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Development of an expert system for the diagnosis of eye refractive disorders using a web-based certainty factor method case study: Optik Bringin Jogja

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ABSTRACT

Refractive eye disorders—including myopia, hyperopia, astigmatism, and presbyopia—are a vision health problem whose prevalence continues to increase in Indonesia. However, public access to adequate examination facilities remains very limited. Frequent overlap in symptoms between one disorder and another complicates independent identification without expert assistance. This study aims to develop a web-based expert system that assists the public in conducting initial screening for refractive eye disorders using the Certainty Factor (CF) method, based on knowledge obtained through interviews with certified optical refractologists at Optik Bringin Jogja. The system was built using the PHP programming language with the Laravel framework and MySQL as the database management system, and can be accessed through a browser without additional installation. The CF method is applied to gradually calculate a diagnostic confidence value based on a combination of expert and user CF values for reported symptoms. Functional testing using the black-box method shows that all system features function as expected. Accuracy testing was conducted on 50 patient records from Optik Bringin Jogja, resulting in an accuracy rate of 92%, with 46 of 50 cases matching the system's diagnosis to the optical refractionist's diagnosis. The results of the study show that the Certainty Factor method is effective when applied to refractive disorders with overlapping symptoms, making it suitable as an initial screening tool before patients receive further treatment from experts.

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1. INTRODUCTION

The eye is a vital organ that supports almost all daily human activities, from reading, studying, working, to driving. When visual function is impaired, a person's productivity and quality of life can decrease significantly(Hersya & Suhail, 2026). One of the most common visual impairments in society is refractive error, a condition in which the eye's optical system is unable to focus light properly on the retina, so the image received by the brain is not sharp (Ariasih, n.d.). Refractive errors include four main types, namely myopia (nearsightedness), hyperopia (farsightedness), astigmatism (cylindrical), and presbyopia, which generally appear with age. Globally, the results of a meta-analysis of 243 studies from 73 countries showed that in 2020, as many as 157 million people experienced moderate to severe visual impairment due to uncorrected refractive errors, an increase of 72 percent compared to 2000, and refractive errors are the leading cause of preventable visual impairment globally(Putra et al., 2019). In Indonesia, this condition is no less worrying. A screening study in Samarinda City found that of 336 school-age children examined, 325 (96.7%) were identified as having refractive errors, with the 14-17 age group most affected. Another study in Jakarta post-pandemic also reported a prevalence of refractive errors in elementary school children of 40 percent, with myopia being the most prevalent type, followed by hyperopia and astigmatism (Sembiring et al., 2024).

The high rate of refractive errors in Indonesia is not matched by adequate treatment. Post-pandemic research in Jakarta showed that although the prevalence of refractive errors among elementary school children reached 40 percent, the rate of successful correction was only 4 percent (Agus et al., 2017). This significant gap is caused by limited eye examination facilities across various regions, the unaffordable cost of specialist consultations for some communities, and low awareness of the importance of regular refractive examinations. (Girsang & Fahmi, 2019) also emphasized that refractive error screening in schools remains very limited due to teachers' limited role and knowledge as the front line of detection, so that many sufferers only become aware of their condition when the visual impairment is already quite severe. This condition indicates the need for early-detection instruments that are easily accessible to the wider community, without relying on experts' availability.

The process of identifying refractive errors is highly uncertain because symptoms are subjective and often overlap across error types. A person with myopia and someone with astigmatism, for example, can complain of almost identical symptoms such as blurred vision and difficulty seeing objects at a certain distance(Permana et al., 2018). Research at Rex Mundi High School in Manado found that of the 225 subjects examined, 49 children had refractive errors, with astigmatism being the most common, often not recognized by sufferers because its symptoms are similar to those of myopia. Research in West Jakarta also reported that of the 601 students examined, 309 (51.4%) had refractive errors, and most cases were not detected before the examination. This condition makes it difficult for the public to perform independent identification without a system that can process uncertainty in a structured manner, so many sufferers do not immediately seek help because they do not recognize the type of error they are experiencing (Wahyudi et al., 2019).

