

An Expert System for Early Diagnose of Vitamins and Minerals Deficiency On The Body

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Abstract—Mineral and vitamin plays an important role for the human body. Vitamins are useful for the growth process, the setting, and the improvement of body functions while mineral plays a role in several stages of reactions energy metabolism, growth, and maintenance of the body. The importance of vitamins and minerals resulted in the need to be maintained levels of vitamins and minerals in the body. Many do not know that the symptoms are felt in the body is the result of a deficiency of a particular vitamin or mineral that is often too late for the unknown and the resulting need for a doctor's visit. Deficiency of the vitamin and mineral can be determined earlier using science field of artificial intelligence through expert systems. An expert system vitamin and mineral deficiencies is composed of 11 vitamins and 6 minerals. From the acquisition of knowledge by an expert, found 46 symptoms and generates 35 rules represented using decision tables. Search method uses a forward chaining while deficiencies to deal with the uncertainties arising used method of application Mycin certainty factor. To facilitate the users, the system is made by using mobile technology. Based on testing performed to the expert can be proved that the expert system built able to diagnose the deficiency of vitamins and minerals with a value of 100% accuracy the truth. By knowing deficiency that occurs then the handling and prevention can be done in a timely fashion.

Keywords— *expert systems, certainty factor, forward chaining, vitamins and minerals.*

I. INTRODUCTION

Population growth relatively quickly, accompanied by the increase of life expectancy, increasing the number of population in the world. It is estimated that the total world population today amounts to 5 billion people. With a population of that size also increased complex of problems that have arisen, such as food, clothing, shelter, health and so forth. In the health problems the more the number of patients with a disease and so does the type of disease.

Therefore, it is necessary to build a system that can help health professionals, patients or anyone in the field to alleviate

job. The author makes an application design expert system that can diagnose an illness in humans. This system is a prototype and is made as simple as possible, so that users can easily use and redesign of this expert system for other diseases. One of the problems in the medical world or medicine is an imbalance between patient and doctor. In addition, most of the people are not medically trained so that when experiencing symptoms of the illness may not necessarily be able to understand how to overcome them. It is unfortunate if the actual symptoms can be treated early into a more serious disease due to lack of knowledge. Actual knowledge can be acquired from books or Internet sites that discuss health. However, to learn it is not easy because in addition require a long time to understand it, these sources are not certain to diagnose diseases such as that done by a doctor.

The system is made is limited to the diagnosis of a disease based on the characteristics of the disease. Because there are still many people who do not know the symptoms of a disease. By using this expert system, the disease can be identified by looking at the symptoms that may explain and describe whether a person suspected of having a disease or not, or other diseases.

An expert system is one part of the science of artificial intelligence that lately has developed very rapidly. The system is designed to mimic the expertise of an expert in answering questions and solve a problem in many areas. This expert system is a computer program that is capable of storing knowledge and rules of a special expert. Expert systems are very helpful for decision making, in which the expert system can collect and store the knowledge of the person or persons expert in a knowledge base (knowledge base) and using a system of reasoning resembles an expert in solving problems.

Thus, according to [1] This expert system can solve a particular problem because it saves overall knowledge. In medicine already many emerging applications expert system capable of diagnosing a variety of diseases in humans,

including diseases of the eye, ENT (ear, nose, throat), mouth organs (heart, liver, kidney), and [2] Although it has many, as mentioned above, but there are still many diseases that have not made the diagnosis system, so expect more and more expert systems created for other diseases. Given this expert system, a layman can detect the presence of disease in themselves or others based on symptoms perceived by answering questions on the application as well as to consult a doctor. Thus, the layman can detect the disease and its treatment solutions early on so that treatment can be done immediately, even to do prevention against certain diseases [3]. So, with the development of expert systems, it is expected that any layman can resolve particularly complex issue that fact can only be solved with the help of experts [4].

Vitamins and minerals are nutrients or substances that are very important for the body and is one of the determinants of health in the human body. Vitamin is a substance of complex compounds that are needed by the body very important role to help the setting or the activity of the human body while the minerals are micronutrients that function to the growth process, regulation, and repair functions of the body [5].

