Intestine Disease Diagnosis System Using Certainty Factor Method

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Abstract

Inside the human body there are many important organs, one of which is the intestine. Intestinal disease / digestive disease is a disease that most often attacks the digestive tract in humans. There are several intestinal diseases that are dangerous and there are also harmless intestinal diseases. In this research, researchers created an android-based expert system application that can provide information to the users about diseases that are being suffered through the symptoms experienced by the user. The process of making expert system applications using the certainty factor algorithm. The certainty factor algorithm is used to accommodate the uncertainty of an expert's. The mechanism that be used in the certainty factor algorithm on each symptom uses a measure of increased belief (MB) and measure of increased disbelief (MD). Expert system applications that have been built to detect intestinal diseases based on Android have been successfully implemented with a presentation of accuracy of 99.7265625%. by that percentage, it show us that the diagnosis of symptoms of the selected disease is in suitable by the experienced of user, and has the accuracy determined by the system.

Keywords: Expert System, Certainty Factor Algorithm, Intestinal Disease

1. INTRODUCTION

Inside the human body there are many important organs, one of which is the intestine. Intestinal disease / digestive disease is a disease that occurs in the digestive tract of the human intestine. Diseases of the digestive tract are dangerous diseases and cause many deaths. Often times people are lazy to consult with a doctor because the queue is long or busy by their job.

Expert systems follow the behavior of an expert in dealing with a problem. There is one case a patient comes to a doctor to check his body for health problems, the doctor will examine and make a diagnosis. If the doctor is busy, the implementation of the diagnosis will be replaced by an expert system. The main

objective of expert systems is not to replace the position of an expert, but for the knowledge and the experience of experts who are experts in their fields [1]. Therefore, the existence of an expert system is to be expected to help people suffering from diseases, especially in the stomach, to check their own symptoms using an android smartphone without having to wait for the queue or interfere with their working hours.

Artificial intelligence is part of computer science that makes machines (computers) able to work like humans. Intelligent systems are systems that are built by using artificial intelligence techniques. One of many expert systems are learned in artificial intelligence is using the Certainty Factor Method.

Certainty Factor (CF) is "Amount that reflects the level of trust in the Hypothesis of existing information". The factors of the symptoms of the diseases will be calculated by the CF method, so that an accurate type of complaint will be obtained. As its implementation by utilizing an equipment namely Mobile such as a smartphone, gadget [2]. Research on intestinal disease is very necessary to prevent the occurrence of death caused by lazy people to conduct consultations.

The expected benefits from this research is an information on the diseases suffered by users when they are sick and can be used as material information, references, articles and archives as a benchmark.

Research related to intelligent systems including the research conducted are:
1. Diagnosis of Ornamental Plant Disease Using Web-Based Certainty Factor Method to produce an application to diagnose diseases of ornamental plants [3].
2. Expert System to Diagnose Cholesterol in Adolescents with Web-Based Certainty Factor (CF) Method" resulted in an application for diagnosing cholesterol disease [4].
3. Application of the Certainty Factor Method in Osteoporosis and Osteoarthritis Risk Detection Expert Systems" produced an application for the diagnosis of osteoporosis and osteoarthritis [5].
4. Expert System for Diagnosing Pregnant Women Using the Certainty Factor (CF) Method [6].
5. Mental Disorders in Children with the Certainty Factor Method resulted in an application that can determine mental disorders in children using the certainty factor method [7].
6. Case-Based Reasoning for Diagnosis of ENT (Ear Nose and Throat) resulted in a case-based reasoning system for diagnosing ENT disease [8].
7. Case-Based Reasoning for the Diagnosis of Heart Disease" resulted in a system capable of recognizing heart disease [9].
8. An Expert System Using Certainty Factor for Insomnia Acupoint Determination. This research produces acupuncture points based on symptoms from patients who experience insomnia [10].

2. METHODS
2.1 Problem Analysis
A disease that attacks the intestine is a disease that we need to be aware of because it can cause death for someone from the effects of the intestinal illness itself. At present, there are still many patients who are reluctant to do consultations due to remote places and a very long consultation process. The consultation process starts from the registration, and then after the registration process is complete, the waiting process is queued. After that, a consultation process with the doctor was only carried out and finally the drug collection process. From these processes, there are still weaknesses including the process of consulting with doctors requires a long time if the queue process is long so that the delay in handling patients.

