Expert System for Diseases Diagnosis in Living Things: A Narrative Review

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Abstract. Expert systems are a branch of artificial intelligence, namely by storing expertise from human experts into computers and storing knowledge in computers so that users can consult like human experts. Expert systems are now being applied to diagnosing diseases in humans, animals, and plants. With this system users becoming more practical and knowledgeable in diagnosing natural diseases. a good expert system must provide a good and accurate result so that it can be use. Factors that influence system accuracies such as classification methods, input analysis, and technology are considered for the development of a good expert system to serve it functions as an expert. The purpose of this paper is to analyze these factors for the development of a better system.

Keywords— Expert Sistem; Animal Diseases, Human Diseases, Plants Diseases, Narrative Review.

1. INTRODUCTION

Expert System (ES) one is a branch of the strongest branches of Artificial Intelligence (AI), which turned out to be the most important branch of computer science. The is purposed is to detect certain problems in a particular field, by extracting, compiling, analyzing and re-using of information and experience of the human expert in the field and annexed into the system. These systems can address the problems in this area without fully rely on specialist in diagnosing their problems by confining the symptom and criteria information collected.

[1] [2].

The ES is applied in several areas of life as in humans, animals, and plants. In humans the purpose of the expert systems is to detect the types of human organ disease such as breast cancer [3],[4], foot diseases [5], organs in the human body which involves such types of diseases; chest-pneumonia, bronchitis, and asthma [6], urination problem [1], thyroid diseases [4], and heart valve diseases[7]. There is also a type of cardiovascular disease; cristyc and alveolar echinococcosis [8], diagnosing hypertension [9], vascular heart diseases [10],[11], thyroid[12]. While in animals some of the expert systems are used to diagnose for pig diseases [13], fish diseases[14], which are associated
with animals that are being oftenly maintained. In plants, the ES are using to diagnose cultivated crops are plant species;[15], Pakistani wheat[16], Jamaican coffee[17], rice plant[18], and Indian mango[19].

In addition, this research must not only studies the extensive development of expert systems. The methods of classification of appropriate symptoms and good input analysis will also affect performance in expert systems that are useful for reducing error rates and increasing the level of accuracy in the system. These studies will help to produce output that is also relevant to enhance better usage in the future indirectly to help implements the system as an expert and minimize the areas. Therefore, finding the best methods and technologies according to your needs is important to get the best system performance. The next section explains the methods in this study. Section 3 will discuss the research, whiles section 4 concludes the paper.

2. METHOD

This paper begins from the section’s method of describing how the researchers conducted the analysis. in their study, analysis findings for the diagnosis of diseases in humans, animals, and plants which has been reviewed in previous studies of expert systems, shows how the system can help institutions and governments in tackling diagnosis more easily with the knowledge equivalent of the experts.

The purpose of this paper are to summarize and analyze previous research on the approach to the expert system and technology methods used. the author focuses on things that affect the approach to the goodness of the future system. the results will be proven at the level of system quality in terms of specificity, sensitivity or accuracy of the system, as well as the type of expert system that is displayed based on their respective categories. more detailed and produce information needed for the next development. the examining discussion, the end result is how far the expert system has helped life, and in conclusion, these studies are to finding the best solution and methods in other for development purposes to the expert system in the future.

2.1. Literature Search Strategy

The review consists of selected sources from research journals, review papers, and conference proceedings. The development of research references are ranging from identifying the keyword "expert system" and "diseases diagnosis. This paper focuses more specifically on the expert system on humans, animals, plants, and also specializes in diseases diagnosis of these three objects. These words were refined using databases like IEEE, Science Direct and Google Scholar. The literature reference finding of this research was based on the title and the abstract by manually filtered through the website, solely. The reference research finding was extracted from the online publish journals in Indonesia and English language writing for the year 2008 - 2018.

2.2 Eligibility Criteria

From the reference finding collected, the author was first to choose reference journal base on the title generally. It was then filtered the content based on the abstract, purposes, methods and conclusions. Following criteria below were also been the main focus for the content selection: (1). the research should cover the area in the field of information technology (2). research purposes must make a system with the expert system associated with living things such as humans, animals, and plants. (3). Research results and findings that include the following conditions: (a). journals obtained should be specialized in disease diagnosis only, (b). studies have methodologies in the application of expert systems.