Lack or deficiency of the vitamins and minerals can be a problem for human health, causing various diseases in the body. Many do not know that the symptoms are felt in the body is the result of a deficiency of a particular vitamin or mineral that is often too late for the unknown and the resulting need for a doctor's visit.

There are fields of artificial intelligence that can help to find out early vitamin and mineral deficiencies and can also assist medical professionals in determining the vitamin and mineral deficiency is an expert system. With the construction of expert systems, in addition to prospective patients, young doctors or physicians who have recently graduated and trainee doctor can see the patient's condition based on symptoms owned whether in accordance with the analysis of a specialist.

Expert systems are built using the advanced search (forward chaining) and to deal with the uncertainties arising used method of Certainty Factor. Knowledge is presented in the form of a decision tree. The technology used is based on android mobile devices and applications in the form of Android Application. The type of vitamin deficiencies contained in this expert system consists of vitamins A, B (B1, B2, B3, B5, B6, B12), C, D, E and vitamin K, while types types of minerals consist of Macro minerals (Calcium (Ca), phosphorus (P), Magnesium (Mg)) and Micro Minerals (Zinc (Zn), iron (Fe), copper (Cu)).

II. LITERATURE REVIEW

An expert system is a computer program designed to make decisions such as the decision taken by one or several experts. According to [6], expert systems are intelligent computer software that uses knowledge and inference procedures to solve a problem that is quite complicated or require an expert's ability to solve it. According to [7], the expert system is a computer program designed to model the ability of problem solving is done by an expert. Then, according to [8], the expert system is an artificial intelligence program that combines the knowledge base (knowledge base) with an inference engine. Inference is a process of acquiring knowledge based on experiences that occur.

From the description above we can conclude that the expert system can be applied to many areas of life, including in the

field of medicine, the physician experts we can help diagnosing early as first aid at home before deciding to go to the doctor.

Expert System was developed in the middle of 1960 by Artificial Intelligence Corporation. Period of artificial intelligence research is dominated by a belief that reason is combined with advanced computer will generate the achievement of experts or even superhuman. An attempt in this direction is the General Purpose Problem-Solver (GPS). GPS in the form of a procedure developed by Allen Newell, John Cliff Shaw, and Herbert Alexander Simon of Logic Theorist is an attempt to create intelligent machines. GPS itself is a predecessor to the Expert System (ES). GPS attempted to codify the steps needed to transform the initial situation into a state predetermined destination.

In the mid 1960s, a change of program rounder (general-purpose) into the specialist program (special-purpose) with DENDRAL developed by E. Feigenbaum of Stanford Universitas and then followed by MYCIN. DENDRAL manufacture leads to the following conclusions: GPS is too weak to be used as a basis for building a high-ES is staged work. Human problem solving is good only if it operates in a very narrow domain. Expert System must be updated regularly for new information. Such changes can be efficient when using a rule-based knowledge representation. Complex problem requires knowledge that a lot of problem areas. In the mid-1970s, several Expert System began to emerge. A key knowledge learned at that time was The Power of Expert System is derived from its specific knowledge, not of formalism formalism conclusion and patterns used.

Early 1980s, the Expert System technology which is initially limited by the academic atmosphere began to emerge as commercial applications, particularly XCON, XSEL (developed on the R-1 at Digital Equipment Corp.) and CATS-1 (developed by General Electric).

Expert System to perform medical diagnosis have been developed since the middle of 1970. An expert system for the diagnosis is first made by Bruce Buchanan and Edward Shortliffe at Stanford University. This system is named MYCIN [9]. MYCIN is an interactive program that does the diagnosis of disease and infection minigitis bacremia and provide recommendations antimicrobial therapy. MYCIN able to provide explanations on the reasoning in detail. In the pilot, she was able to demonstrate the ability of such a specialist. Although MYCIN never used routinely by doctors, MYCIN a good reference in artificial intelligence research another.

Several previous studies have been done either for the early detection of deficiency of vitamins and minerals as well as the study of similarity methods used. In his research, Syatibi^[3] establish a diagnosis expert system cowhide web based with certainty factor method. The steps in the research include better data collection methods of data obtained from the literature as well as from the acquisition of knowledge from experts via interviews, then do a knowledge representation of the data already obtained to be used as a knowledge base of the expert system [10]. Uncertainty method used is the certainty factor used to calculate or treat any symptoms based on the weight that was obtained from observation. From the results of testing the system, it is said that the use of methods certainty factor in the system has given good results so as to produce an expert system application that can be used to help diagnose skin disease in cattle by physical symptoms that are owned by a cow.

