

## **Expert System For Detection of Cataracts Disease Using The Certainty Factor Method**

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### **Abstract**

A cataract is an eye disease that causes visual impairment in the eye, the most significant cause of blindness in Indonesia. The rate of blindness in Indonesia caused by cataracts has reached 35% among the elderly 50 years and over. With the development of technology and the shortage of ophthalmologists, an expert system is needed to assist eye health experts by incorporating expert intelligence into the system in the form of fact-based data from the interview results. So that with this expert system, it is hoped that it can help society find cataracts in the eye as a form of early prevention of the chance of suffering from cataracts. The certainty factor method is used in the system to determine the certainty value of the facts that have been entered into the system to obtain a percentage level with a value of 93% so that with the help of this method, system users can find out the type of disease from each symptom.

## **1. Introduction**

The eyes are the five most important senses that humans have to see. Suppose interference with the eye can be fatal for people with eye disorders. Blindness is an eye disease that causes visual disturbances in the eyes, which have the most cases in Indonesia, especially among the elderly [1]. Cataracts come from the Greek word ("katarrhakies,") which means waterfall. In Indonesian, it is called lobular, namely vision, as if it is covered in a waterfall due to cloudy lenses [2]. Cataracts are a degenerative process in the form of cloudiness in the eyeball's lens, which causes a decrease in the ability to see, which can cause blindness [3]. Cases of blindness are often caused by cataracts, where in general, sufferers have several symptoms, such as the eye's lens that

becomes cloudy and opaque along with the vision that starts to blur periodically [4]. Apart from these symptoms, other indicators can cause cataracts, including the aging process or trauma to the eyes. The eyes are often exposed to UV radiation or gadget rays directly and excessively [5]. When the pandemic hit, the use of gadgets increased due to the need to do work or assignments online, which is one of the risks of getting cataracts from an early age apart from having hereditary or genetic cataracts.

The magnitude of the possibility that a person suffers from cataracts due to daily habits that can unknowingly harm vision, an expert system is needed to help society gain knowledge from a system that already contains the knowledge of an expert so that the expert system can act as an intermediary between experts and users in

providing solutions of the problems that expert system users are experiencing [6]. There are various types of cataracts, but the type that often affects many cases in Indonesia is senile cataracts [7]. In the expert system that the researchers built, several types of cataracts will be classified according to several symptoms experienced by users, namely senile cataracts, traumatic cataracts, nuclear cataracts, and complicated cataracts. A method is needed to obtain diagnostic results in assisting the expert system process. In this system, researchers will use the certainty factor method in building an expert system for diagnosing cataracts in the eye.

The certainty factor (CF) method is used to overcome uncertainty to obtain a decision with various conditions [8]. Using this method will assist researchers in obtaining decisions from research results in the form of types and symptoms of cataracts that the user suffers to obtain decisions in the form of types of cataracts that are being suffered. So that users can identify these symptoms, whether they have a positive chance of cataracts or not, as an early prevention measure for cataracts in the eye.

## 2. Research Methods

This research was carried out using the SDLC (Software Development Life Cycle) method with waterfall mode, consisting of stages: data collecting, analysis, design, and implementation in the flow diagram represented in Figure 1.

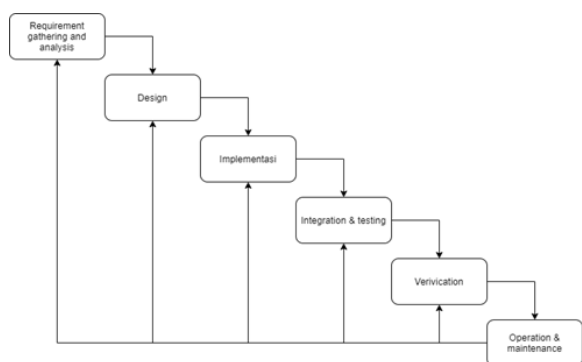


Figure 1. Flow diagram of the research method

### 2.1. Requirement Gathering and Analysis

Data collection and analysis will be done initially according to research needs [9]. This process will assist researchers in concluding research results by collecting data and providing research results in the form of variables and

symptoms needed through interviews with ophthalmologists, especially in the field of cataracts at Solo Eye Hospital.

