IMPLEMENTATION OF INFERENCE ENGINE WITH CERTAINTY FACTOR ON POTENTIAL DIAGNOSIS OF BRAIN TUMOR DISEASE

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Abstract—An expert system is a system that has the ability of experts or experts who master a particular field to assist in solving problems. Certainty factor (CF) is one of the methods in an expert system that can define the level of certainty based on facts to show the level of confidence of the expert. This study aims to apply a certainty factor (CF) algorithm to solve the problem of diagnosing potential human brain tumors. Because the symptoms that are felt are not necessarily brain tumors, it is necessary to analyze whether the person has the potential to have a brain tumor or not, even if the potential level is. Brain tumor disease is one of several types of dangerous conditions. This disease is caused by the abnormal growth of cells around the brain. This research produces an application that can diagnose potential brain tumor diseases based on symptom input selected by the user. Then the expert system can display the diagnosis results in percentages and solutions from the results of the diagnosis. The study results indicate that the CF method can solve the problem of uncertainty by giving a degree of confidence from an expert and system user. The accuracy test results resulted in an accuracy value reaching 95%. These results indicate that the system can function and can diagnose potential brain tumor diseases properly.

Keywords: Expert System, Certainty Factor, CF, Brain Tumor Potential.

Abstrak—*Sistem pakar merupakan sistem yang memiliki kemampuan ahli atau pakar yang mengusai bidang tertentu, sehingga dapat membantu dalam penyelesaian pemecahan masalah. Certainty factor (CF) adalah salah satu metode pada sistem pakar yang mampu mendfinisikan tingkat kepastian yang didasari pada fakta sehingga bisa menunjukkan tingkat keyakinan dari pakar. Penelitian ini bertujuan untuk menreapkan algoritma certainty factor (CF) untuk penyelesaian permasalahan masalah diagnosa potensi penyakit tumor otak manusia. Karena gejala yang dirasakan belum tentu itu merupakan tumor otak, maka perlu dilakukan analisa apakah orang tersebut berpotensi mengalami tumor otak atau tidak, kalaupun berpotensi seberapa tingkatannya. Penyakit tumor otak merupakan satu diantara beberapa penyakit jenis penyakit berbahaya. Penyakit ini disebabkan karena tumbuhnya sel-sel secara tidak normal di sekitar otak. Penelitian ini menghasilkan aplikasi yang dapat mendiagnosa potensi penyakit tumor otak berdasarkan masukan gejala yang dipilih oleh pengguna. Kemudian sistem pakar mampu menampilkan hasil diagnosa dalam persentase dan solusi dari hasil diagnosa. Dari hasil penelitian menunjukkan bahwa metode CF dapat menyelesaikan permasalahan ketidakpastian dengan cara memberi nilai derajat keyakinan dari seorang pakar dan pengguna sistem. Hasil pengujian akurasi menghasilkan nilai akurasi mencapai 95%. Hasil tersebut menunjukan bahwa sistem dapat berfungsi dan mampu melakukan diagnosa potensi penyakit tumor otak dengan baik.*

***Kata Kunci**: Sistem Pakar, Certainty Factor, CF, Potensi Tumor Otak*

INTRODUCTION

Artificial intelligence or artificial intelligence is one of the fields of computer science that discusses how to build systems that can complete work like humans do (Setyaputri et al., 2018). Expert system is one part of artificial intelligence. An expert system is a system that adopts the knowledge of an expert in a particular field into a computer so that the computer can solve problems, and experts do that(Sucipto et al., 2019). Expert systems will always relate to knowledge, facts, and reasoning for problem-solving, which experts from specific fields usually carry out. An expert will face problems receiving patient answers in diagnosing because there are uncertain answers, such as "maybe." The certainty factor (CF) approach is used to overcome the uncertainty factor. CF is a method that can define the level of certainty based on facts to explain the level of confidence of an expert (Borman, Napianto, et al., 2020). CF has the

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advantage of presenting calculation results based on the level of confidence in the symptoms felt by the patient or system user so that good accuracy and precision are produced (Riadi, 2017). CF can take measurements of facts or issues of uncertainty. In CF, some rules have been set, and there is a different confidence level value and hypothesis that exists on the confidence level value (Arifin et al., 2017).

