

The Expert System Application For Diagnosing Human Vitamin Deficiency Through Forward Chaining Method

Dony Novaliendry*

Departement of Electronic
Engineering, National Kaohsiung
University of Applied Sciences
Kaohsiung, Taiwan
dony_novaliendry@ymail.com

Cheng-Hong Yang**

Departement of Electronic
Engineering, National
Kaohsiung University of
Applied Sciences
Kaohsiung, Taiwan
chyang@cc.kuas.edu.tw

Denno Guara Labukti A.Y

Departement of Electrical
Engineering, Technical Faculty,
State University of Padang
Padang, Indonesia
enno.deani@gmail.com

Abstract — Vitamins are organic foods that are indispensable for the growth and health of the body. In case of health problems, especially lack of vitamins, people are more trusting doctor and nutritionist to find out whether the treatment is still low-level disorder or chronic. With the use of technology applications such as expert systems, the needs of society in diagnosing early vitamin deficiency can be realized. An expert system is one branch of artificial intelligence to learn how to “adopt” an expert way of thinking and reasoning in solving a problem, and contains a decision and draw conclusions from a number of facts. Application of expert system diagnosis of vitamin deficiency in humans is in the form of desktop-based application. This application uses forward chaining method and technique of depth first search engines. Forward Chaining method is a method that is driven by the data where the tracking starts from the observation of the input information and then try to describe the conclusions. Application of expert system is able to facilitate community in diagnosing early vitamin deficiencies that can save time, costs, and makes it easy for the user.

Keywords: *Vitamins, Expert System, Forward Chaining, JAVA, MySQL*

I. INTRODUCTION

The rapid growth of technology nowadays has spread into many sectors. In line with this phenomenon, we are obliged to take advantage of this development such as using computer in health sector.

Health is the most precious priority for every human because humans cannot fulfill their living if they suffer a disease. There are many aspects which can affect human's health condition, started from the external factor into the internal one. One example of external factor is the unhealthy living environment. This living environment may cause many harmful germs or bacteria attack human's immune system. While, the example of internal factor is the nutrition especially any nutrition which are being consumed

every day and other nutrition that comes from sunlight.

II. METHODS

Vitamin is an organic component which is required by human's body in a limited amount and it must be supplied from diet because body cannot synthesize the vitamin itself [1].

Vitamin is a complex chemical compound which is needed by our body to help any process of body's movement. Vitamin plays role as catalyst in bio-chemistry reaction at human's body. Vitamin is divided into two category, fat soluble vitamin (vitamin A, D, E, K) and water soluble vitamin (vitamin C and B complex). Vitamin has many advantages for body's health and it will be dangerous if human's body is lack of vitamin.

The best way that must be done if our bodies are lacks of vitamin is through having consultation to doctor and nutritionist. Unfortunately, the consultation cannot be done every time due to the limited amount of working hours. It seems that society as the service users need more a nutritionist who can easily diagnose the problem earlier in order to do the prevention.

Based on the employee data of Health Department of Padang city, Indonesia, [2], it reveals that Puskemas (Public Health Center) doesn't have medical specialist doctor, only 35 general practice doctors, 53 dentistry, 240 midwifery, and 207 nurses. While, the amount of nutritionist is 39 people and only 3 people working in the county. It seems that the health service nowadays is lack of doctor and nutritionist to take care of any nutrition problem including vitamin deficiency. This can be solved through using the technological application to solve the problem nutrition problem especially vitamin.

Expert system is a smart computer program that use knowledge and inferential procedure to solve difficult problem that needs expert to solve it [3].

An expert is a person who has capability in particular domain, has knowledge or special skill which doesn't have and know by anybody else. In

general, expert system is a system which adopted human's knowledge into computer so computer can solve any problems like what the expert does. This expert technological system is consists of expert system language, program and hardware which are designed to help the development and production of expert system [4].

The time problem and cost are the major problem in designing the application in this expert system. The design of application in this expert system is a "desktop based" which runs in one computer. The expert system application is built with programming language JAVA and DBMS implementation (Database Management System) using MySQL.

