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Expert System Utilizing Bayesian Theorem Method for Hernia Disease

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ABSTRACT

A hernia is the protrusion of an organ or tissue through an abnormal opening. It occurs when the contents of a cavity protrude through a defect (weak channel) or a weak part of the corresponding cavity wall. In children, hernias usually occur in one of two places: around the navel or in the groin or scrotum area. Reckless handling of hernia, especially in cases of umbilical hernia in children, can lead to serious problems, even death. Therefore, accurate information is crucial in managing hernia in children, and it can be facilitated by an expert system application using the Bayesian Theorem method. The Bayesian Theorem is a theorem commonly used to calculate probabilities for a specific hypothesis. It serves as the basis for Bayesian statistics, with applications in microeconomics, science, game theory, and medicine. Research findings conclude that the expert system built is highly beneficial in expediting early treatment of hernia in children. The developed expert system application is dynamic in determining symptoms, weights, and solutions, allowing for customization. The Bayesian Theorem method proves to be suitable for swift and accurate implementation in diagnosing and treating hernia in children. The accuracy level of the testing results using the Bayesian Theorem method is 100%.

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1. INTRODUCTION

Artificial intelligence (AI) is a computer science field that empowers computers to exhibit intelligent behavior. AI solves problems by utilizing computers to tackle complex issues through processes resembling human reasoning. The primary goal of artificial intelligence is to enhance the normal functions of computers by combining them with human intelligence, such as reasoning, drawing conclusions, learning, and problem-solving. Artificial intelligence technology is studied in various fields, one of which is expert systems [1].

An expert system is a system capable of emulating the reasoning of an expert so that a computer can solve problems in a manner similar to how experts typically do. The knowledge stored in an expert system is generally derived from a human expert in the respective field. The crucial role of an expert can be replaced by a computer program that, in its working principles, provides definite solutions similar to those provided by an

expert. Expert systems are commonly used for consultation, analysis, diagnosis, and aiding in decision-making [2].

In recent decades, the diagnosis of various diseases has been conducted utilizing machine learning methodologies [3]. In the decision-making process, we can leverage decision support system methods, which are one of the branches of artificial intelligence [4]. In the realm of image processing, digital images are manipulated using a digital computer for classification or other purposes to derive new information and knowledge [5].

Hernia is the protrusion of an organ or tissue through an abnormal opening. It involves the protrusion or projection of the contents of a cavity through a defect (weak channel) or a weak part of the corresponding cavity wall. A hernia consists of a ring, sac, and hernia contents. It occurs when there is a protrusion of the peritoneum containing visceral organs from the abdominal cavity through a locus minoris resistensi (a place or area of weakness), either congenital or acquired [6].

In children, hernias typically occur in one of two places: around the navel and in the groin or scrotum area. A hernia occurring around the navel is called an umbilical hernia (commonly referred to as an "outie" belly button), while in the groin area, it is known as an inguinal hernia (commonly referred to as a "hernia" or "condor"). Careless handling of hernias in children, especially in cases of umbilical hernias, can lead to serious problems, even death.

2. METHOD

The method is a systematic way or technique used to work on a case. In conducting this research, the author employed 2 (two) study methods:

1. Field Study

   This method involves conducting direct field studies to collect data, with a direct survey to the study location. The data collection techniques employed by the author include:

   a. Interview

      Interview is a data collection technique involving direct question-and-answer sessions with relevant informants. The author conducted interviews directly with doctors at the Haji Medan General Hospital regarding hernia diseases.

   b. Observation

      Observation is an effective data collection method to study a system. The author observed ongoing activities directly.

   c. Sampling

      Sampling is a data collection method to take samples or examples. The author examined available documents related to hernia diseases in children.

2. Library Research

   The author conducted library research to obtain data related to the thesis from various sources such as books, the internet, and other readings.

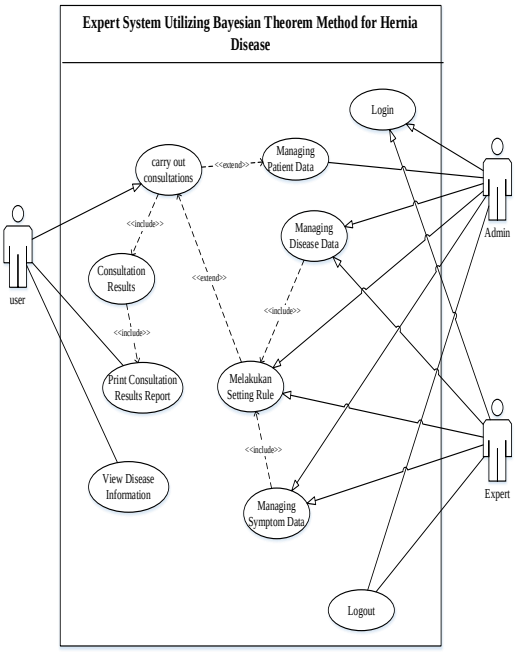
3. RESULTS AND DISCUSSION

3.1. System Design

The system design utilizes several forms of diagrams from UML, namely: Use Case Diagram and Class Diagram.

3.1.1. Use Case Diagrams

A use case is a sequence/description of a set of related interactions forming a system in a structured way, executed or supervised by an actor. Use cases are employed to model the behavior of objects in a system. Typically, a use case is depicted as an ellipse with solid lines, usually containing a name. Use cases illustrate the system processes (system requirements from the user's perspective). The form of the use case diagram designed by the author can be seen in Figure 1.