The CF method can work well if implemented in expert system development. It is evidenced by previous research concluding that this method can provide high accuracy results in resolving uncertainty (Ardiansyah et al., 2019), (Liana & Lubis, 2018), (Sulistiani & Muludi, 2018). In this study, the CF algorithm will be implemented in solving the problem of diagnosing potential brain tumors in humans. Brain tumor disease is one of several types of dangerous conditions. This disease is caused by the growth of abnormal cells around the brain (Prebiana & Astuti, 2020).

In this disease, there will be cell growth shaped like a lump or in the form of cell tissue that grows and maybe one of the symptoms of brain cancer. Brain tumors are part of tumors in the nervous system (Prebiana & Astuti, 2020). Patients with brain tumors in Indonesia each year reach approximately 300 patients. Brain tumors attack adults and children who can be affected by this disease. Not a few people underestimate this dangerous disease. Therefore, recognizing and detecting early symptoms of brain tumor disease becomes essential before a brain tumor attacks. So it takes awareness and vigilance of all elements of society, from medical personnel to the general public, against the various symptoms of this brain cancer. But the symptoms that are felt are not necessarily brained tumors. So it is necessary to analyze whether the person has the potential to have a brain tumor or not. So, we need a system that can diagnose brain tumor disease so that people can recognize the symptoms of this disease and have knowledge about the disease. This study aims to develop an expert system that can identify whether a person has the potential to have a brain tumor or not by implementing a certainty factor (CF) algorithm.

MATERIALS AND METHODS

For the research to run by the objectives, it is necessary to have a structured research stage. Figure 1 below shows the steps of the research carried out.

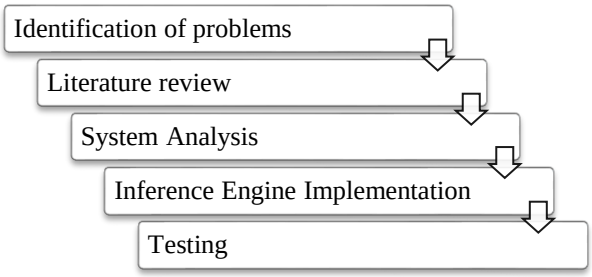

Figure 1. Research stages

A. Identification of problems

At the problem identification stage, finding the problem behind this research is carried out. In this stage, the researcher determines the limits of the disease to be discussed, the research objectives, and the benefits of this research. This research discussion aims to create an expert system to determine the potential for brain tumor disease to make it possible to diagnose potential brain tumors early on.

B. Literature review

At this stage, the researcher collects sources of knowledge related to research in the form of books and scientific articles. At this stage, knowledge and related theories are needed about brain tumor disease, expert systems, and the Certainty Factor (CF) algorithm.

C. System Analysis

In the analysis stage, the researchers collected or indexed data to know the symptoms in patients with brain tumors. At this stage, knowledge acquisition, knowledge representation, and rule building will also be carried out related to the symptoms of brain tumor disease.

D. Inference Engine Implementation

The inference engine used is a certainty factor (CF) algorithm. This method can prove whether a fact has a definite or uncertain value (Annisa, 2018). Certainty factor is formulated through the following equations (1) and (2):

$$CF[H,E] = MB[H,E] - MD[H,E] \quad \text{.....(1)}$$

Where H is a measure of confidence, and E is the confidence percentage.