Research by Latumakulita [11] to build an expert system to diagnose the disease in children using certainty factor of uncertainty. The steps in the research is the method of data collection both data obtained from the literature as well as from the acquisition of knowledge from experts via interviews, where the symptoms experienced by the child's illness will be given the level of trust by experts then carried knowledge representation of the data that has been obtained to be used as a knowledge base and an expert system implemented through a desktop-based program.

Research by Sari [12] reinforce the journal to build an expert system to diagnose dengue fever using certainty factor. In his research, said that the application of the method certainty factor can facilitate in providing a solution to the calculation of the symptoms experienced by the user and how definite degree of certainty of the user or patient suffering from dengue fever. Research [12] conducted research by interviewing an expert or experts in the field of health to obtain data about the symptoms of dengue fever later of these symptoms is given a weighting method certainty factor based on confidence level experts of symptoms that cause fever and data already collected used as a knowledge base of the expert system for diagnosing dengue. An expert system is a computer program designed to model the ability of problem solving is done by an expert [13]. Useful and convenient as it helps them to find the information that they want in the shortest time [14]. The Expert System increases in value for technology, to assist in overcoming the information era that is rapidly more advance [15].

III. RESEARCH METHODS

In this study were divided into several stages that are used to build an expert system application, starting from the stage of problem identification or analysis, knowledge acquisition and knowledge representation. In this study also used the method certainty factor to deal with the uncertainty of the results in the application of expert systems.

A. Identify the Problem and Knowledge

Making this expert system begins with determining the problem, in this case is to determine the lack or deficiency of vitamins and minerals in the body. It is very important to determine which will further the knowledge required in the system. The identification process begins from the knowledge acquisition of knowledge and continued with knowledge representation.

B. Knowledge Acquisition

The acquisition of knowledge is a process to collect data knowledge will be a problem. In this study used two types of data obtained through different ways. The data used is primary data taken directly through the speakers in this case the experts that people be made the object of research to get information and data. Search primary data in this study will be conducted by interviewing an expert who was one of the doctors who are currently working in one hospital in Pekanbaru. In this study also obtained information from the health books in the library, research journals and other literature that supports this research.

C. Knowledge Representation

After the data collection process is completed, then the representation of data into the knowledge base and the rule base is then encoded, organized and described in draft form another so that a systematic form. The knowledge representation made into an expert system diagnostics defisiensi

these vitamins and minerals is to use the decision table and then formed a production rule.

IV. RESULTS AND DISCUSSION

Table 1 is a decision table vitamin and mineral deficiencies that contains the relationship between symptoms and diseases. From the decision table is created rule (rule) for this expert system. Total disease consists of 17 diseases and symptoms as much as 46 symptoms. As Table 1 is an explanation of the 45 kinds of symptom deficiency. From the symptoms, and it is known deficiency of a person along with solutions to address these deficiencies.

TABLE I. VITAMIN AND MINERAL DEFICIENCY DECISION

rules to:	id symptoms																						id diseases	value of expert
	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	G18	G19	G20	G21	G22		
1	x			x	x																		P1	0.8
2		x		x	x																		P1	0.8
3			x	x	x																		P1	1
4						x			x	x													P2	1
5							x		x	x													P2	0.8
6								x	x	x													P2	0.6
7											x		x	x									P3	0.8
8												x	x	x									P3	0.6
9															x			x					P4	1
10															x	x							P4	0.8
11															x		x						P4	0.8
12																x				x			P5	0.6
13								x											x				P5	1
14									x												x		P6	0.8
15						x															x	x	P7	0.8
16							x														x	x	P7	0.6

Rules to:	Id Symptoms																		Id Diseases	Value of Experts	
	G6	G8	G21	G23	G24	G25	G26	G27	G28	G29	G30	G31	G32	G33	G34	G35	G36	G37			G38
17				X	X	X														P8	1
18							X	X												P9	0.8
19							X		X											P9	1
20										X	X									P10	0.8
21										X		X								P10	0.8
22													X	X	X					P11	1
23			X										X	X						P11	0.6
24																X	X			P12	0.8
25															X	X				P12	0.4
26		X														X				P12	0.8
27																		X	X	P13	0.8
28	X																	X		P13	0.4

