problem-solving service in a particular problem domain [1]. When the problem domain deals with public needs, such as a disease case [2,3], it should be able to reach wide target users. The presence of the evolving communication services needs to be explored to achieve this expectation.

The previously developed expert system as an online service, which uses Web and WAP interfaces as in [4] and expanded by SMS as in [5], has given several access service options. However, the newly emerging communication devices, such as smartphones, have become another alternative that can be potentially used in implementing an expert system. Basically, smartphone works as another ordinary computer that is uses operating system software for its computing processes. One of those is the Android operating system, which enables a couple of applications running on it [6].

An Android application can work independently or online using a network connection, for instance, the Internet. Some applications employ network connections for accessing centrally stored data in server [7]. In order to access the data, Android applications can use web service [7, 8, 9]. Furthermore, Android Software Development Kit (SDK) also provides some Application Programming Interfaces (APIs) to access the web service [10]. Those capabilities that

Android applications are offering will be the basis of the proposed expert system.

This paper proposes the development of expert system based on Android application with the web service that provides direct access to the knowledge base that is represented in [4]. As an online system, the developed application is supposed to be able to generate a user interface dynamically in the consultation process from initial state to obtain a conclusion [11]. The web service development is based on the interaction concept that refers to the decision tree model.

2.0 RELATED WORK

Studies related to the development of the expert systems using mobile applications have been applied in some particular cases. In [12], the mobile application is used to interpret arterial blood gas that is examined and to monitor critical patients. In [13], the mobile application is used for the early detection of diabetes that leads other potential diseases. While at [14], the mobile application is used to evaluate the nutritional condition of an individual by assessing their physical characteristics and eating habits.

While many cases are generally associated with people who need a solution, it takes a kind of expert system that accommodate a common approach. This research is to expand the online expert system services (Web and WAP) using a decision tree approach with mobile application services. Thus, the cases expressed in the decision tree can be accommodated by the system.

3.0 SYSTEM DESIGN

The system design is built based on our previous work in [4], but with several improvements, including Android based consultation (Figure 1). The previous services in our prior work were only limited to Web and WAP based services. The knowledge base was developed using a decision tree model represented in a database system. Separated applications were built, such as a consulting application for users to run consulting services and development application for the Knowledge Engineer (KE) to manage the knowledge base.

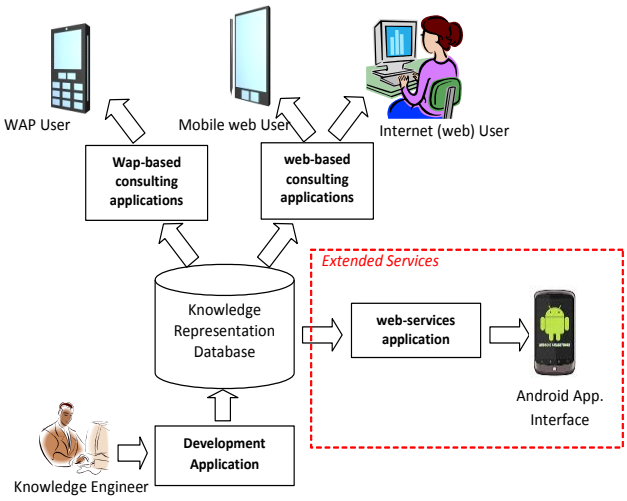


Figure 1 Design of system architecture

3.1 Database Representation of Decision Tree

The main part of an expert system is a knowledge base, which makes knowledge representation acquired from experts. The decision tree is one example of knowledge representation concepts through several rules that is commonly used for supporting decision making process [15]. The decision tree is a particular model with a hierarchical structure that contains several decision rules, which are recursively branches of states into homogenous areas of solution [16].

This study uses the decision tree model as a representation of the knowledge base. Figure 2 captures a sample of the decision tree that contains connected nodes. The nodes can be categorized as decision nodes and leaf nodes. If decision nodes play as initial state, then it is called root node. Decision nodes provide a branch to the next nodes, while leaf nodes indicate end of a path that consists of the conclusion. Decision nodes function to direct path flows, which establish rules.