From the problems that have been explaining, an expert system is needed that can help doctors deal with patient complaints quickly. Through the expert system, patients can find out what diseases are suffered based on symptoms that have been experiencing. Figure 1 below is an architecture of expert systems.
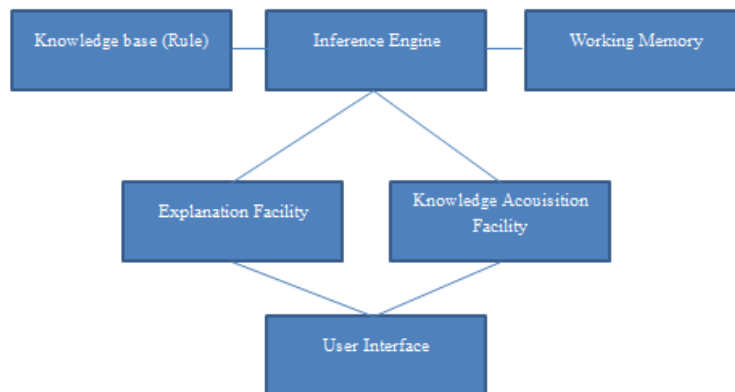

Figure 1. Expert Systems Architecture [11]

2.2 Certainty Factor Method
The Certainty Factor method is a method that is used to calculate the certainty factor in determining the symptoms and types of diseases suffered by users.

2.2.1 Determined the Combined Certainty Factor
Certainty Factor is the final Certainty Factor of a prospective conclusion. Combined CF is the last CF of a candidate conclusion. This CF is influencing by all parallel CFs of the rules that produce the outcome. If different symptoms cause the same disease, then it is included in the general certainty factor equation.

For example, in symptom G (G1, G2 ... Gn) creates disease P, then there is a value E (E1, E2, ..., En) that also causes disease P, there are values CF1 (P, G) and CF2 (P, G). The level of certainty produced by the system in determining the diagnosis is CF combination as formulated in equation (1) [6].

$$CF_{combination}[CF1,CF2] = CF1 + CF2 * (1 - CF1) \dots\dots\dots\dots\dots\dots(1)$$

The advantages of this Joint Certainty Factor are suitable for expert systems that measure something definite or uncertain such as diagnosing disease, and the calculation of this method is only valid for one count, and can only process two data so that accuracy is maintaining.

2.3 Intestinal Diagnosis Expert Systems

The steps for calculating the Certainty Factor shown in Figure 2. The first step is to calculate the value of CF (E) based on symptom data, by reducing Measure of Belief (MB) and Measure of Disbelief (MD) which is the expert value of a symptom of an illness. After calculating the amount of CF (E), then do the calculation using the CF formula combination to get the value of each rule. The process of diagnosing intestinal disease shown in Figure 3.
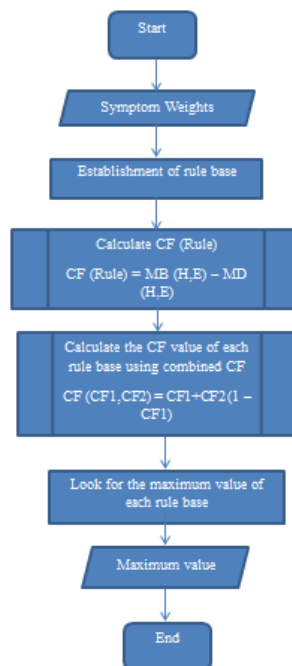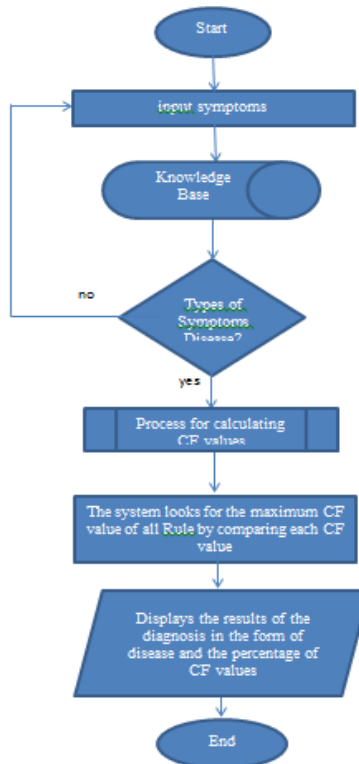

Figure 2. Certainty Factor Measurement Flowchart

Figure 3. Diagnosis Systems Flowchart with Certainty Factor

2.4 Analysis of Calculation of the Certainty Factor Method

Certainty Factor (Rule) value is generating from an interpretation (term) of an expert, where the amount is changing to a specific CF value according to table 1.