The data needed in this system include types of cataracts and cataract symptoms. In this research, four types of cataracts will be identified. Table 1 is used as a result of user consultation on the symptoms experienced through a question-and-answer process on the system. Types of cataracts and their codes are shown in Table 1.

Table 1. Types of cataracts

Types Code	Diseases
PK01	Senile cataract
PK02	Traumatic cataract
PK03	Nuclear cataract
PK04	Complicated cataract

Other data needed in the system is the symptoms of cataracts. Table 2 describes the code of symptoms and symptoms of eye cataracts. When users consult the system, eye cataract symptoms are used as questions that will be output.

Table 2. Symptoms of cataracts

Symptoms Code	Symptoms Description
K01	Blurred vision
K02	Sensitive to direct light
K03	Double vision
K04	Foggy or cloudy vision
K05	Sore eyes
K06	More comfortable with a dim vision
K07	There is a white circle when looking at the light.
K08	Decreased color vision
K09	Changing lens size frequently

After the data needed for research purposes in the form of symptoms and types of cataracts, the data will be processed in the data processing and system design stages, where the data will be processed systematically and planned for research purposes, and the system will begin to be designed in the form of an expert system [10]. And the result of this expert system design is that the user can use the system to make it easier to find out the type of cataract the user suffers from [11]. The results of the diagnosis can be known after the user uses the expert system and selects the symptoms that are being suffered to get results from the system that



has been obtained based on facts from experts [12]. The certainty factor method will be used to determine the certainty factor as a decision-making tool in an expert system.

2.2. Certainty Factor Value

The Certainty Factor method indicates a measure of the certainty of a fact with the rule that the highest CF value is + 1.0 (Definity) and the lowest CF value is -1.0 (Definity Not) [13]. Where is the positive value that represents the value of confidence? Meanwhile, the negative value represents the confidence value of the CF, which is defined as follows:

$$CF(H, E) = MB(H, E) - MD(H, E) \dots\dots\dots(1)$$

Where:

- CF (H, E) = certainty factor
- MB (H, E) = level of confidence in hypothesis H, if influenced by evidence e (between 0 and 1)
- MD (H, E) = level of confidence in hypothesis H, if influenced by evidence E(between 0 and 1)

The confidence level will be obtained in 2 ways: the Net Belief method and the results of interviews with experts at Solo Eye Hospital. If there is no CF value for each symptom, the basic formula will be used to diagnose the disease [13].

1. CF as a single premise or symptom

$$CF_{\text{symptom}} = CF_{\text{user}} \times CF_{\text{expert}} \dots\dots\dots(2)$$

2. If there are rules with the same or more than one conclusion, then CF will be calculated by the following equation:

$$CF_{\text{combine}} = CF_{\text{old}} + CF_{\text{symptom}} \dots\dots\dots(3)$$

3. Meanwhile, to calculate the percentage of disease, the equation is used:

$$CF_{\text{percentage}} = CF_{\text{combine}} \times 100\% \dots\dots\dots(4)$$

Each symptom will have a value range of 0.0-1.0, and the diagnosis results will be obtained through a single symptom starting with a rule, while multiple symptoms will be separated into each new rule, after which they are calculated into CF using equation 2. Meanwhile, if more than one symptom is obtained, it will be calculated into CF using

equation 3 to obtain the percentage of confidence [14].

The data will be processed systematically and planned for research purposes, and the system will begin to be designed as an expert system [15]. Users can use the system to make finding the type of cataract they are experiencing more accessible. The diagnosis results can be known after the user uses the expert system and selects the symptoms experienced by the user [16].