Refraction examination services in Indonesia, including at Optik Bringin Jogja, which is handled by certified optical refractologists in accordance with the Minister of Health Regulation Number 1 of 2016, still depend entirely on the patient's physical presence. Optical refractologists are health workers officially authorized to perform eye refraction examinations. Still, their professional knowledge and experience have not yet been captured in a publicly accessible digital system (Bimantoro, 2017). The examination process, which can only be conducted face-to-face, creates real obstacles for people with time, distance, or mobility limitations. Previous studies on eye disease expert systems also show that no system specifically builds its knowledge base from certified optical refractologists, and no one focuses exclusively on the four types of refractive disorders, namely myopia, hyperopia, astigmatism, and presbyopia, in one integrated system that can be accessed independently by the public on a web-based basis.

The development of artificial intelligence, particularly in the field of expert systems, opens up opportunities to address the three problems above in an integrated manner. An expert system is software designed to replicate an expert's decision-making capabilities in a specific domain, based on a structured knowledge base. (Ambrus et al., n.d.)built a web-based expert system for the initial diagnosis of eye disease using the

Forward Chaining and Certainty Factor methods, and obtained a diagnosis matching result of 100 percent agreement with the expert's decision. proved that an expert system using the Certainty Factor method is capable of producing a measurable diagnosis of eye disease with transparent confidence values for users. also demonstrated the effectiveness of the expert system approach for diagnosing eye disease, even though it used the Fuzzy Mamdani method (Naiborhu et al., 2025). The Certainty Factor method was chosen in this study because of its ability to handle the uncertainty inherent in the process of diagnosing refractive errors — namely by assigning a confidence value to each symptom based on expert assessment, then gradually combining these values to produce a percentage of confidence in a diagnosis(Putra et al., 2021).

Based on a review of previous studies, some gaps remain unfilled. First, there is no expert system that specifically and exclusively handles all four types of refractive eye disorders simultaneously within a single integrated system. Second, none of the previously developed eye disease expert systems build their knowledge bases from certified optical refractionists as expert sources, even though optical refractionists are the health professionals with the legal authority to conduct refraction examinations. Third, there is no web-based system that can be accessed independently by the public to conduct initial screening for refractive disorders without requiring physical presence at an optical facility (Adam et al., 2021). Therefore, this study developed a web-based expert system for the early identification of refractive eye disorders, including myopia, hyperopia, astigmatism, and presbyopia, using the Certainty Factor method, with a knowledge base built directly from in-depth interviews with optical refractionists at Optik Bringin Jogja. Optik Bringin Jogja was chosen because it is an active optical practice, handled by certified optical refractionists with clinical experience that can be professionally documented. The main contribution of this research is the integration of verified local expert knowledge into a digital system that can be accessed independently, thereby serving as a bridge between the need for early screening of refractive disorders and the community's limited access to experts (Yuwono et al., 2017).

The development of artificial intelligence, particularly expert systems, offers opportunities to support the early identification of refractive eye disorders. Previous studies have demonstrated the effectiveness of expert systems for diagnosing eye diseases using methods such as Forward Chaining, Certainty Factor, and Fuzzy Mamdani. However, several gaps remain. Most existing systems focus on general eye diseases rather than specifically addressing refractive disorders. In addition, no previous study has developed an integrated expert system that covers all four major refractive errors—myopia, hyperopia, astigmatism, and presbyopia—simultaneously. Existing systems also do not utilize knowledge obtained directly from certified optical refractologists, despite their legal authority and expertise in conducting refraction examinations. Furthermore, there is still a lack of web-based systems that enable the public to perform independent preliminary screening for refractive disorders. Therefore, this study develops a web-based expert system for the early identification of refractive eye disorders using the Certainty Factor method, with a knowledge base derived from certified optical refractologists at Optik Bringin Jogja. The system aims to provide an accessible screening tool while integrating expert knowledge into a digital platform.

2. RESEARCH METHOD

2.1 Research Materials

The materials used in this study consisted of two types: data on refractive error symptoms along with expert confidence values, and patient diary data. All of these materials were obtained directly from Optik Bringin Jogja through interviews with optical refractologists and through review of patient diary records. The four types of refractive errors studied were identified, each with distinct symptom characteristics, although they may appear similar in some areas(Sari et al., 2022).