For CF involving one premise, you can use the following equation:

$$CF[H,E] = CF_{[user]} \times CF_{[expert]} \quad \text{.....(2)}$$

To determine the level of trust or confidence from the expert, based on the table of trust value rules (Hariyanto & Sa'diyah, 2018), which can be seen in Table 1 below:

Table 1. Trust Value Rules

Weight Assurance	Level
Very Confident	1
Sure	0,8
Pretty Sure	0,6
Slightly Confident	0,4
Don't know	0,2
Not Sure	0

If there are cases that have several symptoms, then the CF solution can use the following formula (3):

$$CF_{combained} = CF_1 + CF_2 \times (1 - CF_1) \quad \text{.....(3)}$$

CF1 and CF2 have the same hypothesis. CF1 is the value of the certainty factor of evidence one on the idea, while CF2 is the value of the certainty factor of evidence two on the hypothesis. Then this CFcombined result will be called CFold for the following combination.

E. Testing

At this stage, the researcher conducts functional testing of the system to determine the suitability between the design made and the features that exist in the system.

RESULTS AND DISCUSSION

The initial stage in developing an expert system for diagnosing potential brain tumor disease is to acquire knowledge to obtain data that can be used as a knowledge base, including data on symptoms, conditions, solutions, and the value of beliefs for each sign and disease from experts. Table 2 is a table of symptoms that have the potential to have brain tumor disease.

Table 2. Table of Symptoms of Brain Tumor Disease

No	Symptom Number	Symptom
1	G1	Headache gradually
2	G2	Nausea and vomiting for no reason
3	G3	Disturbed memory
4	G4	convulsions
5	G5	Legs or arms tingling and numb
6	G6	Impaired or unclear vision
7	G7	Sense of hearing is problematic
8	G8	It's hard to move, and balance is disturbed

Some of the solutions provided by the system based on symptoms that system users will enter can be seen in table 3.

Tabel 3. Solutions Table

Solution Number	Condition	Solution
S1	$CF_{Combine}$ < 20 %	Take care of your body condition, eat more foods that contain high nutrition, be diligent in exercising, and always be cheerful and happy
S2	$CF_{Combine}$ >= 20 % and <= 99 %	Should be more alert, and please consult a doctor for further examination.
S3	$CF_{Combine}$ > 99 %	Immediately consult your doctor to get medical treatment as soon as possible.

The following is a case study in the application of CF to determine the potential for brain tumor disease based on input from system users. Table 4 is an example of a system user's answer case.

Table 4. Table of Answers (Examples of Cases)

Questions	Answers	Level
Are you getting headaches gradually?	Pretty sure	0.6
Do you experience nausea and vomiting for no apparent reason?	A little	0.4
Is your memory disturbed?	Not	0
Are you having a seizure?	Do not know	0.2
Are your legs or arms tingling and numb?	A little	0.4
Do you have vision problems such as blurred vision?	Pretty sure	0.6
Are you having problems with your sense of hearing?	Not	0
Do you have balance problems or difficulty moving?	Do not know	0.2

The user's answer from the above case will then calculate the certainty factor value by multiplying the weight of the expert's and user's beliefs, as in table 5 below.

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Table 5. Table of User CF Values

Symptom	Level	CF User
G1	0,6	0,6
G2	0,2	0,4
G3	0,6	0
G4	0,4	0,2
G5	0,4	0,4
G6	0,2	0,6
G7	0,2	0
G8	0,8	0,2

The process of calculating rule 1:
$CF_{symptom1}$ = $CF_{[user]} * CF_{[pakar]}$
= 0,6 * 0,6
= 0,36

The process of calculating rule 2:
$CF_{symptom2}$ = 0,4 * 0,2
= 0,08

The process of calculating rule 3:
$CF_{symptom3}$ = 0 * 0,6
= 0

The process of calculating rule 4:
$CF_{symptom4}$ = 0,2 * 0,4
= 0,08

The process of calculating rule 5:
$CF_{symptom5}$ = 0,4 * 0,4
= 0,16

The process of calculating rule 6:
$CF_{symptom6}$ = 0,6 * 0,2
= 0,12

The process of calculating rule 7:
$CF_{symptom7}$ = $CF_{[user]} * CF_{[pakar]}$
= 0 * 0,2
= 0