The approach that is used to control the inferential of this expert system is forward chaining method. Forward chaining is a group of inferential multiple which undertake searching of one problem into its solution. This method is motorized by data-driven where the searching system is started from the observation result of input information then the conclusion or hypothesis is figured and searched through the current information.

The developed forward chaining method will be implemented in inference engine of expert system. Inference engine of expert system is computer program that answers questions from user. It processes all information from the knowledge base by firing rules and facts [5]

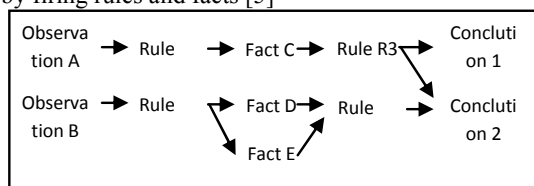


Figure 1. Forward Chaining Process [3]

The next technique is the method of inference depth first-search engine. Depth-first search engine to surf the rules in depth of the root node to move down to the level in the sequence.

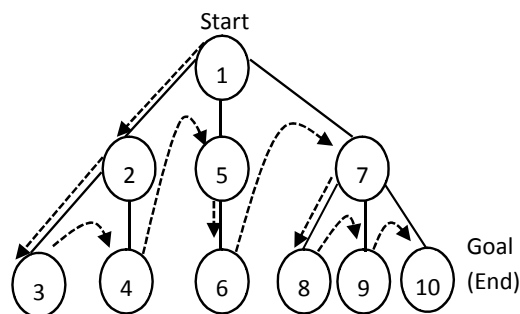


Figure 2. Flowchart of the dept-first search

Expert system is not classified into a system which will replace the role of human expert in finding a solution of particular problem, while it is used to help the expert. The expert system can be used to deepen and widen knowledge in particular

domain, even it can be used to help experts' activity as an experienced assistant.

The design of this expert system will be built by using the following systemic ware model like context diagram, even list, data flow diagram leveled and some UML diagram such as class diagram, use case diagram, sequence diagram, and activity diagram. UML (unified modeling language) is a general syntax to make a logical model of a particular system and used for figuring the system. Thus, it will be easily to be understood in the analysis and design phase. UML is a kind of visual language for modeling and communication about a system by using diagram and supporting texts [6]. UML is usually served in a form of diagram or figure including inheritance, association, and composition. Every complex system will be better if it is represented in a simple model which describes the whole system.

III. ANALYSIS AND SYSTEM DESIGN

A. Application Design Concept

The design of expert system application to diagnose human vitamin deficiency can be done in some steps;

Creating a knowledge basis by collecting data about the vitamin names, vitamin deficiency symptoms, vitamin deficiency dosage which based on the daily value percentage (AKG) and others. The knowledge basis discuss method which experts may be done in getting and arranging data into production "rule" in the basic rule.

After getting the data from knowledge basis process, the next step is arranging those data into basic data in a form relational table.

Creating inference machine is also a part of expert system. It is used to do an analysis by using previous settled rules and display how experts update saved data or the new one.

Arranging user interface which becomes a media for having communication between user and expert system.

1) User Analysis

A system may run well and suitable with our expectation if we can provide an analysis about everyone who accesses the system. Here is the user who can access the system;

Admin is the system administrator who has authority to do the data management of vitamin, symptoms, rule and user.

Expert (doctor and nutritionist) is a person who experts in nutrition aspect which has authority to do the data management of vitamin, symptoms, rule and patient medical record.

Patients are the users who have role to inform their vitamin deficiency diagnosis through entering their personal data and vitamin deficiency symptoms.

2) Vitamin Analysis

Vitamin A, known as retinol, is a vitamin for creating good vision especially in the evening.

Vitamin A is also needed by the retina of the eye in the form of retinal. This vitamin also plays important role to protect skin and immune system. Vitamin A is easy to break in heat, sun and air attack.