2.2 Symptom Data

The symptoms used in this system were obtained from direct interviews with optical refractionists at Optik Bringin Jogja. During the interviews, the optical refractionists listed common symptoms associated with refractive disorders, including myopia, hyperopia, astigmatism, and presbyopia. These symptoms were then represented in a matrix of the relationship between symptoms and refractive disorders to demonstrate the association of each symptom with a specific disease (Wart & Lubis, 2025).

2.3 Patient Data

Patient data were obtained from patient records at Optik Bringin Jogja and served as test material to evaluate the accuracy of the system's diagnoses (Rosya, 2015). Each data entry included the patient's name, gender, age, symptoms, and the examination results or final diagnosis determined by the optical refractologist. The total dataset for 50 patients reflects the variety of ages and types of refractive errors encountered in real-world practice (Priyambadha & Eviyanti, 2024).

2.4 Research Tools

Several hardware and software tools supported the system development and testing process in this study. These tools were selected based on the technical requirements for developing a web-based expert system using PHP, Laravel, and MySQL.

2.5 Research Path

This study uses the Turban Model framework as a guide for expert system development. The Turban Model consists of four main stages: intelligence, design, implementation, and selection. Each stage produces output that becomes input to the next stage until the expert system is completed and tested (Bagaskara et al., 2024).

2.6 Intelligence Stage

The intelligence stage is the initial stage in the Turban Model, which aims to identify problems and gather all the information needed to build the system. In this research, data and knowledge were collected in three ways. A literature review was conducted by reviewing scientific journals discussing the clinical symptoms of myopia, hyperopia, astigmatism, and presbyopia. The results of the literature review were used as an initial reference in compiling a list of symptoms, which was later validated by experts (Namirha, 2021).

2.7 Design Stage

The design phase is the detailed system design phase based on the results of the intelligence phase. This phase involves developing a knowledge base and designing the system to be implemented. The expert CF value is determined based on direct interviews with optical refractionists at Optik Bringin Jogja.

a. Research Data

The research data used to test the system's accuracy are patient records from Optik Bringin Jogja, as listed in Table 3.3. The data comprises 50 patients and includes reported symptoms and the final diagnosis determined by the optical refractologist.

System Flowchart. A system flowchart is used to describe the system workflow from the user entering symptoms to the system generating a diagnosis using the Certainty Factor method (Permana et al., 2018).

2.8 Implementation Stage

The implementation phase is the process of applying the system design results to a usable application. This phase involves building a web-based expert system for early identification of refractive errors using the PHP programming language, the Laravel framework, and MySQL as a database, based on the theoretical foundation outlined in Chapter 2.

At this stage, the Certainty Factor method is also implemented in the system, enabling it to process user-entered symptom data and produce a diagnostic confidence value, expressed as a percentage, that is easy for the general public to understand. The final result of this implementation stage is a web-based expert system that can be run to carry out the initial identification of refractive eye disorders, including myopia, hypermetropia, astigmatism, and presbyopia (Setyaputri et al., 2018).

2.9 Election stage

The selection stage is where the Certainty Factor method is applied to process the user's symptom input into a diagnostic decision. At this stage, the system calculates confidence values in parallel for all four refractive disorders at once, namely myopia, hyperopia, astigmatism, and presbyopia, based on the symptoms selected by the user. For each selected symptom, its combined CF value is calculated for each disease, then gradually combined to produce a final CF value per disease. The diagnosis displayed to the user is the disorder with the highest final CF value among the four disorders calculated, so the system always produces a single primary diagnosis recommendation along with its confidence value as a percentage (Rachman, 2020).

The Certainty Factor (CF) value represents the system's confidence level in a diagnosis, whereas diagnostic accuracy reflects the degree of agreement between the system's diagnosis and the expert's diagnosis; therefore, a high CF value indicates stronger diagnostic confidence but does not necessarily imply higher accuracy without validation against expert assessments.