After selecting the symptoms, the results will be obtained from the system that has been obtained based on facts from experts using the certainty factor method as a decision aid in an expert system [17]. The table of cataract symptom value weights explains the symptom code, symptom name, the CF value for each disease, and the CF value for each symptom of cataract disease. Table 3 is used in the calculation process to determine the CF value.

Table 3. CF value of cataract symptoms

Symptoms Code	Symptoms	Cataract Diseases			
		P01	P02	P03	P04
K01	Blurred vision	0.8	0.6	1.0	0.4
K02	Sensitive to direct light	0.6	1.0	0.2	0.4
K03	Double vision	0.6	0.4		0.8
K04	Foggy or cloudy vision	0.2		0.8	0.6
K05	Sore eyes	0.4			0.6
K06	More comfortable with a dim vision		0.4		0.8
K07	There is a white circle when looking at the light	0.8		1.0	
K08	Decreased color vision		1.0	0.8	
K09	Changing lens size frequently		0.8		0.6

Table 4 explains the rules that each cataract has and its symptoms. Rules are used to determine the type of disease that will be determined based on



the symptoms that have been determined in the system [18]. This rule tracks cataracts based on the symptoms entered into the system.

Table 4. Rules

No	Rules
1	IF blurred vision (K01) AND sensitivity to direct light (K02) AND double vision (K03), THEN there are white circles when looking at light (SENILE)
2	IF blurred vision (K01) AND sensitivity to direct light (K02) AND double vision (K03) AND more comfortable with dim vision (K06), THEN color vision fades (TRAUMATIC)
3	IF blurred vision (K01) AND double vision (K03) AND foggy vision (K04) AND white circles when looking at light (K07) THEN (NUCLEAR)
4	IF blurred vision (K01) AND sensitive to direct light (K02) AND foggy vision (K04), THEN eye sore (COMPLICATIONS)

The user weight values in Table 5 explain the answers and weights of the answers the user chooses when carrying out the question-and-answer process in the system. User weight value will be used when the user answers the symptoms in the system and consults with an expert [19].

Table 5. User values

User CF	CF Values
Not	0
No	0,2
Not sure	0,4
Pretty sure	0,6
Yes	0,8
Definitely Yes	1

The percentage of confidence described in Table 6 is the total percentage of cataracts so that the user knows the confidence value and the percentage level of the possibility of cataracts being suffered.

Table 6. Percentage of Confidence Cataracts

Confidence Value	Percentage Level
0%-59%	Maybe not sure
60%-79%	Probably definitely
80%-99%	Almost certain
100%	Definitely yes

### 3. Results and Discussion

#### 3.1. Calculation of Certainty Factor Value (User)

Input values for calculating diagnosing the type of cataract with a CF value by the user. Based on the symptoms experienced by system users without knowing the type of cataract disease. The symptoms that users have are:

- Blurred vision (K01). User trust value: 0.8
- Sensitivity to direct light (K02). User trust value: 0.4
- Double vision (K03). User trust value: 0.6
- There are white circles when looking at light (K07). User trust value: 0.8

Based on the user's answers in the process of diagnosing cataracts using the certainty factor method as follows:

##### 1. The calculation for senile cataract disease

$$\begin{aligned}
 CF_{combine1} (CF_{symptom1}, CF_{symptom2}) &= CF_{symptom1} + CF_{symptom2} * (1 - CF_{symptom1}) \\
 &= 0.8 + 0.24 * (1 - 0.8) \\
 &= 0.8 + 0.24 * (0.2) \\
 &= 0.8 + 0.048 \\
 CF_{old1} &= 0.848
 \end{aligned}$$

$$\begin{aligned}
 CF_{combine2} (CF_{old1}, CF_{symptom3}) &= CF_{old1} + CF_{symptom3} * (1 - CF_{old1}) \\
 &= 0.848 + 0.36 * (1 - 0.848) \\
 &= 0.848 + 0.36 * (0.152) \\
 &= 0.848 + 0.054 \\
 CF_{old2} &= 0.902
 \end{aligned}$$