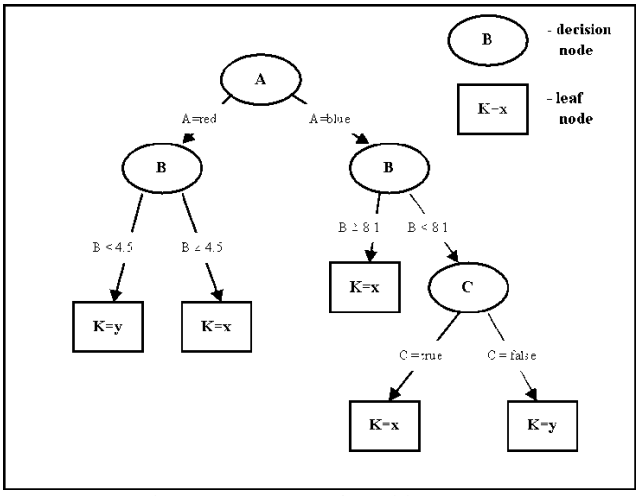


Figure 2 Example of decision tree

The knowledge base as central data of the different type of applications should be accessible. Then, it must be presented in a generic form such as a database. The database consists of tables to accommodate the elements of the decision tree model. The elements are: (1) definition of domain problem or case, (2) definition of facts or symptoms as a representation of decision nodes, (3) definition of the conclusion as a representation of leaf nodes, and (4) the definition of node relations to construct the rules. Figure 3 shows the design of the database model that consists of Case Table that defines the domain problem, Symptom Table that defines facts or symptoms, Diagnose Table that defines conclusions, and Rule Table that defines nodes with their relations.

The Rule Table accommodates the construction of the rule base. The starting consultation process is identified by value in Is Root Node field. If the value is true, then Identifcation_Question field will be read to select Symptom Question based on Symptom Id. Answer_Description field is the part to represent a label of relations that it is generally an answer option that is displayed for users. Answer_Link field consists of symptom id that leads the next identification question or diagnose id that leads a conclusion. The end of consultation process is marked by the value of Is Answer Leaf Node field. If this value is true, it indicates that the last node is leaf node.

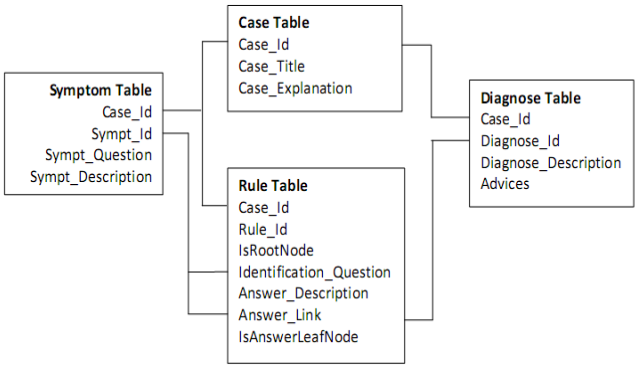


Figure 3 Design database

The Android applications will exploit the expert system knowledge representation stored in the database. A web based development application is created as an interface like a Content Management System (CMS), to manage knowledge base for Knowledge Engineer. While in consulting applications, a generic interpretation is needed, although it covers different platform. This interpretation is needed so that an appropriate process in the consulting application can perform the seeking process in the decision tree representation, ranging from the initial facts in the root to node to a conclusion in the leaf node. The decision tree seeking mechanism refers to [4] and is described as follows:

a. According to selected case or domain problem, querying the rule table that indicates root node.
b. Generating an question identification page that is illustrated bellow:
   i. Selecting Identification question through querying symptoms table where sympt_id is similar to the selected sympt_id field from rule table.
   ii. Choosing an appropriate answer that will lead to the next branch based on each selected record from rule table that contains answer type variable element (either decision node or leaf node) and selected answer (either sympt_id or diagnose_id).
c. From user's answer that is chosen:
   i. If the answer is decision node, querying a record from the rule table that identifies symptoms that match the selected sympt_id. Then, it returns to step b.
   ii. If the answer is leaf node, querying a record from the diagnosis table based on selected diagnose_id field generates a conclusion page that shows diagnosis results and suggestions.

Furthermore, the application must accommodate the mechanism to trace available paths as a representation of the rules. These applications should be evaluated to test the tracing of the paths that may occur. A path is chosen to represent an interaction scenario, then the application is applied to the case that the specified nodes can be passed until the end of the predetermined node. This should be applied to all paths of the case model presented in the decision tree.