3. RESULTS AND DISCUSSIONS

These findings suggest that AI-based medical expert systems can improve access to early health screening by integrating expert knowledge into digital platforms. The study also highlights the importance of uncertainty-handling methods, such as Certainty Factor, for producing transparent and interpretable diagnostic recommendations. Furthermore, the results support the role of AI as a decision-support tool that complements, rather than replaces, healthcare professionals.The result of this research is a web-based expert system that can aid in the early diagnosis of four eye disorders: myopia, astigmatism, hyperopia, and presbyopia. The system was built using the PHP programming language, the Laravel framework, and MySQL as the database. The system is designed to provide diagnostic results based on user-selected symptoms using the Certainty Factor method. The following is a screenshot of the successfully developed system interface(Wijaya & Tanjung, 2020).

3.1 Front – End View (User Interface)

a. Home Page / Login

This page is the system login. Users enter their email address and password to access the diagnostic features.

b. User Dashboard

After logging in, users are directed to a dashboard page that displays a summary of system information and a navigation menu to available features.

c. Diagnosis Form

This page displays a list of symptoms for the user to select. Each selected symptom is accompanied by a CF value, indicating the user's level of confidence in the symptom, on a scale of 0.2 to 1.0.

d. Diagnostic Results

After the user presses the process button, the system displays the diagnosed disease name, the final CF percentage, the confidence category, a brief disease description, and follow-up suggestions.

e. Disease Page

This page displays information about the four eye disorders covered by the system: myopia, astigmatism, hyperopia, and presbyopia. Each disorder is accompanied by common symptoms and a brief explanation to help users understand the conditions they may be experiencing.

f. History Page

This page displays a list of diagnostic results performed by the logged-in user, complete with the examination date, selected symptoms, and the diagnostic results and their CF values.

3.2 Administrator Panel View

a. Admin Dashboard

The administrator's main page displays a summary of system data, including the number of registered users, the number of diagnoses performed, and statistics on the most frequently detected diseases.

b. Manage Disease

This page allows administrators to add, change, and delete disease data along with descriptions and treatment suggestions.

c. Manage Symptoms

Administrators can manage all symptom data used in the system, including adding new symptoms or changing the names of existing symptoms.

d. Manage CF

This page allows the administrator to update the expert's CF value for each symptom-disease pair. Updating the CF value is done without modifying the program code; it is done through this interface.

e. History Report

Administrators can view the complete diagnosis history for all registered users, including details of each user's symptoms and diagnosis results.

3.3 Certainty Factor Calculation

The goal is to verify that the system's inference engine produces correct output and is consistent with the optical refractionist's judgment.

3.4 Discussion

Based on the analysis carried out in the previous sub-chapter, several important findings warrant thorough discussion, including system accuracy, characteristics of CF values by disease, handling of overlapping symptoms, and the effectiveness of the Certainty Factor method as a whole. Performance per Disease Type(Oktaviansyah et al., 2022)

a. System Accuracy

Testing data from 50 patients at Bringin Optik showed that the expert system generated diagnoses consistent with the analysis of optical refractionists in the majority of cases, achieving an accuracy rate of 92%. A summary of the accuracy rates per disease type is shown in the following table.

Table 1. Summary of Accuracy per Disease

No	Disease	Number of Cases Tested	Correct Diagnosis	Accuracy	CF Range
1	Myopia	14	13	92.9%	80% – 100%
2	Astigmatism	13	11	84.6%	80% – 100%
3	Hypermetropia	12	11	91.7%	80% – 96%
4	Presbyopia	11	11	100%	80% – 100%
	Total	50	46	92%	80% – 100%

b. Analysis of CF Values per Disease

Myopia consistently produces relatively high CF values, ranging from approximately 80% to 100%. This is because the main symptoms of myopia in the knowledge base—such as blurred distance vision (CF = 1), frequently focusing on objects (CF = 1), and difficulty seeing at night (CF = 0.8)—have high expert CF values and are quite specific, so the likelihood of overlap with other conditions is relatively small.

Astigmatism also produces high CF values, ranging from 80% to 100%, but has a greater potential for ambiguity. This is because some symptoms, such as headaches, eye fatigue, and light sensitivity, also occur in other conditions such as hyperopia. However, the presence of typical symptoms, such as shadowing/double text and crooked lines, helps the system increase the confidence level of the diagnosis.

