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Expert System for Diagnosing Brain Tumors Using the Certainty Factor (CF) Method

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a r t i c l e i n f o

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a b s t r a c t

The development of computer technology helps many aspects of life. One aspect of life that takes advantage of technological developments is the health sector, in order to solve problems including brain tumors. Brain Tumor Disease is the growth of abnormal cells in or around the brain in an unnatural and uncontrolled manner. Patients with brain tumors continue to increase every year, because the initial symptoms are often underestimated. Therefore created a software that can help diagnose brain tumors using the certainty factor method.

a b s t r a k

Perkembangan teknologi komputer membantu banyak aspek kehidupan. Salah satu aspek kehidupan yang memanfaatkan perkembangan teknologi adalah bidang kesehatan, guna mengatasi berbagai masalah termasuk tumor otak. Penyakit Tumor Otak adalah pertumbuhan sel-sel abnormal di dalam atau sekitar otak secara tidak wajar dan tidak terkendali. Penderita tumor otak terus bertambah setiap tahunnya, karena gejala awalnya sering kali dianggap remeh. Oleh karena itu dibuatlah sebuah perangkat lunak yang dapat membantu mendiagnosis tumor otak dengan menggunakan metode Certainty Factor.

ACM Computing Classification System (CCS)
EBSCOhost
Communication and Mass Media Complete (CMMC)

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1. Introduction

Health is a fundamental aspect of human life, as it enables individuals to pursue their goals and engage in various activities. To maintain health, it is essential to adopt a balanced and disciplined lifestyle, minimizing the risk of illness. Neglecting a healthy lifestyle, however, can make individuals more vulnerable to diseases and infections. Despite the awareness of disease symptoms, many individuals tend to disregard them for various reasons, such as fear of confronting the potential diagnosis. This fear, however, may exacerbate the condition due to delayed intervention by medical professionals. One such condition that is often overlooked is brain tumors, as their symptoms closely resemble those of other common ailments. These symptoms include headaches, nausea, vomiting, memory disturbances, seizures, and tingling sensations, among others. A brain tumor is characterized by the abnormal growth of cells in or around the brain, and these cells proliferate in an uncontrolled manner. Several factors, including exposure to radiation, age, genetic predisposition, and hereditary conditions, contribute to an increased risk of developing brain tumors. Artificial Intelligence (AI) refers to the simulation of human intelligence within machines, allowing them to perform tasks that typically require human cognitive abilities. AI systems can adapt and improve over time by learning from data, making them increasingly effective in various fields, including healthcare.

Expert systems, a subset of AI, are designed to replicate the decision-making abilities of human specialists. These systems are employed in problem-solving tasks such as diagnosis and prediction. In medical applications, AI and expert systems can assist in diagnosing diseases by analyzing symptoms and available data. The Certainty Factor (CF) method is commonly used in situations where expert opinions involve uncertainty, such as when an expert expresses their judgment with terms like "likely" or "almost certain." This method quantifies the level of confidence in a diagnosis or conclusion, providing a clearer understanding of the certainty surrounding a hypothesis. The Certainty Factor is calculated using the formula: CF[h,e] = MB[h,e] – MD[h,e], where MB represents the expert's confidence in the hypothesis based on evidence, and MD reflects the level of disbelief or uncertainty. Brain tumors, characterized by the abnormal growth of tissue in or around the brain, can present a range of symptoms including headaches, nausea, memory problems, seizures, and vision disturbances. These symptoms, which often overlap with those of other conditions, make early detection challenging. Tumors can be either benign or malignant, with malignant tumors (cancer) being more dangerous. Early identification of brain tumor symptoms is essential for prompt intervention and effective treatment.

2. Research Methodology

The methods used in this study include system requirements analysis, system needs, certainty factor method. In the early stages, the initial symptoms of tumor disease are determined along with the determined expert values.