Vitamin B1, known as tiamin, is a one kind of vitamin which contributes important role to keep the skin health and helpful in converting carbohydrates into energy for our daily routines. Besides that, this vitamin is also beneficial to help protein and fat metabolism process.

Vitamin B2 or Riboflavin, act as one component of coenzyme flavin mononucleotide and flavin adenine di-nucleotide. These two enzymes are important in energy regeneration for body through respiration. This vitamin is also beneficial in creating steroid molecule, red blood cell, and glycogen. It is also used to support the growth of some organs, like skin, hair and nails.

Vitamin B3 or Niacin, plays role in carbohydrates metabolism to produce energy. It also has role in fat and protein metabolism. This vitamin has a great contribution to control the blood glucose, high blood pressure, migraine healing and vertigo.

Vitamin B5, also known as Pantotenat Acid, has a great role in many types of body metabolisms, like in the reaction of breaking the food nutrition, especially fat. Another advantage of this vitamin is controlling communication between central nervous system and brain, producing fatty acid compound, sterol, neurotransmitter, and body hormone.

Vitamin B6, known as pyridoxine, is an essential vitamin for body growth. This vitamin plays important role in nutrition metabolism. It also produces antibody as a protection from harmful antigen or unknown composition.

Vitamin B7 is also known as biotin or vitamin H. Vitamin B7 helps body to process glucose so our body can produce energy. This vitamin may decrease the blood glucose, and help to build and defend the muscular fabric, bone marrow, and nervous.

Vitamin B9 is also known as folic acid. It is beneficial to help body in growing the new cell. This vitamin can help baby growth, prevent cervix cancer, and also prevent osteoporosis for woman. For man, this vitamin is functioned to cure lever, anemia medication, and hemoglobin construction.

Vitamin B12 or sianokalabamin, is a type of vitamin which is only produced by animal. This vitamin plays role in caring the nervous cell, creating RNA and DNA molecule, and then creating blood platelet.

Vitamin C or ascorbic acid plays important role in creating collagen composition. This composition is an important protein in structuring skin fabric, joint, bone, and other supporting fabrics. This vitamin is the essential antioxidant composition to protect body from free radicals and pollution.

Vitamin D is usually found in fish, eggs, milk and cheese. This vitamin plays important in role in the growth human's bones. Vitamin D helps in

calcium metabolism and bones mineralization. Skin cell will directly produce vitamin D after affected by sun light (ultraviolet).

Vitamin E plays important role in caring many cells in human body, started from skin cell, eyes, red blood cell, to liver. This vitamin also can protect humans' lungs from air pollution. This health value deals with the work of vitamin E in human's body as an essential antioxidant composition.

Vitamin K plays role in creating better blood circulation and wound covering. Any deficiency of this vitamin will cause bleeding inside the body and difficulties in blood coagulating when injury happens.

3) Vitamin Deficiency Symptoms Analysis

To diagnose vitamin deficiency, it is better to know the symptoms of the problem. Although it is only a usual symptom, doctor and nutritionist should take a decision.

Some symptoms that deal with vitamin deficiency in human as follow [7][8][9][10]:

Tabel 1. Vitamin Deficiency Symptoms

No	Vitamin Deficiency Symptoms
1	Decreased endurance
2	Weight loss
3	Digestive system problem
4	Loosing appetite
5	Queasy
6	Spewing out
7	Stomach cramps
8	Diarrhea
9	Infected easily
10	Scurvy
11	Back bones anomaly
12	Anemia
13	Bleeding inside the body
14	Difficulties in blood coagulation
15	Cram
16	Muscle weakness
17	Over tiring
18	Muscle ache
19	Decreasing in muscle coordination and reflection
20	Sense of needles in hands
21	Sense of needles on feet
22	Tingling in hands
23	Tingling on feet
24	Burning sensation in the feet
25	Difficult to walk
26	Rachitic
27	Osteomalasia
28	Bleeding under the skin
29	Dermatitis
30	Dry skin
31	Scaly skin
32	Decreased vision
33	Cataract
34	Xerophthalmia
35	Eyes cannot stand the light
36	Feels hot and itchy eyes
37	Inflammation of the lips
38	Cracked corners of the mouth
39	Inflammation of the tongue
40	Wound redness of the tongue
41	Thrush
42	Rapid tooth loose
43	Bleeding gums