Hyperopia produces a more variable range of CF values, ranging from 80% to 96%. This variation reflects differences in the number and combination of symptoms reported by patients. Symptoms such as headaches when reading, rapid eye fatigue, and blurred vision when viewing up close are also common in presbyopia, leading to close CF values in some cases.

Meanwhile, presbyopia produces relatively stable, high CF values, ranging from 80% to 100%. This is due to fairly typical symptoms, such as having to move objects farther away when reading, eye fatigue when viewing up close, and difficulty focusing at different distances. Furthermore, age is also an important factor that helps the system strengthen the diagnosis, so the accuracy rate for this condition tends to be higher than for other conditions.

c. Overlapping Symptom Analysis

Some symptoms, such as headaches when reading/focusing (G04), eye fatigue or strain (G05), and blurred vision when viewing near (G02), occur in more than one disorder in the knowledge base, such as hyperopia, astigmatism, and presbyopia, with varying expert CF values. The Certainty Factor method addresses this by weighting the relationship between each symptom and disorder. More typical symptoms, such as blurred vision at a distance (G01) in myopia and straight lines appearing crooked (G09) in astigmatism, are assigned higher CF values so the system can still determine the most appropriate diagnosis. However, in some cases, discrepancies persist due to overlapping symptoms between disorders, so the CF values across diagnoses can be close, affecting overall system accuracy.

d. Effectiveness of Certainty Factor Method

The test results demonstrate that the Certainty Factor method is effective when applied to an expert system for diagnosing eye disorders. This method has two main strengths in the research context. First, the ability to gradually combine confidence values across multiple symptoms enables the system to produce fairly accurate diagnostic decisions even when the number and types of symptoms reported vary between patients. Second, the involvement of an optical refractionist as a source of expert CF values is a key factor in ensuring the system's knowledge base reflects assessments consistent with field practice.

e. Work System Summary

Table 2. Summary of Work System

No	Stage	Process	Results
1	System Development	Development of front-end (homepage, diagnosis form, results, history) and back-end (manage disease, symptoms, CF, reports) interfaces	Web-based expert system ready to use
2	CF Inference	User symptom input → combined CF (expert CF × user CF) → stepwise combination → final CF	Diagnosis of eye disorders + percentage of confidence
3	Functional Testing	Black-box testing on system features	All features work as expected
4	Accuracy Testing	Comparison of system diagnosis with the results of optical refraction expert analysis on 50 patient data	Accuracy 92% (46/50 cases matched)
5	Evaluation	Analysis of CF per disease, overlapping symptoms, and effectiveness of the method	High CF in specific symptoms (Myopia & Astigmatism); Variable CF in overlapping symptoms (Hyperopia & Presbyopia)

f. Limitations and Development Plans

Although the test results showed 92% accuracy from 50 available patient data sets, it should be emphasized that some data discrepancies still occurred. These discrepancies generally occur in cases with overlapping symptoms between eye disorders, such as hyperopia and presbyopia or myopia and astigmatism. More representative accuracy results can be achieved by increasing the number of test data sets and a wider variety of cases. In the future, the system can be developed by expanding its scope to include more eye disorders, periodically updating expert CF values based on input from optical refractionists, and integrating online consultation features to optimize the system's reach and benefits (Aldisa, 2023).

4. CONCLUSION

Future research could explore hybrid approaches that combine Certainty Factor with machine learning, fuzzy logic, Bayesian inference, or deep learning methods. Such integrations may improve diagnostic accuracy, enable automatic knowledge acquisition from data, and provide more robust handling of uncertainty while maintaining the interpretability of expert system recommendations.

First, a web-based expert system for the early diagnosis of eye disorders, namely myopia, astigmatism, hyperopia, and presbyopia, was successfully designed and built using PHP with the Laravel framework, MySQL as a database, and a browser-accessible interface without additional installation. The system is equipped with an interactive diagnostic feature for general users, as well as an administration panel that enables flexible updates to the knowledge base without changing the program code. All developed features were declared to work well based on black-box testing results, which showed that the outputs were as expected.