3.2 Web Service for Knowledge Base Access

The web service mainly provides data exchange as a particular service by utilizing request and response mechanism. At this stage, the client will send a particular request and the server will provide a specific response that contains the necessary data for the user. Thus, all information regarding the web service has to be identified according to the user's need. Figure 4 illustrates a sequence diagram concerning data identification with client-server interaction approach.
The client-server interaction starts with an initial question code (Q1) request that is carried out by the client. Server then will send back an appropriate response containing the initial question item (Q1-item), answer options concerning the question, and answer link. The answer link could be a code that refers to the next question (Qm) or refers to the decision (Dn). Afterwards, the client will send the next request back to the server with appropriate link. This process will continue until the client obtains the last response from the server that contains final decision (Dx-Item). According to interaction identification as mentioned earlier, the process to provide appropriate web service includes database query according to particular request and proper data generation with a specific format to provide the suitable response.

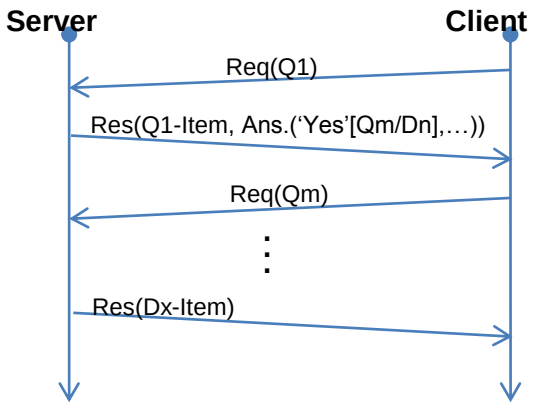


Figure 4 Interaction of client-server

This study employs REST web service that uses simple HTTP calls to read data from server [7, 8]. REST is also lighter than other web service protocols, i.e. SOAP, as it does not provide any mechanisms to describe themselves to clients, and to advertise their existence. Moreover, REST can be implemented using almost any tool, leading to lower bandwidth and shorter learning curve, although, the clients have to know what to send and what to expect.

As this web service uses REST architecture, the request is merely sent using plain HTTP POST requested to the server. The server then sends the response for the request using standard HTTP response and JSON data encapsulation. The JSON is selected because it provides more modest data capsulation than XML and uses less space.

3.3. Android Application for Consulting Interface

The Android basically consumes the provided REST web service, handles user request, and presents the web service response in an appropriate Android activity layout. This application is coded in Java programming language and developed using standard Android SDK. The design of the Android application is shown in Figure 5.

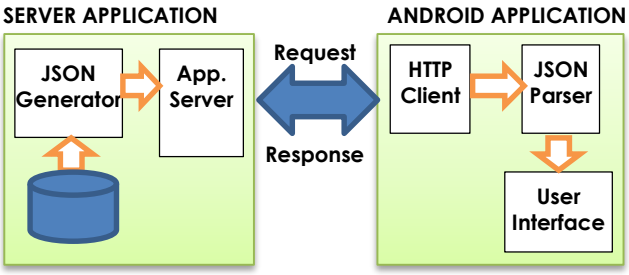


Figure 5 Android application design

In order to consume the REST web service, this application requires Apache HTTP client class in Java as a default communication gateway [7]. This class will act as a simple HTTP client that will respond user queries by sending corresponding REST requested to the server and process the following REST response as well. As network communication occasionally suffers from communication errors, e.g. resource not found and connection timeout, this application also supports exception handling that will increase application reliability.

The JSON data obtained from previous the REST response will then be parsed using basic Java JSON parser to extract proper information. This process is important to arrange a user interface that shows raw JSON data in a proper way. This Android application follows the interaction mechanism that is previously described

4.0 EXPERIMENTAL

This system is implemented as a prototype of web service developed using PHP and Android Application developed using Java Platform. PHP handling RESTful API transforms query data from MySQL database into the form of JSON. Java Platform for Android Application uses Apache HTTP client library to the support communication to server and uses Java JSON parser to extract information. This paper emphasizes on the consultation service using Android application in the smartphone with an experimental example using decision tree seeking scenario.

As a case example for testing the application system, this study uses a case of Dengue Fever consultation that refers to [5]. The case is a disease that becomes the concerns of many countries including Indonesia. WHO has classified the severity of the disease and provided guidelines for the treatment of the disease in [17]. Based on the severity of the disease, the system test aims to provide consultation service by identifying facts or symptoms that is easily known to obtain appropriate advice from identified disease levels. In [5], the decision tree model of this case is created as shown in Figure 6.