Table 1. Certainty Factor's Value

CF Value	-1.0	-0.8	-0.6	-0.4	-0.2 to 0.2	0.4	0.6	0.8	1.0
Uncertain Term	Definitely Not	Almost Certain Not	Probably Nnot	Maybe Not	Unknown	Maybe	Probably	Almost Certainty	Definitely

In the expert system, the process of diagnosing symptoms of an intestinal disease is represented using predetermined production rules. The rules of diagnosis in this expert system can be seen in Table 2 while the percentage of conclusions shown in Table 3.

Table 2. List of Disease Diagnosis Rule

ID	Rule
1.	IF Mushy and Slushy
	AND Continously to the toilet
	AND nauseous and vomit
	AND loss of appetite
	AND fever
	AND stomach cramps
	AND stomache
	AND bloody sfeces
	AND many kind of Feces
	THEN diarrhea
2.	IF stomach cramps and bloated
	AND difficult to defecate
	AND distended stomach
	AND feels like there's feces left after defecate
	AND stomache
	THEN constipation
3.	IF bloody when defecate
	AND lump in the anus
	AND feces come by it's own
	AND mucous come around the anus
	AND iritate around the anus
	THEN Hemoroid
4.	IF stomach bloated
	AND cant fart
	AND diarrhea
	AND nauseous and vomit
	AND fever
	THEN appendicitis
5.	IF pain around stomatch
	AND loss of appetite
	AND body weight decrease significantly
	AND bloody diarrhea
	THEN colitis

Table 3. The Interpretation List of Disease Diagnosis Rule

No.	Percentage Level	Certainty Value
1	0% - 50%	Small Possibility
2	51% - 79%	Certainly
3	80% - 99%	Most Likely
4	100%	Very Sure

2.4.1 Example calculation of the Certainty Factor Method.
In this example, a patient experiences several symptoms which shown in Table 4.

Table 4. Symptoms and Disease

No.	Symptoms of diarrhea	Diarrhea	Blind Gut
1	Soft and Runny Stool	0.6	0
2	Stomach ache	0.6	0
3	Abdominal cramps	0.4	0
4	Nausea and vomiting	0.2	0.6
5	Loss of appetite	0.4	0
6	Fever	0.4	0.6
7	Blood in the stool	0.6	0
8	A lot of stool is produced	0.6	0
9	Continuously to the toilet	0.6	0
10	Bloated	0	0.6
11	Cannot dispose of fart	0	0.6
12	Constipation or diarrhea	0	0.4

From Table 4 can be seen where the symptoms already have expert weights will be calculated and will produce a diagnosis of the disease by the data selected by the patient. Following is the calculation of the Symptom Certainty Factor method shown in Table 4.

1. Diarrheal Disease
   IF Soft and Runny Stool
   AND Continuously to the toilet
   AND Nausea and vomiting
   AND Loss of appetite
   AND Fever
   AND Abdominal cramps
   AND Stomach ache
   AND Blood in the stool
   AND A lot of stool is produced
   THEN diarrhea

   Then the calculation is as follows:
   CFcombination CF1,2= CF1 + CF2*(1- CF1) = 0.6 + 0.6 * (1 - 0.6) = 0.6 + 0.24= 0.84
   Result CF= 0.84
   CFcombination CF = Result CF + CF3 * (1- Result CF) = 0.84 + 0.4 * (1- 0.84) = 0.84 + 0.064= 0.904
   Result CF = 0.904
   CFcombination CF= Result CF + CF4 * (1- Result CF) = 0.904 + 0.2 * (1- 0.904) = 0.904 + 0.0192= 0.9232
   Result CF= 0.9232
   CFcombination CF= Result CF + CF5 * (1-Result CF) = 0.9232 + 0.4 * (1- 0.9232) = 0.9232 + 0.03072 = 0.95392
   Result CF = 0.95392

CFcombination CF= Result CF + CF6 * (1- Result CF) = 0.95392 + 0.4* (1-0.95392) = 0.95392 + 0.018432 = 0.972352

Result CF = 0.972352

CFcombination CF= Result CF + CF7 * (1- Result CF) = 0.972352 + 0.6 * (1-0.972352) = 0.972352 + 0.0165888 = 0.9889408

Result CF = 0.9889408

CFcombination CF= Result CF + CF8 * (1- Result CF) = 0.9889408 + 0.6 * (1-0.9889408) = 0.9889408 + 0.00663552 = 0.99557632