Second, the Certainty Factor method was successfully implemented in the system to address the uncertainty inherent in diagnosing eye disorders. This uncertainty arises because some symptoms, such as headaches when reading, eye fatigue, and blurred vision, can occur in multiple disorders. The CF method addresses this by assigning different confidence values to each symptom-disorder relationship and then gradually combining them using the CF combination formula. As a result, the system can generate diagnoses with understandable confidence percentages. Third, based on the accuracy testing of 50 patient data sets at Bringin Optik, the system achieved 92% accuracy, with 46 of the 50 cases matching the system's diagnosis to the optician's refraction expert's analysis. The four cases that did not match were cases with overlapping symptoms between eye disorders, such as hyperopia and presbyopia or myopia and astigmatism, resulting in a different but still close diagnosis. This accuracy rate indicates that the system is suitable for use as an initial screening tool. However, it is not intended to replace the experts' role in determining the final diagnosis.

Overall, this study demonstrates that the Certainty Factor method is an appropriate approach for expert systems in the domain of eye disorders with overlapping symptoms. The direct involvement of optical refraction experts as sources of expert CF values is a crucial factor in determining the quality and reliability of the resulting system. This research opens several avenues for further development that subsequent researchers and Bringin Optik, as a potential user of the system, can pursue. First, the scope of disorders within the knowledge base needs to be expanded. Currently, the system only covers four eye disorders: myopia, astigmatism, hyperopia, and presbyopia. Other disorders, such as cataracts and retinal disorders, also require early detection. This expansion of coverage requires a knowledge acquisition process involving experts. Second, expert CF values should be reviewed and updated periodically. Knowledge and practice in eye health evolve, so updating symptom confidence values for specific disorders is necessary to maintain system relevance. The existing update mechanism within the administration panel can be utilized for this purpose. Third, the amount of test data can be increased to obtain more representative evaluation results. Testing with a larger data set and a broader range of cases will provide a more robust picture of the system's accuracy. Fourth, further research can combine the Certainty Factor method with other approaches, such as Fuzzy Logic or probabilistic-based methods, to improve the system's ability to handle cases with ambiguous symptoms. Fifth, the system can be further developed by adding an online consultation feature that allows users to interact directly with experts, so that it functions not only as a self-screening tool but also as a support for broader health services.

REFERENCES

Adam, A. F., Fitri, I., & Nathasia, N. D. (2021). *Analisis Perbandingan Tiga Metode Untuk Mendiagnosa Penyakit Mata Pada Manusia. 8*(4).

Agus, F., Wulandari, H. E., & Astuti, I. F. (2017). *Expert System With Certainty Factor For Early Diagnosis Of Red Chili Peppers Diseases. 2*(2), 52–66.

Aldisa, R. (2023). Penerapan Metode Certainty Factor Dalam Mendiagnosa Penyakit PES. *Journal of*

Computer System and Informatics (JoSYC), *4*, 436–442. https://doi.org/10.47065/josyc.v4i2.3139

Ambrus, A., Lum, F. C., & Garratt, S. (n.d.). *Refractive Errors Preferred Practice Pattern ®*. https://doi.org/10.1016/j.ophtha.2022.10.031

Ariasih, N. K. (n.d.). *Perancangan sistem pakar untuk mendiagnosa penyakit mata merah visus turun dengan metode certainty factor*. 264–267.

Bagaskara, M., Hartanti, D., & Atina, V. (2024). Sistem Pakar Diagnosa Penyakit Mata Dengan Metode Certainty Factor. *JURNAL FASILKOM*, *14*, 484–490. https://doi.org/10.37859/jf.v14i2.7251

Bimantoro, F. (2017). *Sistem Pakar Diagnosa Penyakit Mata Menggunakan Metode Certainty Factor Berbasis Android*. *1*(1), 1–10.

Girsang, R. R., & Fahmi, H. (2019). *Sistem Pakar Mendiagnosa Penyakit Mata Katarak Dengan Metode Certainty Factor Berbasis Web*. *11*(1), 27–31.