$$\begin{aligned}
 CF_{combine3} (CF_{old2}, CF_{symptom4}) &= CF_{old2} + CF_{symptom4} * (1 - CF_{old2}) \\
 &= 0.902 + 0.64 * (1 - 0.902) \\
 &= 0.902 + 0.36 * (0.098) \\
 &= 0.902 + 0.035 \\
 CF_{old3} &= 0.937
 \end{aligned}$$

The conclusion that the last CF<sub>old</sub> same as the CF<sub>symptom</sub>, based on the results of the CF calculation, is as follows:

$$\begin{aligned}
 \text{Percentage} &= CF_{symptom} * 100\% \\
 &= 0.937 * 100\% \\
 &= 93\%
 \end{aligned}$$

##### 2. The calculation for traumatic cataract disease

$$\begin{aligned}
 CF1 &= CF_{expert} * CF_{user} = 0.6 * 0.2 = 0.12 \\
 CF2 &= CF_{expert} * CF_{user} = 0.4 * 0.2 = 0.08 \\
 CF_{combine} &= 0.12 + (0.08 * (1 - 0.12)) = 0.19 \\
 \text{Confidence Percentage} &= 0.1904 * 100\% = 19\%
 \end{aligned}$$

##### 3. The calculation for nuclear cataract disease

$$\begin{aligned}
 CF1 &= CF_{expert} * CF_{user} = 1.0 * 0.6 = 0.6 \\
 CF2 &= CF_{expert} * CF_{user} = 0.8 * 0.4 = 0.32 \\
 CF_{combine} &= 0.6 + (0.32 * (1 - 0.6)) = 0.72 \\
 \text{Confidence Percentage} &= 0.728 * 100\% = 72\%
 \end{aligned}$$



4. Calculation for complicated cataract disease  
 $CF_1 = CF_{\text{expert}} * CF_{\text{user}} = 0.4 * 1.0 = 0.4$   
 $CF_2 = CF_{\text{expert}} * CF_{\text{user}} = 0.6 * 0.2 = 0.12$   
 $CF_{\text{combine}} = 0.4 + (0.12 * (1 - 0.4)) = 0.47$   
 Confidence Percentage =  $0.472 * 100\% = 47\%$

### 3.2. Result of the Symptoms Data (User)

The following is the result of the symptom data, where the user will be directed to the consultation page. On this page, the user can choose the symptoms experienced by the user by selecting an option based on how severe the symptoms are being experienced, as shown in Figure 2.

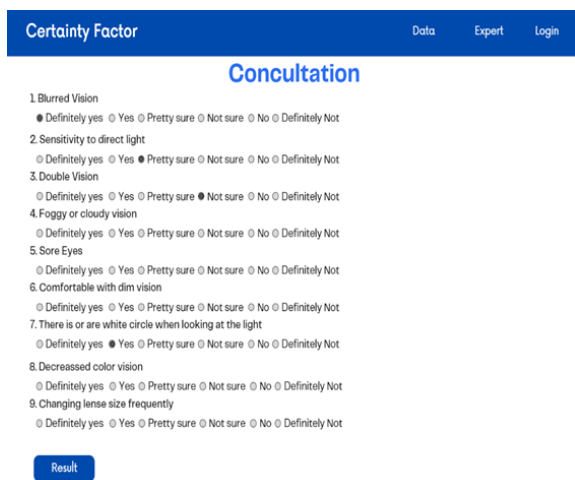


Figure 2. Consultation Page

The percentage of cataracts the user suffers will also appear on the diagnosis results page, as shown in Figure 3. Where users have a high probability of suffering from senile cataracts, with a percentage of 93%