Rules to:	Id Symptoms															Id Diseases	Value of Experts
	G6	G15	G16	G17	G22	G26	G39	G40	G41	G42	G43	G44	G45	G46			
29	x						x	x								P14	0.8
30			x				x	x								P14	1
31					x				x	x						P15	0.8
32											x	x				P16	0.6
33						x						x				P16	0.8
34												x	x	x		P17	0.8
35					x								x	x		P17	1

TABLE II. LIST OF NAMES DEFICIENCY SYMPTOMS OF VITAMIN AND MINERAL

ID	ID Symptoms	Name Symptoms	ID	ID Symptoms	Name Symptoms
1	G1	The growth of the body is not perfect	24	G24	Pain in the pelvis and spine
2	G2	arising acne	25	G25	Swelling of the gums

3	G3	There bitot spots (white spots like the foam on the outer layer of the cornea)	26	G26	Wounds heal slowly
4	G4	Experiencing blindness	27	G27	Decreased sexual desire
5	G5	Itchy eyes and burning	28	G28	Hair loss
6	G6	Decreased appetite	29	G29	Bleeding in the nose
7	G7	Digestion is often compromised / excessive urination	30	G30	Easy bruising body
8	G8	Insomnia or sleeplessness	31	G31	In women menstruation flowing
9	G9	Fast heart rhythms	32	G32	Bleeding of the gums
10	G10	Scaly skin on the hand around	33	G33	Sprue
11	G11	Dry mouth	34	G34	Out of breath
12	G12	There are cracks in the corners of the mouth	35	G35	excessive sweating
13	G13	Skin irritation / redness	36	G36	Constipation or difficult bowel movements
14	G14	Reduced body resistance is characterized by severe flu	37	G37	Muscles are very weak
15	G15	Frequent vomiting or nausea	38	G38	The body feels sluggish and tired
16	G16	Muscle cramps often	39	G39	Fibromyalgia (certain body parts are sensitive to the touch usually in the neck and pelvis)
17	G17	Often felt soreness in the mouth	40	G40	Headache / migraine
18	G18	Sensitive skin when exposed to sunlight	41	G41	reduced concentration
19	G19	Experiencing headaches	42	G42	Nails looked thin and concave / nail spoon
20	G20	Delaga (skin on cracked heels)	43	G43	Have a high fever
21	G21	His arms and legs felt weak	44	G44	slow growth
22	G22	Anemia is characterized by a pale face	45	G45	Bone demineralization (pain and severe pain at the waist)
23	G23	Burning sensation that occurs in the mouth and throat	46	G46	Depigmentation (hair and skin discoloration)

TABLE III. LIST OF NAMES DEFICIENCY DISEASES VITAMINS AND MINERALS

ID	Id Diseases	Name Diseases
1	P1	Deficiency of Vitamin A
2	P2	Deficiency of Vitamin B1
3	P3	Deficiency of Vitamin B2
4	P4	Deficiency of i Vitamin B3
5	P5	Deficiency of Vitamin B5
6	P6	Deficiency of Vitamin B6
7	P7	Deficiency of Vitamin B12
8	P8	Deficiency of Vitamin C
9	P9	Deficiency of Vitamin D
10	P10	Deficiency of Vitamin E
11	P11	Deficiency of Vitamin K
12	P12	Calium
13	P13	Phophor
14	P14	Magnesium
15	P15	Mineral deficiency Zinc / Zinc (Zn)
16	P16	Mineral Deficiency Iron / Ferrum (Fe)
17	P17	Mineral deficiency Copper / Cuprum (Cu)

A. Handling Uncertainty

In this study used a method certainty factor (CF) for the treatment of the uncertainty of the expert system. CF value will be in the range of 1 to -1 where the value 1 states the absolute trust and absolute value of -1 expressed distrust. In MYCIN also used the concept of threshold which used threshold level is 0.2 which is denoted by δ (delta). Equation (1) is used to determine CF premise of a rule [10].