Hersya, W., & Suhail, M. A. (2026). *Diagnosa Gangguan Mata pada Manusia Berbasis Web Menggunakan Metode Fuzzy Expert System*.

Informasi, J., Putra, B. P., & Yunus, Y. (2021). *Sistem Pakar dalam Mendiagnosis Penyakit Mata dengan Menggunakan Metode Forward Chaining*. *3*, 128–133. https://doi.org/10.37034/jidt.v3i3.122

Kasus, S., & Optikal, R. (2015). *Aplikasi Diagnosis Kelainan Refraksi Mata Dan Tips Perawatan Mata Dengan Metode Forward Chaining Berbasis Web*. *7*(2), 153–164.

Naiborhu, R. A., Tama, R., Agus, A., & Mardalius, P. (2025). *Konsultasi Katarak Dengan Prosedur Certainty Factor*. 245–256. https://doi.org/10.33364/algoritma/v.22-1.2276

Namirha, A. (2021). *Aplikasi Sistem Pakar Diagnosa Penyakit Anemia Menggunakan Metode Forward Chaining*. *1*(3).

Oktaviansyah, M., Tamara, R., & Fitri, I. (2022). Sistem Pakar Untuk Mendiagnosa Penyakit Mata Menerapkan Metode Certainty Factor dan Forward Chaining. *JURNAL MEDIA INFORMATIKA BUDIDARMA*, *6*, 645. https://doi.org/10.30865/mib.v6i1.3542

Permana, Y., Wijaya, I. G. P. S., & Bimantoro, F. (2018). Sistem Pakar Diagnosa Penyakit Mata Menggunakan Metode Certainty Factor Berbasis Android. *Journal of Computer Science and Informatics Engineering (J-Cosine)*, *1*, 1. https://doi.org/10.29303/jcosine.v1i1.11

Priyambadha, A., & Eviyanti, A. (2024). Web-Based Expert System for Eye Disease Diagnosis Using Certainty Factor Method. *Academia Open*, *8*. https://doi.org/10.21070/acopen.8.2023.4554

Putra, E., Asri, Y., Prayitno, B., & Dahroni, A. (2019). *SISTEM PAKAR UNTUK MENGIDENTIFIKASI PENYAKIT MATA*. *8*(1), 17–25.

Rachman, R. (2020). SISTEM PAKAR DETEKSI PENYAKIT REFRAKSI MATA DENGAN METODE TEOREMA BAYES BERBASIS WEB. *Journal Informatika*, *7*, 68–76. https://doi.org/10.31311/ji.v7i1.7267

Sari, W. A., Lubis, A. P., & Syahputra, A. K. (2022). *Diagnosis Penyakit Saraf Manusia Dengan Metode Forward Chaining Dalam Sistem Pakar*. *9*(3), 2246–2260.

Sembiring, A. S., Winata, H., & Kustini, R. (2024). *Sistem Pakar Untuk Mendiagnosis Penyakit Mata Rabun Jauh Pada Anak Karena Penggunaan Gadget Menggunakan Metode Certainty Factor*. *3*(November), 834–842.

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

Wahyudi, A., Gama, O., Sukadana, I. W., & Prathama, G. H. (2019). *Sistem Pakar Diagnosa Awal Penyakit Mata (Penelusuran Gejala dengan Metode Backward Chaining)*. *1*(2), 71–76.

Wart, J., & Lubis, H. (2025). Sistem Pakar untuk Diagnosis Penyakit Mata dengan Certainty Factor dan Forward Chaining. *Journal of Information Systems, Informatics and Computing*, *9*, 447. https://doi.org/10.52362/jisicom.v9i2.2218

Wijaya, B., & Tanjung, J. (2020). An Expert System for Diagnosing Eye Diseases in Humans Using the Certainty Factor Method-Based Web. *SinkrOn*, *5*. https://doi.org/10.33395/sinkron.v5i1.10579

Yuwono, D. T., Fadlil, A., Informatika, M. T., Ahmad, U., & Yogyakarta, D. (2017). *PENERAPAN METODE FORWARD CHAINING DAN CERTAINTY FACTOR PADA SISTEM PAKAR*. *04*(02), 136–145.