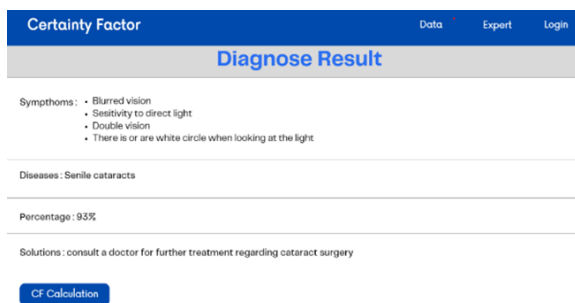


Figure 3. Result of Diagnose

A calculation results page will appear as shown in Figure 4 using the certainty factor method as a

determinant of the certainty of the user's chosen value on the consultation page

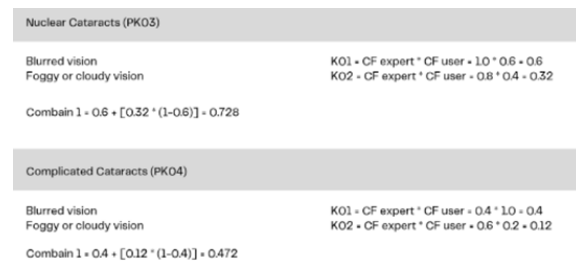


Figure 4. CF Result of Diagnose

### 3.3. Result of Confidence Percentage (User)

From calculations using the certainty factor method for each type of disease. The maximum CF value is 93 or 0.937 for senile cataracts (PK01).

Table 7. User Confidence Percentage

Diseases	Confidence Percentage
Senile	93%
Traumatic	19%
Nuclear	72%
Complicated	47%

From the results of calculating the CF value, it is obtained that the confidence value is almost certain according to the table of the percentage of confidence and positive users suffering from senile cataracts, as shown in Table 7.

## 3. Conclusion

From the results of expert system research to diagnose cataracts in the eye using the certainty factor method, it can be concluded that this expert system can assist in facilitating the work of cataract experts and helping society as a form of early prevention of positive risks of developing cataracts. The maximum value obtained from the calculation of the CF value is 93% with senile cataracts. So that can be obtained the level of confidence that it is almost sure that the user suffers from senile cataract.

## 4. References

- [1] R. Raenida and Z. Zukhri, "Sistem Pakar Diagnosis Dini Penyakit Katarak Menggunakan Metode Rule Based Reasoning," *Semin. Nas. Inform. Medis*, p. 2019.
- [2] R. Permana, R. Sovia, and H. P. Putra,