Result CF= 0.99557632

CFcombination CF= Result CF + CF9 * (1- Result CF) = 0.99557632 + 0.6 * (1-0.99557632) = 0.99557632 + 0.002654208 = 0.998230528

Result CF = **0.998230528**

Then the CF value of the symptoms chosen for the diarrheal disease is likely to be **99.82%.**

2. Appendicitis
   IF Bloated
   AND Cannot dispose of fart
   AND Constipation or diarrhea
   AND Nausea and vomiting
   AND Fever
   THEN Appendix

   Then the calculation is as follows:
   CFcombination CF1,2= CF1 + CF2*(1- CF1) = 0.6 + 0.6 * (1 - 0.6) = 0.6 + 0.24= 0.84

   Result CF= 0.84

   CFcombination CF = Result CF + CF3 * (1- Result CF) = 0.84 + 0.4 * (1-0.84) = 0.84 + 0.064= 0.904

   Result CF = 0.904

   CFcombination CF= Result CF + CF4 * (1- Result CF) = 0.904 + 0.6 * (1-0.904) = 0.904 + 0.0576= 0.9616

   Result CF= 0.9616

   CFcombination CF= Result CF + CF5 * (1-Result CF) = 0.9616 + 0.6 * (1-0.9616) = 0.9616 + 0.02304 = 0.98464

   Result CF = **0.98464**

Then the CF value of the selected symptoms for appendicitis is probably **98.46%.**

Based on calculations carried out using the Certainty Factor method for each

disease, the maximum CF value of 99.82% is obtaining with a diagnosis of Diarrhea, so it is concluding that by patients suffering from **Diarrhea**.

2.5 Knowledge Representation

Knowledge representation in this research is carrying out after the knowledge acquisition process has been carried out. Knowledge representation is carried out with the aim of developing a structure that will help the process of coding knowledge into a system that is building. Knowledge representation is carried out using the production rules [10].
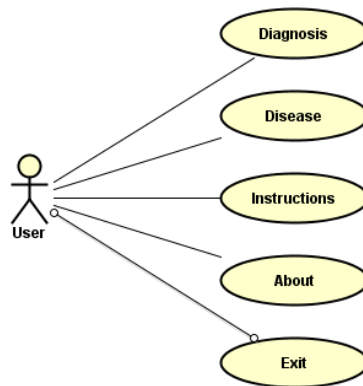
2.6 Usecase Diagram

Figure 4. Proposal System Usecase Diagram

Figure 4 explains how a user can use the application that being build. The claim that is growing has several menus, including the diagnosis of diseases suffered by patients, disease menus, application usage instructions, about applications.

2.7 Class Diagram

Class Diagram of an Android-based intestinal disease expert system application with the Certainty Factor method shown in Figure 5.
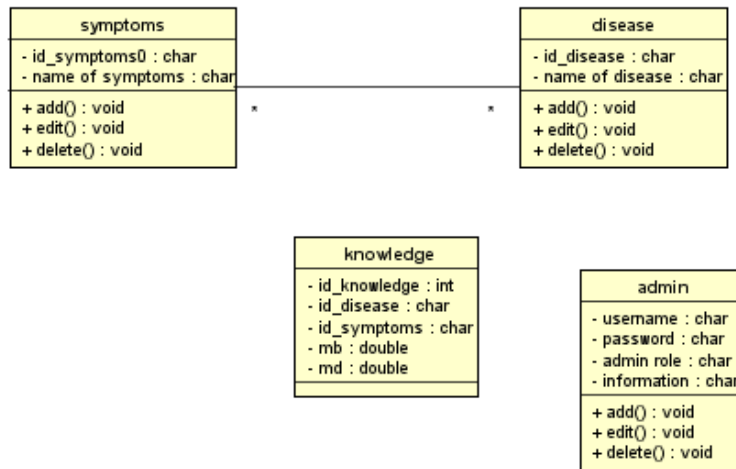
Figure 5. Class Diagram

3. RESULT AND DISCUSSION
3.1 Application Main Page
This main page is the initial display of an expert system application for diagnosing intestinal diseases. On this page there are several menus including diagnosis, disease, application usage instructions, about the form and also the exit menu.

3.2. Diagnosis Page
This diagnostic page displays the symptoms suffered by the patient by checking the signs suffered. If it has finished, the application will display the disease experienced by the patient based on the symptoms that have to choose.