Table 1. Symptoms and expert scores

No	Code	Symptom	Mark Expert
1	G1	Gradual headache become more frequent and more severe	0.6
2	G2	Nausea and vomiting without cause	0.2
3	G3	Memory disorders	0.6
4	G4	Seizures	0.4
5	G5	Tingling and numbness in arms or legs	0.4
6	G6	Visual disturbances such as blurred vision	0.2
7	G7	Related issues with the sense of hearing	0.2
8	G8	Balance disorders, difficulty moving	0.8

Table 2. Confidence weighting

No	Information	Weight Belief
1	Not sure	0
2	Don't know	0.2
3	A little bit sure	0.4
4	Pretty sure	0.6
5	Certain	0.8
6	Very sure	1

Table 3. Percentage of conclusions

Level presentation	Probability value
0-50%	Little Chance or Small Chance
51-79%	Possibility
80-99%	Most likely
100%	Very Sure

Table 4. Example of calculation

Symptom	Answer	Weight
Headaches gradually become more frequent and more severe	Certain	0.8
Nausea and vomiting without cause	A Little Bit Sure	0.4
Memory disorders	Pretty Sure	0.6
Seizures	A Little Bit Sure	0.4
Tingling and numbness in the arms or legs	A Little Bit Sure	0.4
Vision disorders such as vision blurry	Pretty Sure	0.6
Problems related to the senses hearing	Don't know	0.2
Balance disorders, difficulty when move	Very Sure	1

The basic formula for CF is as follows:
CF[H,E]=MB[H,E]-MD[H,E]
CF[H,E]1=CF[H]*CF[E]
CFcombine CF[H,E] 1,2 + CF[H,E] 2* [1-CF[H,E]1]
CFcombine CF[H,E] old,3 = CF[H,E] old + CF[H,E] 3 * [1-CF[H,E] old]
From the known formula and weights, we can calculate the CF value as follows: CF[H,E] 1 = CF[H] 1 * CF[E] 1
=0.6 * 0.8
=0.48
CF[H,E] 2 = CF[H] 2 * CF[E] 2
=0.2 * 0.4
=0.08
CF[H,E]3 = CF[H] 3 * CF[E] 3
= 0.6 * 0.6
= 0.36
CF[H,E] 4 = CF[H] 4 * CF[E] 4
= 0.4 * 0.4
= 0.64
CF[H,E] 5 = CF[H] 5 * CF[E] 5
= 0.4 * 0.4
= 0.16
CF[H,E] 6 = CF[H] 6 * CF[E] 6
= 0.2 * 0.6
= 0.12
CF[H,E] 7 = CF[H] 7 * CF[E] 7
= 0.2 * 0.2
= 0.04
CF[H,E] 8 = CF[H] 8 * CF[E] 8
= 0.8 * 1
= 0.8
Then combine the CF values
CFcombine CF[H,E] 1,2 = CF[H,E] 1 + CF[H,E] 2 * (1- CF[H,E] 1)
= 0.48 + 0.08 * (1-0.48)
= 0.48 + 0.0416
=0.5216
CFcombine CF[H,E] old,3 = CF[H,E] old + CF[H,E] 3 * (1- CF[H,E] old)
=0.5216+ 0.36 * (1 – 0.5216)
=0.5216 + 0.172224
= 0.693824 old 2
CFcombine CF[H,E] old2,4 = CF[H,E] old + CF[H,E] 4 * (1- CF[H,E] old2)
= 0.693824 + 0.64 * (1 – 0.693824)
=0.693824 + 0.1959526
= 0.8897766 old 3
CFcombine CF[H,E] old3,5 = CF[H,E] old + CF[H,E] 5 * (1- CF[H,E] old3)
= 0.8897766 + 0.16 * (1 – 0.8897766)
=0.8897766 +
= 0.9074123 old 4

CFcombine CF[H,E] old4,6 = CF[H,E] old + CF[H,E] 6 * (1- CF[H,E] old4)
= 0.9074123 + 0.12 * (1 – 0.9074123)
=0.9074123 + 0.0111105
= 0.9185228 old 5
CFcombine CF[H,E] old5,7 = CF[H,E] old + CF[H,E] 7 * (1- CF[H,E] old5)
= 0.9185228 + 0.04 * (1 – 0.9185228)
= 0.9185228 +
= 0.9217819 old 6
CFcombine CF[H,E] old6,8 = CF[H,E] old + CF[H,E] 8 * (1- CF[H,E] old6)
= 0.9217819 + 0.8 * (1 – 0.9217819)
=0.9217819 + 0.0625745
= 0.9843564 old 7
CF[H,E] old7 * 100 = 0.9843564 * 100
= 98.43564%

So that the calculation results are obtained using a certainty factor with a confidence level percentage of 98.43564%

3. Results and Discussion

Results

After the analysis and design are done, then the implementation or trial process will be carried out, so that the results obtained can be maximized. This brain tumor diagnosis website is built using HTML and CSS, and uses the JavaScript programming language. The form displays questions that must be answered by the user as in Figure 1.