- “Sistem Pakar Certainty Factor Dalam Mendiagnosis Indikasi Penyakit Katarak Pada Anak,” *Sebatik*, vol. 24, no. 1, pp. 136–142, 2020.
- [3] Y. Reswan and Rulisman, “Analisis Perbandingan Algoritma Certainty Factor Dan Algoritma Naive Bayes Dalam Mendiagnosa Penyakit Katarak,” *J. Innov. Informatics(Jii)*, vol. 1, no. 3, pp. 170–175, 2022.
- [4] R. Hidayaturahmah, T. M. Andayani, and S. A. Kristina, “Analisis Faktor-Faktor Klinik yang Mempengaruhi Kualitas Hidup Pasien Katarak di Rumah Sakit Dr. YAP, Yogyakarta Analysis of Influencing Clinical Factors on Quality of Life of Patients with Cataract at Dr. YAP Hospital,” *J. Farm. Dan Ilmu Kefarmasian Indones.*, vol. 8, no. 3, p. 207, 2021.
- [5] Adie Wahyudi Oktavia Gama, I Wayan Sukadana, and Gede Humaswara Prathama, “Sistem Pakar Diagnosa Awal Penyakit Mata (Penelusuran Gejala dengan Metode Backward Chaining),” *J-Eltrik*, vol. 1, no. 2, p. 34, 2021.
- [6] A. F. Adam, “Analisis Perbandingan Tiga Metode Untuk Mendiagnosa Penyakit Mata Pada Manusia,” *JATISI (Jurnal Tek. Inform. dan Sist. Informasi)*, vol. 8, no. 4, pp. 1654–1664, 2021.
- [7] S. I. Gusti Ngurah Anom, P. Anak Agung Ayu Lie Lhiannza Mahendra, P. I. Putu Bayu Surya, A. I. Kadek Dwiki, J. Ni Putu Narithya, and P. Pendidikan Profesi Dokter, “LAPORAN KASUS: KATARAK SENILIS MATUR,” 2022.
- [8] Y. Purnama, I. Ismail, D. Noviandri, Y. Hendriyani, P. T. Nguyen, and I. P. A. Darmawan, “Expert System in Detecting Children's Intelligence using Certainty Factor,” *J. Crit. Rev.*, vol. 7, no. 1, pp. 52–55, 2020.
- [9] M. Oktaviansyah, R. Tamara, and I. Fitri, “Sistem Pakar Untuk Mendiagnosa Penyakit Mata Menerapkan Metode Certainty Factor dan Forward Chaining,” *J. Media Inform. Budidarma*, vol. 6, no. 1, p. 645, 2022.
- [10] A. S. Sembiring *et al.*, “Implementation of Certainty Factor Method for Expert System,” *J. Phys. Conf. Ser.*, vol. 1255, no. 1, 2019.
- [11] A. Rahmadsyah, P. S. Ramadhan, and ..., “Sistem Pakar Mendiagnosa Penyakit Katarak Pada Balita Menggunakan Metode Certainty Factor (CF) Berbasis Web,” *J. Cyber ...*, no. x, pp. 1–8, 2019.
- [12] S. M. Hardi, F. P. Surbakti, and Elviwani, “Expert System for Detection Glaucoma Disease Using Certainty Factor Method,” in *Journal of Physics: Conference Series*, 2020, vol. 1641, no. 1.
- [13] B. A. Wijaya and J. P. Tanjung, “An Expert System For Diagnosis Eye Diseases On Human Using Certainty Factor Method Based Web,” *Sinkron*, vol. 5, no. 1, Oct. 2020.
- [14] D. Deslianti, “Penerapan Metode Certainty Factor Dalam Mendiagnosa Penyakit Pada Mata Manusia,” *Agustus*, vol. 3, no. 4, pp. 2655–755, 2020.
- [15] I. H. Santi and B. Andari, “Sistem Pakar Untuk Mengidentifikasi Jenis Kulit Wajah dengan Metode Certainty Factor,” *INTENSIF J. Ilm. Penelit. dan Penerapan Teknol. Sist. Inf.*, vol. 3, no. 2, p. 159, 2019.
- [16] D. Kiray and F. A. Sianturi, “Diagnose Expert System Computer Malfunction Certainty Factor Method,” *J. Comput. Networks, Archit. High Perform. Comput.*, vol. 2, no. 1, pp. 63–71, 2020.
- [17] P. Wahyuningsih and S. Zuhriyah, “Sistem Pakar Diagnosa Penyakit Campak Rubella pada Anak Menggunakan Metode Certainty Factor Berbasis Website,” *J. Teknol. Inf. dan Ilmu Komput.*, vol. 8, no. 1, p. 85, 2021.
- [18] S. Batubara, S. Wahyuni, and E. Hariyanto, “Penerapan Metode Certainty Factor Pada Sistem Pakar Diagnosa Penyakit Dalam,” *Semin. Nas. R.*, vol. 1, no. 1, pp. 81–86, 2020.
- [19] P. Masliana, Y. Siagian, and S. R. M. Azmi, “Penerapan Metode Certainty Factor Pada Sistem Pakar Diagnosa Penyakit Mata,” *Build. Informatics, Technol. Sci.*, vol. 4, no. 2, pp. 962–971, 2022.