3.3. Testing
Testing in this study the author refers to ISO 25010 which has eight characteristics, namely functional suitability, reliability, performance efficiency, usability, security, compatibility, maintainability, and portability. From the eight components, the writer uses four characters, namely Usability, Performance Efficiency, Portability, and Functional Suitability.

a. *Usability testing*

This test uses a questionnaire method with many respondents as many as 30 people consisting of 10 lecturers, 18 students, and two doctor assistants. Before filling out the questionnaire, the respondents are required to try the application that has been making in advance. From the results of the survey,

the percentage is 93.33% so that it can be concluding that the form that has been build can be applied.

b. *Performance Efficiency Testing*

This test uses tools Testdroid. With this tool can be seen concerning memory usage and CPU. Testing is done using several devices that are available on Testdroid tools including Google Pixel 9.0, LG Google Nexus 5 6.0.1, LG Google Nexus 5 D820 5.0. The results of performance efficiency testing using tools Testdroid can be seeing that memory usage is still quite safe so there is no memory leak, while CPU usage can be seeing that the average user is in the safe category.
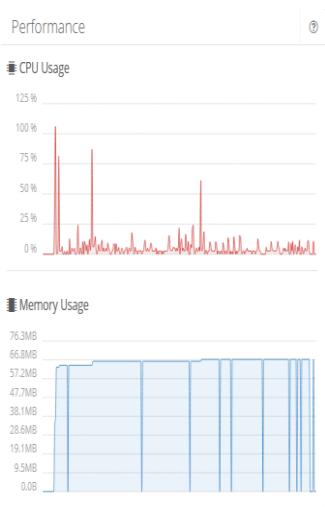

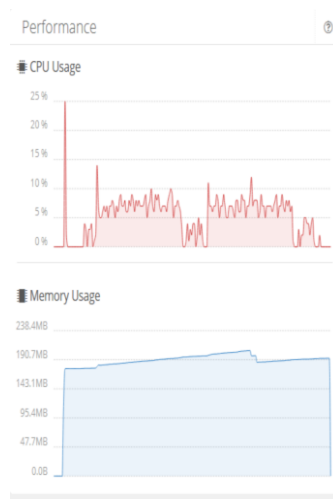Figure 6(a) Google Pixel 9.0 Device
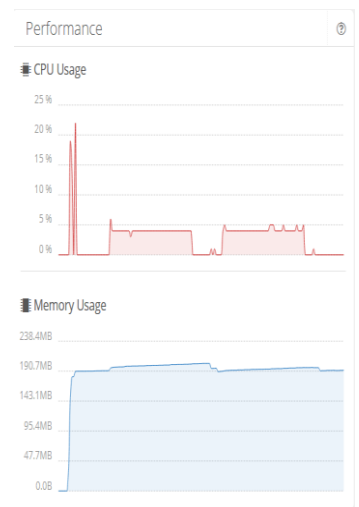
Figure 6(b) LG Google Nexus 5 6.0.1 Device

Figure 6(c) LG Google Nexus 5 D820 5.0 Device

Figure 6. Application Performance Testing

c. *Portability Testing*

This test was done by trying several smartphones with different Android operating systems, including marshmallow, nougat, and KitKat. From the results of tests carried out stating that the applications that have been build can be installed and can run properly.

Table 5. *Portability Aspects Result*

No.	Device Type(s)	Android Type(s)	Installation Process	Application Process Running
1	Xiaomi Redmi Note 4	6.0 (Marshmallow)	Success	Running without an error
2	Xiaomi Redmi 4X	7.0 (Nougat)	Success	Running without an error
3	Samsung Tab 3	4.4 (KitKat)	Success	Running without an error

d. *Functional Suitability Testing*
This test uses a questionnaire method that is giving to 2 people, according to the author of an expert in the field of software engineering. Before giving results, the application is tried to run first, so based on table 3 that the attribute functionality makes the request.

Table 6. *Functional Suitability Testing Table*

Testing Activities	Testing Results	Information
Click the Diagnose Menu	A diagnose form appears	Success
Click the Process Button	Calculation appears as a result of selecting symptoms.	Success
Click the Disease Menu	Disease form appears.	Success
Click the Instructions Menu	Appearance form appears.	Success
Click the About Menu	A form display about the developer appears.	Success

4. CONCLUSION

Based on the research and description described above, it can be concluding that the application of the Certainty Factor method can be used to recognize intestinal diseases with an accuracy rate of **99.82%.**

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