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Android-based expert system design for drug selection using certainty factor

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Abstract. Handling some types of diseases require medical therapy in the form of drug delivery. Appropriate medication should be conducted with assistance from medical experts for doses and types of drugs can be given properly and correctly. This study aims to discuss drug selection system design using certain certainty factor method with android-based. The disease that used as a discussion object is diabetes mellitus disease. System design methodology uses UML (Unified Modelling Language) modelling approach. The design results show that the system can make an early diagnosis of diabetes mellitus type II and drug selection recommendation for diabetes mellitus type II. Since health is essential to the safety of the human psyche, this application system can only be used as the third opinion of the diagnosis of diabetes mellitus type II.

1. Introduction
Diabetes mellitus is a metabolic disease with characteristic of hyperglycaemia abnormalities in insulin secretion, insulin action or both. Diabetes Mellitus is a chronic disease that will be carried on for life. Handling this disease requires the participation of doctors, nurses, nutritionists, and other health workers. Either patients or families have an important role to treat this disease, so it is necessary for them to get education about the disease, prevention, complication and control of diabetes mellitus.

A good understanding will greatly help increase family participation in efforts to overcome diabetes mellitus in order to get better treatments [1]. Therefore, it is necessary to design an information system that can help to make early diagnosis of patients with type 2 of diabetes mellitus.

The previous research, which are similar with this research topics, among others: the implementation of an expert system for diagnosis of diabetes mellitus using Web-based fuzzy logic methods [2]; Android-based expert system to diagnose diabetes using the forward chaining method at Mekar Sari Bekasi Hospital [3]; identification of diabetes mellitus disease using expert system builder [4]; implementation of fuzzy logic in diagnosing diabetes mellitus at a community health centre in East Jakarta [5]; designing an expert system to diagnose diabetes disease with Naive Bayes method [6]; and an online-based expert system to diagnose diabetes mellitus using Naive Bayes method [7]. This study aims to design an android-based expert system for drug selection of type II diabetes mellitus using certainty factor method.
2. Methods
The design model in this study uses the UML (Unified Modelling Language) approach. UML is a language for determining, visualizing, constructing, and documenting artifacts (part of the information that used or generated in the process of making software, artifacts can be models, descriptions or software) of software systems, such as business modelling and systems non other software [8]. Expert is involed to analyze the logic and concept of this research so that reach the reliability [9].

3. Result and Discussion
In the development of modern technology, a technology is developed so that is able to think like humans, namely artificial intelligence technology. An expert system is one part of artificial intelligence that combines knowledge and data tracking to solve a problem that requires human expertise. Expert system analyze the structured data and drive the system predict the case like an expert [10], which attempts to adapt expert knowledge so that computer can solve problems as usually done by experts [11]. In many previous research, expert system has a good ability in decision making, and has advantages, among others: good data accessibility [12], time efficiency, accuracy/ precision [13], supporting decision appropriately [14], more economical [15], broad accessibility [16], improving user understanding [17], improving productivity [18], providing good data and information [19], and used as data storage media [20].

The purpose of this expert system design is intended not to eliminate or replace the role of an expert but rather to socialize the expert knowledge in the form of a system, so that the community can find out directly how to identify whether they have diabetes or not and what medication that is used according to the history of the disease suffered. The role of the doctor is still needed to justify and carry out further examination of the patient's disease if needed. So that, with this system can accelerate and facilitate the work of doctors to diagnose early diabetes and provide an overview of what drugs are used by patients.

3.1. Problem Analysis
People complaints about their body condition and go to the doctor to check the symptoms. After that the doctor diagnoses the patient's illness and prescribes the drug according to the symptoms and the history of the illness that was previously suffered. Along with the number of people with diabetes, to increase knowledge about type II of diabetes mellitus, media is needed to provide information about matters related to type II diabetes mellitus. However, in the use of print media it usually has a weakness, it cannot be read at any time. Based on the results of the problem analysis, obtaining the information easily is an important matter that needs to be considered. With the smart phone, users are expected to know whether they have type II of diabetes mellitus or not, and also give recommendations about drugs for type II diabetes mellitus. To adjust between system applications and system design goals, system requirements analysis is carried out [21].

3.2. System Architecture
In Figure 1 describes a system architecture that defines more specific components in a structured manner and displays how the system runs starting from the user who runs the application and then the application brings up the existing objects. The user is a person who uses the Android-based diabetes drug selection application, the application for the selection of type II diabetes mellitus drugs is applied to the android platform by using the Certainty Factor method, then when the user starts the application, the application will display the main menu, and the user selects the menus that available in the application.

Figure 1. System Architecture.
3.3. Use Case Diagram

Use Case Diagrams are used to model or describe the limitations of the system and its main functions [22]. Use case diagram describes the function of a system from the user's perspective and works by describing the typical interaction between users of a system and its own system through a story of how a system is used. Use case consists of two parts, namely the use case identification and use case scenario.

![Use Case Diagram](image)

**Figure 2. Use case Diagram.**

In Figure 2, the system for diabetes mellitus drugs selection has three main use cases including “get drug information of diabetes mellitus”; “get the information of diabetes mellitus”; and “do the diagnosis process”. In the use case “do the diagnosis process”, there are two specify use case for fill the diagnose questions and fill the body weight and height for calculating the body mass index. Then, in the process of diagnosis, there is certainty factor method that processed the result of diagnosis and give drug recommendation for the user who has diabetes mellitus disease.

| Users | System |
|-------|--------|
| Do Diagnose Process | Show questions form |
| Answer the questions | Calculate the weight of each question |
| | Calculate using Certainty Factor Method |
| Get the diagnosis result and recommendation | Show the result |

**Figure 3. Activity Diagram.**

3.4. Activity Diagram

Activity diagram in Figure 3 explain how user conduct the process of diagnosing the disease so that the diagnosis and recommendations for drug. The process of diagnose the diabetes disease begin from user that access the diagnose function. Then the system will show the diagnose questions form. The user then chooses the answer option and the system will process based on the answer that has been selected, because each answer has a weight to be calculated. After user answers all of the questions, then system will be calculate using certainty factor method. Next, the system will show the result of diagnosis process. If the result is known that the user does not have type II diabetes mellitus then the
processing is complete and if it is known that the user has type II diabetes mellitus, the user chooses the history of the illness and the process system based on the history of the disease then the user can see the drug recommendations of type II diabetes mellitus.