$$R_k(cf) = \begin{cases} \min\{P_i(cf)\}, & \text{if } P_i(cf) \geq \delta \\ \max\{P_i(cf)\}, & \text{if } P_i(cf) \leq \delta \\ 0, & \text{if } |P_i(cf)| < \delta \text{ for any } i \\ 0, & \text{if } P_i(cf) > \delta \text{ for any } i \end{cases}$$

Furthermore Ignizio [10] calculate the output CF rule by using equation (2)

$$cf_k = R_k(cf) \cdot [R_k(cf)]$$

If more than one conclusion is obtained for a disease then combined CF calculation using equation (3)

$$C(cf) = \begin{cases} cf_1 + cf_2 - (cf_1 \cdot cf_2), & \text{if } cf_1 \text{ and } cf_2 \geq 0 \\ \frac{cf_1 + cf_2}{1 - \min(|cf_1|, |cf_2|)}, & \text{if } cf_1 \text{ or } cf_2 < 0 \\ cf_1 + cf_2 + cf_1 \cdot cf_2, & \text{if } cf_1 \text{ and } cf_2 < 0 \end{cases}$$

In this expert system, the value obtained from the certainty factor CF and CF expert users. CF value obtained when users perform diagnostics on a CF specialist symptoms while the value given to a disease in a rule (rule) by using the AND operator in any rule made.

An example of calculation using the CF answer is obtained from the selection of the check box that is displayed by the system to the user, the user provides a checklist or tick the check box on the symptoms G4 (night blindness) with a value of Cf user or the level of confidence among users, namely 1

(definitely), symptoms G5 (eye itching and burning) with a value of Cf user or users confidence level is 1 (definitely), G1 (Tasted Dry mouth) and G2 (Occur Acne) with a value of Cf user or users confidence level is 0.8. Table 4 provides an example of symptoms along with the level of confidence of the symptoms experienced user:

TABLE IV. SYMPTOMS AND CF VALUES USER

Symptoms code	Cf Value User
G4	1
G5	1
G3	0.8
G1	0.8

Based on the user response, obtained rules are met, namely:

Rule 1

IF G4 [Cf User = 1]
AND G5 [Cf User = 1]
AND G1 [Cf User = 0.8]
THEN Vitamin A Deficiency
(Cf Expert = 0.8)

Rule 3

IF G4 [Cf User = 1]
AND G5 [Cf User = 1]
AND G3 [Cf User = 0.8]
THEN Vitamin A Deficiency
(Cf Expert = 1)

one rule is rule 1 and rule 3 with a CF value greater than zero, then do the calculations to find the CF conclusion by using equation (3), namely:

Conclusion (Cf) = $0,64 + (0,8 - (0,64 * 0,8)) = 0,928$.

CF conclusion that Diagnosed Patients with vitamin A deficiency disease, with a confidence level of 0928 or 92.8%. The system will then provide explanations ranging from symptoms that are owned, a deficiency results, levels of confidence and solutions in accordance with the vitamin deficiency owned.

B. Rule-based System Testing / Rules Diagnosis With Experts

Tests performed by an expert system using a black box and with through testing by experts directly. Based on the results of the expert examination, we concluded that neither of the expert diagnosis and diagnosis of the system gives the same conclusion.

The following are some of the format or display expert system for diagnosing vitamin and mineral deficiencies.

Figure 1. Form Login

Login form is the form for entry into the system for patients who are already registered.

Figure 2. Form Diagnosis Form

Form of diagnosis is to determine the patient's diagnosis code that the patient know the percentage rate of vitamin and mineral deficiencies in the body of the patient.

Figure 3. Form Result Percentage

Results form is to display the results of a percentage rate of diagnosis because vitamin and mineral deficiencies.

V. CONCLUSION

The conclusions of this research are:

1. This study has been successfully created a system using the method of calculation certainty factor (CF) to overcome the uncertainty factor that can help diagnose a deficiency of vitamins and minerals in the human body.

2. Based on the test results of the calculation certainty factor (CF) manually and the results of calculations performed by the system obtained the same results in the end determine the level of confidence (CF conclusion) to a diagnosis.

3. The results of validation testing and functionality possessed by the system showed that the system has the functionality of 100% and from based on testing performed by an expert to the result that the system is both a diagnosis of experts as well as the diagnosis of the system gives the conclusion of the same diagnosis.

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