The process of calculating rule 8:
$CF_{symptom8}$ = 0,2 * 0,8
= 0,16

In the case study, the potential for brain tumor disease has several symptoms, so to calculate the CF value in the following way:

$CF_{combine1}$ ($CF_{symptom1}$, $CF_{symptom2}$) =
$CF_{symptom1} + CF_{symptom2} * (1 - CF_{symptom1})$ =
0,36 + 0,08 * (1 – 0,36) =
0,36 + 0,051 = 0,411 (CF_{old1})
$CF_{combine2}$ (CF_{old1}, $CF_{symptom3}$) =
$CF_{old1} + CF_{symptom3} * (1 - CF_{old1})$ =
0,411 + 0 * (1 – 0,411) =
0,411 + 0 = 0,411 (CF_{old2})

$CF_{combine3}$ (CF_{old2}, $CF_{symptom4}$) =
$CF_{old2} + CF_{symptom4} * (1 - CF_{old2})$ =
0,411 + 0,08 * (1 – 0,411) =
0,411 + 0,047 = 0,458 (CF_{old3})

$CF_{combine4}$ (CF_{old3}, $CF_{symptom5}$) =
$CF_{old3} + CF_{symptom5} * (1 - CF_{old3})$ =
0,458 + 0,16 * (1 – 0,458) =
0,458 + 0,086 = 0,544 (CF_{old4})

$CF_{combine5}$ (CF_{old4}, $CF_{symptom6}$) =
$CF_{old4} + CF_{symptom6} * (1 - CF_{old4})$ =
0,544 + 0,12 * (1- 0,544) =
0,544 + 0,054 = 0,598 (CF_{old5})

$CF_{combine6}$ (CF_{old5}, $CF_{symptom7}$) =
$CF_{old5} + CF_{symptom7} * (1 - CF_{old5})$ =
0,598 + 0 * (1- 0,598) =
0,598 + 0 = 0,598 (CF_{old6})

$CF_{combine7}$ (CF_{old6}, $CF_{symptom8}$) =
$CF_{old6} + CF_{symptom8} * (1 - CF_{old6})$ =
0,598 + 0,16 * (1- 0,598) =
0,598 + 0,064 = 0,663 (CF_{old7})

"CFdisease" is seen from the last "CFold." When viewed from the results of calculations that have been carried out, the final value is 0.663 or 66.3%. So, it can be concluded from this case study that 66.3% have the potential to develop brain tumors.

Furthermore, making an expert system starts with user analysis at the implementation stage. The expert system will be used by a user who will answer eight questions related to the symptoms experienced. From the eight user answers, the system will calculate the percentage of the potential for brain tumor disease along with solutions that system users must carry out. Figure 2 is the initial view of the system.

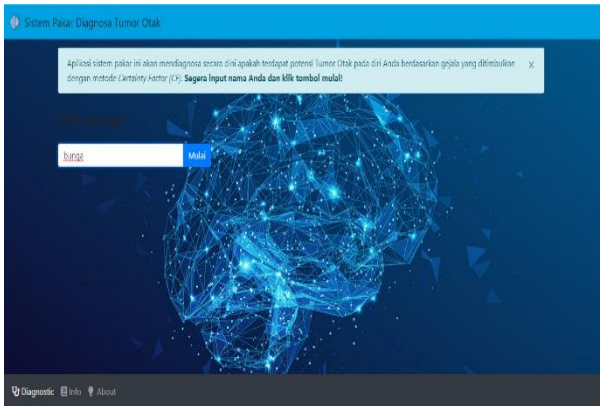

Figure 2. The initial view of the expert system for diagnosing potential brain tumors

The user is asked to enter a name as a user identity on the system start page. Next, the user will be directed to the symptom diagnosis question page, as shown in Figure 3.