Gambar 1. *Use Case* Diagram

3.1.2. Class Diagrams

This diagram is used to illustrate the fundamental differences between classes, the relationships between classes, and where these class subsystems are located. In the class diagram, there are the names of classes, attributes, operations, and associations (relationships between classes).

3.2. Application of the Method

The process of implementing the Bayesian Theorem method in an expert system to diagnose hernia in children is as follows:

A mother wishes to diagnose her child's hernia by answering questions related to the following symptoms:

$$G1 = 0.6 = P(E|H1)$$
$$G2 = 0.8 = P(E|H2)$$
$$G3 = 0.8 = P(E|H3)$$
$$G4 = 0.6 = P(E|H4)$$
$$G5 = 0.8 = P(E|H5)$$

The diagnostic process is conducted by searching for the universal value through summing up all hypotheses based on the mentioned symptoms:

$$\sum_{G5}^{5} k=1 = G1+G2+G3+G4+G5$$
$$= 0.8 + 0.6 + 0.8 + 0.7 + 0.6$$
$$= 3.5$$

After obtaining the sum of the above results, the formula to calculate the universal value is as follows:

$$P(H1) = \frac{H1}{\sum_{k=1}^{5}} = \frac{0.8}{3.5} = 0.23$$
$$P(H2) = \frac{H2}{\sum_{k=2}^{5}} = \frac{0.6}{3.5} = 0.17$$
$$P(H3) = \frac{H3}{\sum_{k=3}^{5}} = \frac{0.8}{3.5} = 0.23$$
$$P(H4) = \frac{H4}{\sum_{k=4}^{5}} = \frac{0.7}{3.5} = 0.2$$

$$P(H5) = \frac{H5}{\sum_{k=5}^{5}} = \frac{0.6}{3.5} = 0.17$$

After determining the value of P(Hi), the probability of hypothesis H without considering any evidence, the next step is:

$$\sum_{k=1}^{5} = P(Hi)*P(E|Hi\text{-}n)$$

$$= P(H1)* P(E|H1)+ P(H2)* P(E|H2) + P(H3)* P(E|H3)+ P(H4)* P(E|H4) + P(H5)* P(E|H5)$$
$$= (0.23 * 0.6) + (0.17 * 0.8) + (0.23 * 0.8) + (0.2 * 0.6) + (0.17 * 0.8)$$
$$= 0.14 + 0.13 + 0.18 + 0.12 + 0.13$$
$$= 0.70$$

The next step is to find the value of P(Hi|E) or the probability that hypothesis Hi is true given evidence E.

$$P(H1|E) = \frac{0.6 * 0.23}{0.70} = 0.20$$
$$P(H2|E) = \frac{0.8 * 0.17}{0.70} = 0.19$$
$$P(H3|E) = \frac{0.8 * 0.23}{0.70} = 0.26$$
$$P(H4|E) = \frac{0.6 * 0.2}{0.70} = 0.17$$
$$P(H5|E) = \frac{0.8 * 0.17}{0.70} = 0.19$$

After determining all the values of P(Hi|E), the next step is to sum up all the Bayesian values using the following formula:

$$\sum_{k=1}^{n} Bayes = Bayes1+Bayes2+Bayes\ 3+ Bayes4+Bayes5$$

$$= (0.8*0.20)+ (0.6*0.19)+ (0.8*0.26) + (0.7*0.17)+ (0.6*0.19)$$
$$= 0.16 + 0.11 + 0.21 + 0.12 + 0.11$$
$$= 0.71 * 100\ \%$$
$$= 71\ \%$$

From the above calculation, it can be concluded that the child of the mother is suffering from umbilical hernia with a percentage of 71%.

The test results were obtained by comparing the system's calculations with manual calculations. This was done to determine the accuracy level of the system using three types of data taken from the sample data. The calculation results can be seen in Table 1.

Table 1. Test Results

No.	Patient's name	Manual Calculation	System Calculation	(T/F)
1.	Adi	70%	70%	T
2.	Fikri	73%	73%	T
3.	Fitra	71%	71%	T

Information:

T = True. Occurs when the system calculation results are the same as manual calculations.

F = False. Occurs when the system calculation results are different from the manual calculation results.

Based on the tests that have been carried out, it is obtained:

Accuracy Level:

= (amount of accurate data/total sample)*100%

= (3/3) * 100%

= 100%

4. CONCLUSION

From the research results, several conclusions can be drawn, including:

1. The expert system built uses PHP programming language and MySql database, making it user-friendly.

2. The expert system facilitates users in diagnosing hernia in children, providing solutions in the form of initial treatment and the management of hernia in children.
3. The testing results of the 'Expert System for Diagnosing Hernia Disease in Children Using the Bayesian Theorem Method' indicate that this expert system can diagnose hernia in children according to the user's responses with an accuracy rate of 100%.

Considering the limitations in the design of the Expert System for Diagnosing Hernia Disease in Children Using the Bayesian Theorem Method, several suggestions and recommendations are proposed for future research and development:

1. Experts should regularly update their knowledge to keep up with the advancements in the field of hernia diseases in children, which can significantly impact the system's ability to diagnose diseases effectively.
2. For the future development of this system, it is recommended to build a more detailed knowledge base.
3. It is advisable to include a data backup facility in the system for potential data loss prevention in case of server damage.

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