44	Depressed
45	Insomnia
46	Hallucinations
47	Senility
48	Arising acne
49	Baldness
50	Rapid hair graying

4) Diagnosis Decision Tree Vitamin Deficiency in Humans

Decision tree diagram is a design that is used to build an expert system. Decision tree diagram will make it easier to draw up the knowledge base and rules of the diagnosis of vitamin deficiency.

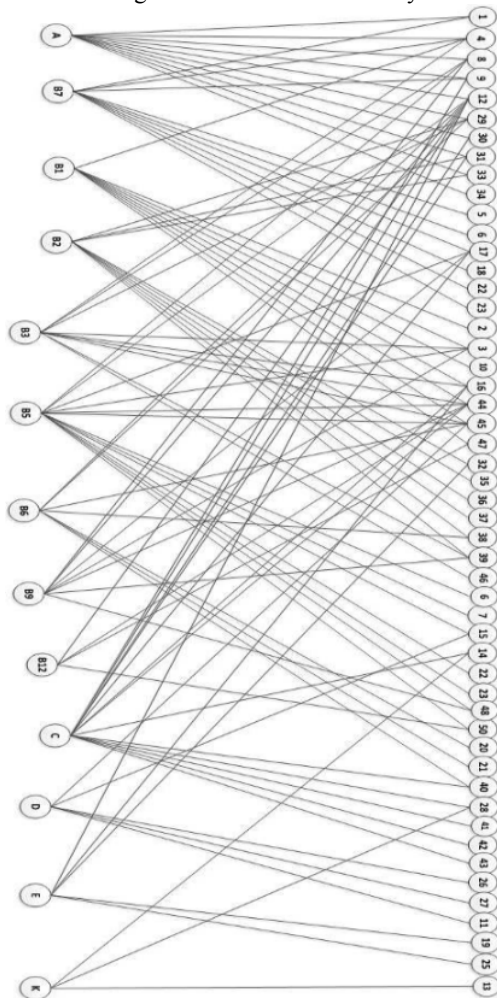


Figure 3. Diagnosis Decision Tree Vitamin Deficiency

The decision tree in this expert system uses forward chaining searching method. This is related to the diagnosis of vitamin deficiency problem in humans. This method is seen helpful in recognizing the symptoms of vitamin deficiency in patients. This tree diagram consists of 13 vitamins and 50 symptoms of deficiency. To diagnose a vitamin deficiency which is felt by the patients, they are given the facility to choose the existing symptoms. Based on this decision tree diagram, it can be seen that every symptom can be directly input into the

decision. In fact, the result of this decision can detect more than one sign of vitamin deficiency.