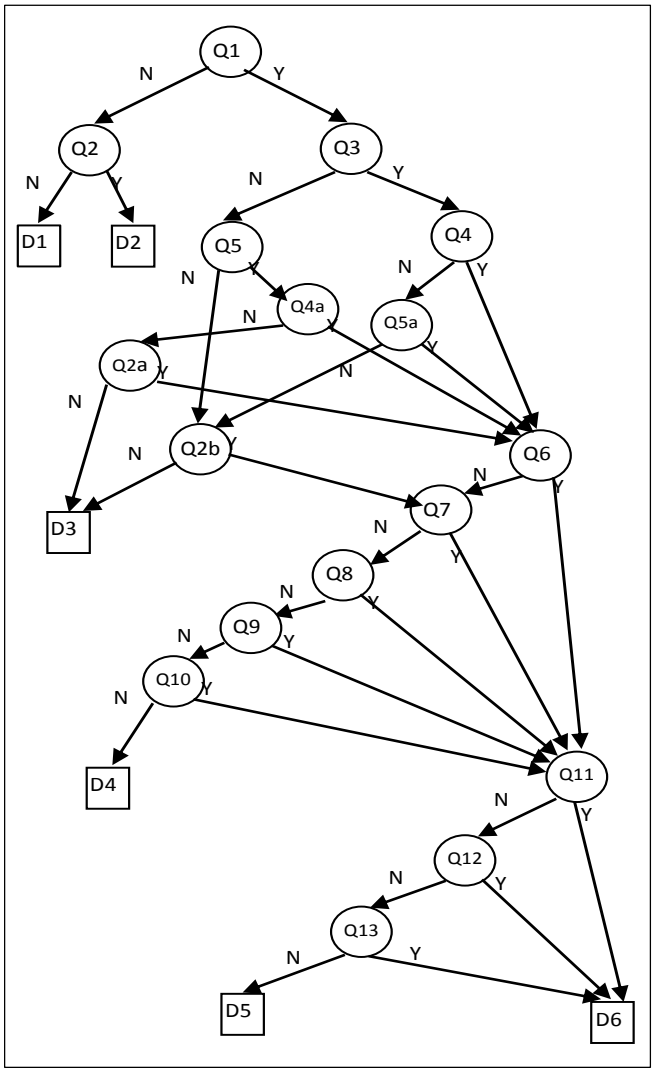


Figure 6 Decision tree model of dengue case

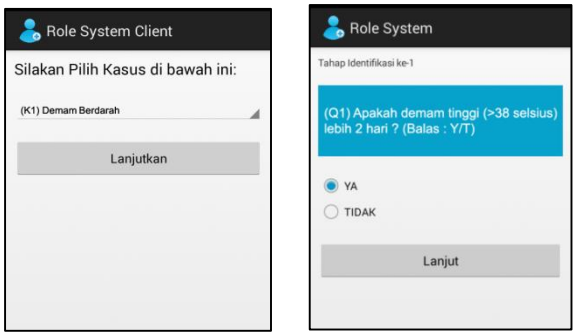


Figure 7(a) Case selection **(b)** first identification question

Figure 7a illustrates an Android based application that shows selected case. In this phase, users are offered to choose the desired case that they want to consult. Figure 7b shows the next phase as consultation process. After choosing the desired case, the users then are given yes-no first question (Q1) concerning the case. This phase will involve a couple of activities until the last question (Q10) as shown in Figure 8a that will direct to reach conclusion (D4) which is shown in Figure 8b.

Figure 8 (a) Last symptom identification that lead to a conclusion. **(b)** A conclusion interface example.

5.0 RESULTS AND DISCUSSION

The Android application uses web service to provide consultation service to users. This consultation service is tested by following the given case that provides the decision tree model of Dengue Fever as shown in Figure 6. The evaluation was conducted to test the tracing paths available in the decision tree. The scenario a path tracing leads the user to trace the following paths Q1-Q3-Q4-Q6-Q7-Q8-Q9-Q10-D4.
Figure 7 and Figure 8 present this application in action.

The given result show that the mechanism consultation (question and answer) has worked through the correct path according to a predefined rule. Tests were performed for all paths that were able to trace from the root node to the expected leaf node. This indicates that the application is able to read the data for symptom identification until it reaches a particular conclusion, which is provided by the web service according to users' answers. Thus, the rules that represent the constructed decision tree are able to point the interaction mechanism between machine and users.

6.0 CONCLUSION

Online expert system using the Android application requires access to a knowledge base that is available through web service. Expert system knowledge base model with a decision tree approach that is stored in the database can generate data in the JSON format

by an arbitrary web service. The Android application can read the data through an HTTP connection. Consultation mechanism is evidenced to be able to run interactively through available path in the decision tree model. Thus, the system is able to accommodate the case that is represented in the decision tree model.

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