3.5. Certainty Factor
In the drug selection system in diabetes using the Certainty Factor (CF) method, where this method is a combination of trust and distrust in a single form. Qualitative data in certainty theory is represented as a degree of confidence. The implementation of this method is used for the questions raised to find out whether the patient has diabetes or not. The general equation that used in the Certainty Factor Method is available in equation (1), below:

\[ CF(H,e) = CF(E,e) \times CF(H,E) \]  

Where:
- \( CF(E,e) \) = certainty factor evidence E that influenced by evidence e
- \( CF(H,E) \) = certainty factor hypothesis assuming evidence is known with certainty when \( CF(E,e)=1 \)
- \( CF(H,e) \) = certainty factor hypothesis that influenced by evidence e

First step:
Users are given a choice of answers that has each weight, then experts determine the value of CF (Certainty Factors) for each symptom. Last, determination of the user's weight value, after a dialogue between expert systems and the user chooses the answer.

Second Step:
The rules that are calculated for the CF value by multiplying the CF_{expert} with the CF_{user} among other:
- \( CF[H,E]1 = CF[H]1 \times CF[E]1 \) \( = 0.20 \times 1 \) \( = 0.20 \)
- \( CF[H,E]2 = CF[H]2 \times CF[E]2 \) \( = 0.15 \times 1 \) \( = 0.15 \)
- \( CF[H,E]3 = CF[H]3 \times CF[E]3 \) \( = 0.15 \times 1 \) \( = 0.15 \)
- \( CF[H,E]4 = CF[H]4 \times CF[E]4 \) \( = 0.30 \times 1 \) \( = 0.30 \)
- \( CF[H,E]5 = CF[H]5 \times CF[E]5 \) \( = 0.80 \times 0.8 \) \( = 0.64 \)
- \( CF[H,E]6 = CF[H]6 \times CF[E]6 \) \( = 0.98 \times 1 \) \( = 0.98 \)

Third Step:
Combining CF values from each rule, where “old” shows the results of the calculation between two data.
- \( CF_{combine} \) \( CF[H,E]1,2 = CF[H,E]1 + CF[H,E]2 \times (1 - CF[H,E]1) \) \( = 0.3200 \) old1
- \( CF_{combine} \) \( CF[H,E]old1,3 = CF[H,E]old1 + CF[H,E]3 \times (1 - CF[H,E]old1) \) \( = 0.4220 \) old2
- \( CF_{combine} \) \( CF[H,E]old2,4 = CF[H,E]old2 + CF[H,E]4 \times (1 - CF[H,E]old2) \) \( = 0.5954 \) old3
- \( CF_{combine} \) \( CF[H,E]old3,5 = CF[H,E]old3 + CF[H,E]5 \times (1 - CF[H,E]old3) \) \( = 0.9919 \) old4
- \( CF[H,E]old4*100\% = 0,9919 \times 100\% = 99,19\% \)

Thus, it can be said that the calculation of certainty factor in diabetes has a confidence level of 99.19%.
3.6. Implementation and Testing

3.6.1 Implements. Interface design is the implementation of application interface in each part. The system is implemented using Eclipse Neon 1.0 to process program code and SQLite to process data. Some of the interface displays that have been implemented is shown in Figures 4 until Figure 6.

3.6.2 Testing. Black-box testing is done by observing the results of the execution through test data and checking the functionalities of the software. Testing the functionality of several menus that have been applied in the application, the black-box testing results from the function of the system are shown in Table 1.

Table 1. The result of Black-box Testing of the System

| Code-Testing Scenario                      | Result | Detail                                      |
|--------------------------------------------|--------|---------------------------------------------|
| STC-01- Choose the About Diabetes menu    | ✓      | Function runs as expected                  |
| STC-02- Choose a menu of Diabetes Medication | ✓      | Successfully open the Diabetes Medication page |
| STC-03- Select the Diabetes Diagnosis menu | ✓      | Successfully open the Diabetes Diagnosis page |
| STC-04- Select the Calculate Body Mass Index | ✓      | Successfully open Body Mass Index page     |
| STC-05- Select the About Applications menu | ✓      | Successfully open the About Application page |
| STC-06- Fill out questions for diagnosis   | ✓      | Certainty factor runs smoothly, there is no error. |
| STC-07- Filling in Body Weight and Height  | ✓      | The calculation was successful              |

Based on the results of black box testing that has been done in Table 1, it can be concluded that applications that are functionally constructed have produced results that are as expected. Some factors that can influence the results of the CF value include selecting answers and also determining the value of CF. The ideal body mass index is also influenced by body weight and height.
4. Conclusion
Application that serves as a medium for drug selection recommendations and understanding of the disease, prevention, complication and early response to type II diabetes mellitus and helps increase family participation in efforts to overcome type II diabetes mellitus. With the use of certainty factor method, it can be diagnosed for patients with type II diabetes mellitus or not. Several factors that can influence the detection of type II diabetes mellitus by the certainty factor method include the weight of the answer option and the expert value based on the symptoms which are asked.

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