5) System Production Rule

Tabel 2. System Production Rule

<p>Rule 1 : If symptom: xerophthalmia or cataract or dry skin or dermatitis or easily infected or decreasing in immunity Then Vitamin A deficiency</p>	<p>Rule 2 : If symptom: muscular weakness or decreased appetite or insomnia or scurvy or impaired memory or weight loss or digestive system problem Then Vitamin B1 deficiency</p>
<p>Rule 3 : If symptom: cataract or decreased vision or feeling hot and itchy eyes or eyes cannot stand the light or dermatitis or inflamed lips or glossitis or depressed Then Vitamin B2 deficiency</p>	<p>Rule 4 : If symptom: Diarrhea or muscular weakness or insomnia or indigestion or decreased appetite or dermatitis or tongue inflammation or hallucinated Then Vitamin B3 deficiency</p>
<p>Rule 5 : If symptoms: muscle spasms or foot numbness or burning sensation in the feet or tingling hands or digestive problem or vomiting or diarrhea or acne arising or rapid hair graying Then Vitamin B5 deficiency</p>	<p>Rule 6 : If symptoms: anemia or wound redness of the tongue or muscle spasms or sense of needles in the legs or sense of needles in the hand or depressed or dermatitis or cracked corners of the mouth or insomnia Then Vitamin B6 deficiency</p>
<p>Rule 7 : If symptoms: nausea or decreased endurance or foot numbness or tingling hands or decreased appetite or vomiting or baldness Then Vitamin B7 deficiency</p>	<p>Rule 8 : If symptoms: tongue inflammation or diarrhea or depressed or digestive problem or tiredness or anemia or arising acne Then Vitamin B9 deficiency</p>
<p>Rule 9 : If symptoms: depressed or anemia or impaired memory or rapid hair graying Then Vitamin B12 deficiency</p>	<p>Rule 10 : If symptoms: thrush or bleeding under the skin or muscle weakness or depressed or tired or anemia or gum problems or failed in wound healing or frequent infections Then Vitamin C deficiency</p>
<p>Rule 11 : If symptoms: muscle spasms or insomnia or fast restless or brittle bones or spinal abnormalities or rachitic and</p>	<p>Rule 12 : If symptoms: decreased vision or anemia or muscle spasms or muscle weakness or difficult to walk Then Vitamin E deficiency</p>

osteomalasia Then Vitamin D deficiency	
Rule 13 : If symptoms: difficulties in blood coagulation or bleeding inside the body or bleeding under the skin Then vitamin K deficiency	

These rules are based on tree decision and forward chaining method which has been discussed before. Through the rules, other form can be designed to create expert system for human vitamin deficiency diagnosis.

B. System Modeling Devices

There are some types of devices which used by the system. However, it is not absolute that every modeling device is integrated into the system. This means that we can use a half of the devices.

1) Event List

The first matter that we should do in designing the system is making a list of every existing event. The events are:

- Patients enter any data of vitamin deficiency problems that they're suffered into list of symptoms.
- The application does the analysis based on the patients' data. The results of analysis will determine the problems list and solution which are suitable with the deficiency.
- The data of diagnosis and solution are given to the patients.
- Admin will cultivate the data on the system
- Admin obtains information from the data at the system
- The experts take over management of the system
- The experts get information from data management at the system

2) Use Case Diagram

Use Case Diagram is a modeling for information system behavior. It is made to identify any functions which exist in an information system and person who is eligible to use the function.

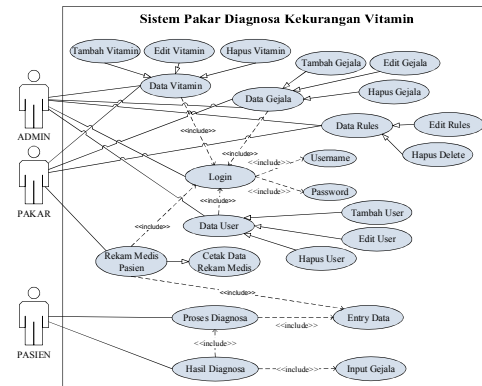


Figure 4. Use Case Diagram

C. Database Designing

1) Entity Relationship Diagram (ERD)

ERD is a part of Vitamin Deficiency Diagnosis Expert System in Human which consists of five entities such as vitamin, symptoms, rules, user, and history. The ERD has 3 relationships.

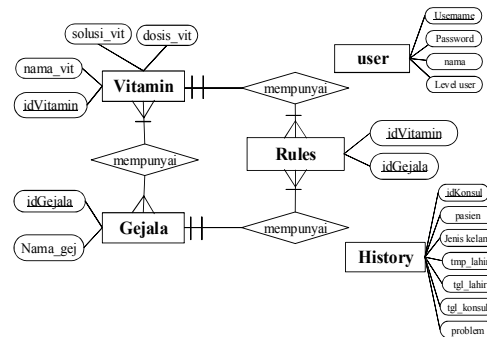


Figure 5. ERD

IV. RESULT

The result of interface modeling is implemented on the human vitamin deficiency expert system test phase by using programming language JAVA as its language development and DBMS MySQL as the data storage.