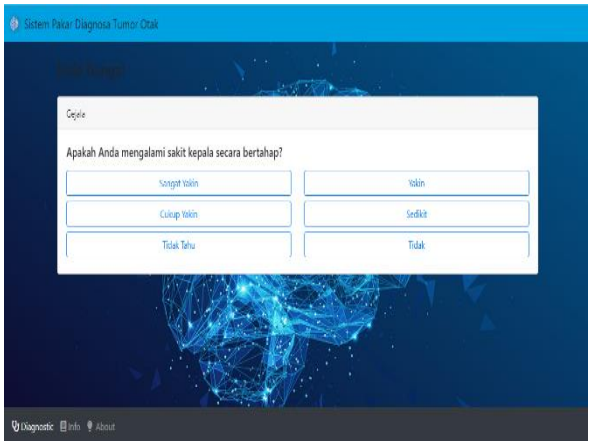

Figure 3. Display of the diagnostic question page

Furthermore, after the user has completed all questions related to the symptoms experienced, the user will be shown the diagnostic results, as shown in Figure 4.

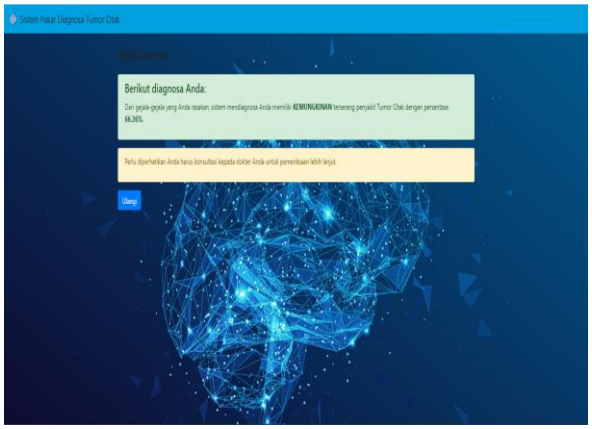

Figure 4. Display of the page for the diagnosis of potential brain tumor disease

In Figure 4, the expert system will display the percentage of the possibility that the user has the potential to have a brain tumor accompanied by the solution provided to the user. The diagnosis results in Figure 4 are the same as entering the answers in the analysis of the previous case study.

The final stage of this research is to test the accuracy of the expert system. The accuracy test is carried out by comparing the results of system diagnostics with experts (Borman, Megawaty, et al., 2020). The test case was randomly carried out with 20 points and then diagnosed using an expert system. The diagnosis results will be compared with the results of the diagnosis by the expert. Of the 20 tested cases that the expert system has diagnosed, the user system can accurately diagnose as many as 17 case studies or if the percentage becomes 85%. The results are then converted into the following criteria: Good, which is in the range of 76% to 100%; Enough, which is in the field of 56% to 75%; Not Good, which is a range of 40% to 55%, and Not Good, if it is below 40% (Sayogo, 2016). If it is converted, then the accuracy results are in the excellent category. It shows that the expert system can diagnose potential tumor diseases using the CF algorithm to function correctly. However, the error rate or errors reaches 15%. Several factors cause this, including the accuracy of results influenced by the user's weight value. If the user is not consistent with the answers, the results will not be optimal. In addition, each potential category has similar symptoms, which can affect the diagnostic results.

CONCLUSION

This research produces an application that can diagnose potential brain tumor disease based on the input of symptoms selected by the user. Then the expert system can display the diagnosis results in percentages and solutions from the results of the diagnosis. The study results indicate that the CF method can solve the problem of uncertainty by giving a value to the degree of confidence of an expert and the person who uses the system. The system that has been built has been tested using an accuracy test that produces an accuracy value of 95%. These results indicate that the system can function and can diagnose potential brain tumor diseases properly.

REFERENCE

Annisa, R. (2018). Sistem Pakar Metode Certainty Factor Untuk Mendiagnosa Tipe Skizofrenia. *IJCIT (Indonesian Journal on Computer and Information Technology)*, *3*(1), 40–46.

