Development of Expert System for Dental and Oral Diseases Diagnose in Certainty Condition

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Abstract - Expert systems are used to solve problems based on the view of an expert. Expert systems are widely used in various fields, such as health. This study aims to create a web-based expert system that is used for the early diagnosis of dental and oral diseases through the initial symptoms that appear from the patient. In its implementation, this research used a descriptive qualitative method completed by collecting data and observation. While the development of expert systems using the prototype development method and the model of the expert system created using the Dempster Shafer method. The acquisition of knowledge about the symptoms of dental and oral diseases from experts is stored in a repository. The implementation of expert system models uses an object-oriented approach. In this study, the results to be achieved are a prototype design of an expert system application used as an initial diagnosis for ordinary users (patient) regarding dental and oral diseases in certain conditions. The initial symptoms suffered are feed in to the expert system interface. Knowledge in the expert system is prepared and store into the system by a specialist in dental and oral disease.

1. Introduction
Oral and dental diseases are the most common chronic diseases. Dental and oral disease is an important public health problem because it can have an impact on individuals and society [1]. The impact of dental and mouth problems is related to existing diseases in the human body [2,3]. In addition, oral and dental diseases affect the quality of life to disrupt their daily lives [4]. In developing countries, diseases such as diabetes and obesity are implications of quality of life and oral health which are interrelated [1].

Communities need to be given an understanding of dental and oral diseases, especially related to the early detection of these diseases. New ways to access information and knowledge are needed. The method that can be used is to apply an expert system to obtain basic knowledge about dental and oral diseases sourced from experts in their fields. An expert system is a computer program that can simulate problem-solving based on an expert's heuristic knowledge according to the expert's field of expertise [5]. Diagnostic expert-based systems are computer systems that seek to emulate the diagnostic decision-making ability of human experts [6]. Medical expert systems developed by the researchers to save lives, speed up the diagnostic process and store its expert knowledge based on experience. The medical expert system that has been built by the researcher is able to provide a good and reliable level of accuracy. For example, an expert system for diagnosing kidney disease, an expert system for examining dental and oral problems, and an expert system for diagnosing skin diseases [7-10]. Associated with an expert system for the diagnosis of dental and oral diseases, there has been quite a lot of research related to this field with various methods used [11-14]. However, based on the existence of the expert system that has been studied, the expert system that has been built is unable to provide a picture that the system can be accessed by the public. In this study, a dental clinic was the
object of research, and an expert dentist became the source of his knowledge. Aims of this study are to build an expert system for the early detection of dental and oral diseases that can be accessed by the public. Conducted in an experienced dental clinic and dentist, this study explored clinical and dentist issues regarding education and early diagnosis of dental and oral diseases.

The dempster Shafer method was used in the development of this expert system. The dempster shafer method is a generalization of Bayesian theory, this theory is about the function of belief in problem-solving [15]. Although this theory is widely used for conditions meeting uncertainty criteria, it does not mean it cannot be done for certain conditions. In this study, to develop an expert system with a high probability result of the early diagnosis for dental and oral disease, symptoms are collected as input data. Symptoms from the patient are calculated by the dempster-shafer method to find the exact disease. The weight of the symptoms is defined by the dentist in the clinic. The exact condition of symptoms is obtained from the dentist's knowledge based on his education and experience. This knowledge is stored in a repository and is used on expert systems. The expert system is built based on web technology with the aim of making it easily accessible to the public. This expert system for the early diagnosis of dental and oral diseases is expected to help sufferers/patients find out the disease they are experiencing. The information generated can provide an overview of the dental and oral diseases suffered before going to the dental clinic.

2. Method

Direct research through field observations is carried out to obtain an exact picture of the problem. Where the object research of this study is a dental clinic. While both primary data and secondary data were obtained from interviews with expert dentists, and literature studies. The data that has been obtained, analyzed using the object-based approach method with analysis tools in the form of use case diagrams, activity diagrams, scenario diagrams, sequence diagrams, and component diagrams. The models will be transformed into the procedure of the expert system through the user interface (Figure 1).