The implementation is done through interpreting the result of the design into complete software, and translating the layout on interface design into complete form of interface system. This is done to know if the designed system can run well based on the previous designing.

A. Form Consultation Results dialog

Form Consultation Results dialog will appear after the button (✓) done on the consultation form at a click. Here's the view of the results of the consultation form dialog in Figure

5.

NO	NAMA VITAMIN	SOLUSI	DOSE
1	Vitamin B7 (Vitamin H / Biotin)	1. Hati	Bayi
		2. Keringat	10-12 tahun : 5 mg
		3. Khamir	7-11 tahun : 6 mg
		4. Keti	Anak-anak
		5. Kacang-kacangan	1-2 tahun : 8 mg
		6. Kolesterol	4-6 tahun : 12 mg
		7. Ubi jalar	7-9 tahun : 12 mg
		8. Gandum utuh	Laki-Laki
		9. Jambu	10-12 tahun : 20 mg
		10. Pisang	13-15 tahun : 25 mg
		11. Jeruk	16-18 tahun : 25 mg
		12. Pakat	19-20 tahun : 30 mg
		13. Semangka	30-40 tahun : 30 mg
		14. Stroberi	50-64 tahun : 30 mg
		15. Biji bunga matahari	65+ tahun : 30 mg
		Wanita	10-12 tahun : 20 mg

BASE DIAGNOSA

Anda Terdeteksi Kekurangan :

1. Vitamin B7 (Vitamin H / Biotin) |

2. Vitamin A (Retinol) |

Figure 5. Form Dialogue Consultation Results Vitamin Deficiency

On the form dialog consultation results will be displayed along with the diagnosis and solution dosage form based on input data from the consultations.

V. CONCLUSION

Ultimately, the conclusions which can be drawn in the “design of expert system application to diagnosis human vitamin deficiency” are : Through this vitamin deficiency diagnosis expert system application; it will help the society to diagnosis their vitamin deficiency problem. This is used to do the early prevention in order to save more time, and fund. In addition, it will be helpful for its users. This application can also be used as comparator or an alternative for decision making (second opinion)

ACKNOWLEDGMENT

I Would like to express my gratitude to all those who gave me the possibility to complete this paper. The special thank goes to DIKTI.

REFERENCES

- [1] Muchtadi, Deddy, Pengantar Ilmu Gizi. Bandung : Alfabeta, 2009.
- [2] Dinas Kesehatan Kota Padang, Profil Kesehatan Tahun 2013. Padang: Dinas Kesehatan Kota Padang., 2013.
- [3] M. Arhami, Konsep Dasar Sistem Pakar. Yogyakarta: Andi Offset, 2005.
- [4] Joseph C. Giarratano, Gary Riley. Expert Systems, Principles and Programming, 2005, ISBN 0-5434-38447-1.
- [5] Lunze, Prof. Dr.-Ing. Jan, Kunstliche Intelligenz fur Ingenieure, Band 1: Methodische Grundlagen und Softwaretechnologie, R. Oldenbourg Verlag, Munchen Wien, ISBN 3-486-22287-2.
- [6] Rossa A.S. & Shalahuddin, Modul Pembelajaran Rekayasa Perangkat Lunak. Bandung: Modula, 2011.
- [7] Hartono, Andry & Endy P.P., A-Z Multivitamin untuk Anak dan Remaja. Yogyakarta: Andi Offset, 2010.

- [8] Cakrawati Dewi & Mustika NH., Bahan Pangan, Gizi, dan Kesehatan. Bandung: Alfabeta, 2012
- [9] Irianto, Kus & Kusno Waluyo, Gizi dan Pola Hidup Sehat. Bandung : Yrama Widya, 2004.
- [10] Yuliarti, Nurheti, A to Z Food Supplement. Yogyakarta: Andi Offset, 2009.