Figure 1. Question page

After the user answers all the questions, the system will process the data using the Certainty factor that has been implemented. An example of the diagnosis results will be displayed to the user as in Figure 2.

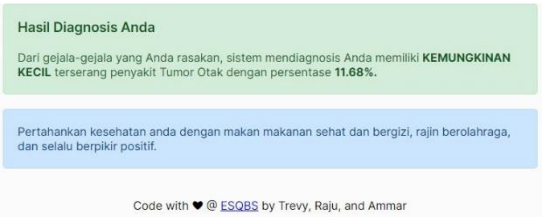

Figure 2. Diagnosis results page

Discussion

This research developed an expert system for diagnosing brain tumors using the Certainty Factor (CF) method. The system aims to assist in the early diagnosis of brain tumors by calculating the confidence level based on symptoms provided by the user. By utilizing the CF method, the system is able to handle the uncertainty often encountered in medical diagnoses, as explained by Dicky Nofriansyah and Puji Sari Ramadhan (2016) in their study on an expert system application for detecting snake venom types and species in patients infected with snake venom. They demonstrated that CF could represent the expert's confidence level in the diagnosis, which is highly relevant in medical contexts where uncertainty is common (Nofriansyah & Ramadhan, 2016). This system operates similarly to the way doctors provide diagnoses—not necessarily with certainty, but with a certain level of probability or confidence. The Certainty Factor method allows the system to calculate and present a confidence value in the form of a percentage, indicating the likelihood that the symptoms provided relate to a brain tumor.

Based on user input, the system generated a CF value of 98.44%, which indicates a high level of confidence in the diagnosis. This aligns with the work of Indriani *et al.* (2018), who applied the CF method in an expert system for diagnosing diseases in children. Their study showed that CF can be effectively used to improve the accuracy of disease diagnoses (Indriani *et al.*, 2018). Additionally, this research is consistent with the application of artificial intelligence in healthcare, as discussed by Kusumadewi (2003), who highlighted that AI, including expert systems, is valuable in analyzing and detecting diseases based on available data patterns. The expert system developed in this study uses web-based technology, making it easy for users to interact with the system. By answering a series of questions related to symptoms, users can obtain a preliminary diagnosis, which is processed using the

CF algorithm. The test results demonstrate that the system provides convenience for users to perform an initial check before consulting with qualified medical professionals. However, despite the high accuracy of the system (98.44%), it is important to note that this system does not replace medical examinations by doctors. As discussed by Rohmawati (2017), while technology can provide good classification for disease diagnoses, the final decision should always rest with medical professionals who have specialized expertise. In this case, the system serves more as an assistive tool that can guide users to seek further medical attention, especially in terms of early tumor detection. Moreover, the system can be further developed by improving the user interface for a more user-friendly experience and adding more specific questions about brain tumors, which can enhance the accuracy of the diagnosis.

Considering the complexity of brain tumor diseases, the system could be enriched by adding more symptoms or risk factors, as well as expanding the range of diseases that can be diagnosed, in line with Kusumadewi's (2003) recommendation for ongoing development of AI applications to remain relevant to the evolving medical needs. Overall, the development of this expert system with the Certainty Factor method shows great potential in assisting the early detection of brain tumors. This system not only provides benefits to individuals in need of preliminary checks but also serves as an educational tool to raise public awareness of the importance of early detection for life-threatening conditions such as brain tumors. In future developments, this technology could be extended to cover a wider variety of diseases with similar symptoms, further improving the accuracy of the system by integrating more advanced AI techniques.

4. Conclusion

From the results of the software design, it can be concluded that the expert system for diagnosing brain tumors is able to provide information to users about temporary diagnoses based on the symptoms they have. This software can also help educate users about brain tumors. And utilizes the artificial intelligence learning method, namely the certainty factor. For further development of the expert system website for diagnosing brain tumors to provide benefits to users, there are several things that can be done, namely improving the appearance of the website to make it more attractive, adding more specific questions related to brain tumors so that the results obtained are more optimal.

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