The results of the analysis will provide an overview of the expert system that must be developed. The prototype method is used for the expert system software development cycle. The use of the prototype method is based on situations and conditions in the research object where the time and accurate results of the information are expected outputs. The flow of activity searching for conditions from expert system input is adjusted to the conditions of input from knowledge sources. The dempster shafer method is used to carry out the process of expertise.
3. Results and Discussion

3.1. Expert System Model

To get an expert system with a level of belief of the results that will be built has positive results, then the value of belief from the strength of symptoms (evidence) from existing diseases is calculated using the notation:

\[ \text{Bel}(X) = \sum_{Y \subseteq X} m(Y) \]  

(1)

With plausibility values mathematically written:

\[ P_l(s) = 1 - \text{Bel}(X) \]  

(2)

3.2. Rule

Using the algorithm for calculating symptoms of dental and oral diseases using the Dempster Shafer method, a draft rule for the expert system has been obtained. The rule will be used to predict the type of disease in a patient based on the symptoms being analyzed. In addition, doctors give weight to each symptom of the disease to provide the level of accuracy of the results of the system. The rules and weights for symptoms of dental and mouth disease can be seen in the following Table 1.

| Disease code | Disease name                  | Code | Symptoms                                      | Weight |
|--------------|--------------------------------|------|-----------------------------------------------|--------|
| P1           | Dental caries                  | G1   | Blackish or brownish stains on the teeth      | 0.95   |
|              |                                | G2   | Small hole in the tooth                       | 0.8    |
|              |                                | G3   | Pain when biting food                         | 0.85   |
|              |                                | G4   | Sensitive teeth                                | 0.7    |
| P2           | Reversible pulpitis            | G2   | Small hole in the tooth                       | 0.8    |
|              |                                | G3   | Pain when biting food                         | 0.85   |
|              |                                | G5   | Short-term pain                                | 0.95   |
| P3           | Irreversible pulpitis          | G6   | There is a deep and large hole in the tooth   | 0.75   |
|              |                                | G7   | Teeth feel throbbing                           | 0.95   |
|              |                                | G8   | Cavities experience pain when eating          | 0.9    |
|              |                                | G9   | Pain reaches the temple of the eye or ear     | 0.95   |
|              |                                | G10  | Tooth pain when there is contact with the tongue | 0.7   |
| P4           | Periapical abscess             | G11  | Swollen and red gums                           | 0.95   |
|              |                                | G7   | Teeth feel throbbing                           | 0.95   |
|              |                                | G12  | Tooth pain when chewing                        | 0.9    |
|              |                                | G13  | Fever                                          | 0.5    |
|              |                                | G14  | There is swollen lymph nodes in the neck       | 0.7    |
| P5           | Gingivitis                     | G15  | Bad breath                                     | 0.8    |
|              |                                | G11  | Swollen and red gums                           | 0.95   |
|              |                                | G16  | Gums bleed easily                              | 0.95   |
|              |                                | G17  | Gums become softer                             | 0.9    |
|              |                                | G18  | The shape of the gum changes slightly blunt    | 0.8    |
|              |                                | G19  | Gums have pain or tenderness                   | 0.8    |
To get an idea of how decisions are made to the expert system that was designed, the following is an algorithm in the determination of dental and oral diseases based on existing symptoms. The algorithm is described in flowchart rules which are drawn in Figure 2. The G notation describes the symptoms that appear while the P notation is used to describe the disease.

![Figure 2. Algorithm to determine dental and Oral disease based on existing symptoms](image)

3.3. Implementation
From the results of the design of the dempster-shafer algorithm to produce a form of rules that can be used later in the implementation phase. The algorithm design was changed into a web-based application that could be used freely by the public. The sequence diagram of the expert system development is shown in Figure 3. The sequence diagram shows a picture of the activities carried out by the user is using the expert system to diagnose dental and oral disease.
The next step after getting an overview of the expert system is implementing the design into an accessible application. As shown in Figure 3 and Figure 4, shows how the interface pages of the expert system are built. Figure 3 is used by the user as an input page for the symptoms of dental and mouth disease. The results of input symptoms will be shown on the interface page in Figure 4.

![Sequence Diagram of Develop System](image)

**Figure 3.** Sequence Diagram of Develop System

**Figure 4.** Symptom Input User Interface
Expert systems designed it easier for patients to get an early diagnosis of dental and oral diseases. Where the results of this expert system can be a reference for doctors in dealing with dental and oral diseases.

4. Conclusion
The application of the Dempster Shafer algorithm to design expert systems has provided clear steps in making a decision regarding the diagnosis of dental and oral diseases: predetermined conditions in the form of disease symptoms and weight values are able to show the level of confidence in the results. The application of an expert system provides results that are not much different from the experts. Thus, patients can find out their initial disease diagnosis first. However, the absolute decision regarding the diagnosis of the disease experienced by the patient is determined by the dentist.

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