Ardiansyah, R., Fauziah, F., & Ningsih, A. (2019). Sistem Pakar Untuk Diagnosa Awal Penyakit Lambung Menggunakan Metode Dempster-Shafer. *Jurnal Ilmiah Teknologi Dan Rekayasa*, *24*(3), 182–196.

Arifin, M., Slamin, S., & Retnani, W. E. Y. (2017). Penerapan Metode Certainty Factor Untuk Sistem Pakar Diagnosis Hama Dan Penyakit Pada Tanaman Tembakau. *Berkala Sainstek*, *5*(1), 21–28. https://doi.org/10.19184/bst.v5i1.5370

Borman, R. I., Megawaty, D. A., & Attohiroh, A. (2020). Implementasi Metode TOPSIS Pada Sistem Pendukung Keputusan Pemilihan Biji Kopi Robusta Yang Bernilai Mutu Ekspor (Studi Kasus : PT . Indo Cafco Fajar Bulan Lampung). *Fountain of Informatics Journal*,

PILAR Nusa Mandiri: Journal of Computing and Information System
Vol. 18, No. 1 March 2022 | DOI: 10.33480/pilar.v18i1.xxxx

5(1), 14–20. https://doi.org/10.21111/fij.v5i1.3828

Borman, R. I., Napianto, R., Nurlandari, P., & Abidin, Z. (2020). Implementasi Certainty Factor Dalam Mengatasi Ketidakpastian Pada Sistem Pakar Diagnosa Penyakit Kuda Laut. *JURTEKSI (Jurnal Teknologi Dan Sistem Informasi)*, *VII*(1), 1–8.

Hariyanto, R., & Sa'diyah, K. (2018). Sistem Pakar Diagnosis Penyakit dan Hama Pada Tanaman Tebu Menggunakan Metode Certainty Factor. *(JOINTECS) Journal of Information Technology and Computer Science*, *3*(1), 1–4. https://doi.org/10.31328/jo

Liana, H., & Lubis, C. (2018). Sistem Pakar Diagnosis Kerusakan Komputer Dan Internet Dengan Certainty Factor Berbasis Web. *Jurnal Ilmu Komputer Dan Sistem Informasi*, *6*(2), 92–94.

Prebiana, K. D., & Astuti, L. G. (2020). Penerapan Metode Certainty Factor (CF) Dalam Pembuatan Sistem Pakar Diagnosis Penyakit Tumor Otak. *Jurnal Elektronik Ilmu Komputer Udayana*, *8*(3), 315–324.

Riadi, A. (2017). Penerapan Metode Certainty Factor Untuk Sistem Pakar Diagnosa Penyakit Diabetes Melitus Pada RSUD Numi Panua Kabupaten Pohuwato. *ILKOM Jurnal Ilmiah*, *9*(3), 309–316.

Sayogo, M. H. (2016). Penerapan Model Problem Based Learning Dalam Proses Pembelajaran Standar Kompetensi Mengukur Dengan Alat Ukur Mekanik Presisi Di Kelas X Smk Negeri Kudu Jombang. *Jurnal Pendidikan Teknik Mesin UNESA*, *5*(02), 84–90.

Setyaputri, K. E., Fadlil, A., & Sunardi, S. (2018). Analisis Metode Certainty Factor pada Sistem Pakar Diagnosa Penyakit THT. *Jurnal Teknik Elektro*, *10*(1), 30–35. https://doi.org/10.15294/jte.v10i1.14031

Sucipto, A., Fernando, Y., Borman, R. I., & Mahmuda, N. (2019). Penerapan Metode Certainty Factor Pada Diagnosa Penyakit Saraf Tulang Belakang. *Jurnal Ilmiah FIFO*, *10*(2), 18. https://doi.org/10.22441/fifo.2018.v10i2.002

Sulistiani, H., & Muludi, K. (2018). Penerapan Metode Certainty Factor Dalam Mendeteksi Penyakit Tanaman Karet. *Jurnal Pendidikan Teknologi Dan Kejuruan*, *15*(1), 51–59. https://doi.org/10.23887/jptk-undiksha.v15i1.13021