3. RESULTS

Research of the finding was originated from twenty different countries including, Palestine[1],[5], Indonesia [2],[20], Turkey [3],[10],[12],[4],[7], Banglades[6], France [8],[21], Malaysia [9], Italy [22], Hong Kong[11], Singapore [23], China [13],[24],[25],[26], Pakistan [16], USA[17], India [18],[19],[27],[28], Ireland [29], Iran[30], [31], Spain[32], Canada[33], Taiwan[34], Gwalior[35],
Pune[36], Spain[37]. Twenty-Four articles was published between the years of 2008–2018 were included in the review[3-20] from conference or journal. For the screening process were from the 17 which then becomes the main focus paper in this study, the details of the result and futher clarification of the stated numbered category are shown as pert table 1 in section 3.1 study on the previous research as below.

3.1 Study on The Previous Research

| Author and Year | focus       | Description                                                                                                                                 |
|-----------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| [3]             | interpretation | In this study, an automatic diagnosis system for detecting breast cancer based on association rules (AR) and neural network (NN) is presented. Feature extraction is the key for pattern recognition and classification. The best classifier will perform poorly if the features are not chosen well. A feature extractor should reduce the feature vector to a lower dimension, which contains most of the useful information from the original vector. So, AR is used for reducing the dimension of the breast cancer database and NN is used for intelligent classification. |
| [4]             | interpretation | The fuzzy rules which will be used in inference engine of Ex-DBC system were found by using the neuro-fuzzy method. Ex-DBC can be used as a strong diagnostic tool with 97% specificity, 76% sensitivity, 96% positive and 81% negative predictive values for diagnosing of breast cancer. That the developed system positive predictive is high is very important. By means of this system can be prevented from the unnecessary biopsy. Beside it can be benefited from this system for training of students in medicine. |
| [5]             | prediction   | In this paper, a proposed expert system was presented for helping the Podiatric physician in diagnosing patients with eighteen different possible foot diseases. Podiatric physician and foot diseases patients can get the diagnosis faster and more accurate than the traditional diagnosis. This expert system does not need intensive training to be used; it is easy to use and has a user-friendly interface. It was developed using SL5 Object Expert System language. |
| [6]             | Prediction   | This research project focuses on the research and development of a web-based clinical tool designed to improve the quality of the exchange of health information between health care professionals and patients. Practitioners can also use this web-based tool to corroborate diagnosis. The proposed system has experimented on various scenarios in order to evaluate its performance. In all the cases, the proposed system exhibits satisfactory results. |
| [7]             | Interpretation | In this paper, we investigate the use of linear discriminant analysis (LDA) and adaptive neuro-fuzzy inference system (ANFIS) to determine the normal and abnormal heart valves from the Doppler heart sounds. The proposed heart valve disorder detection system is composed of three stages. The first stage is the pre-processing stage. Filtering, normalization, and white-denoiqing are the processes that were used in this stage. The feature extraction is the second stage. During the feature extraction stage, Wavelet transforms and short-time Fourier transform was used. As next step, wavelet entropy was applied. |
to these features. For reducing the complexity of the system, LDA was used for feature reduction.

[8] Interpretation Clinical decision-making depends also on setting-specific aspects. The usage of an imaging-based classification system is highly recommended. For AE, early diagnosis and radical (tumor-like) surgery followed by anti-infective prophylaxis with albendazole remain one of the key elements. However, most patients with AE are diagnosed at a later stage, when radical surgery (a distance of larval to liver tissue of >2cm) cannot be achieved.

[9] Diagnosis an expert system using fuzzy for diagnosis of hypertension. The diagnosis process, linguistic variables, and their values were modeled based on expert's knowledge and from existing literature. It is expected that our proposed Fuzzy Expert System can provide a faster, cheaper and more accurate result compared with other traditional methods.

[10] Interpretation In the related previous work, a feature vector which has 256 features was considered as input to the classifiers [11]. The complexity of the previous work was quite high due to the dimension of the input feature vector. Therefore, a data reduction process has emerged. Data reduction with PCA and AIS with fuzzy k-NN was used in this work for diagnosis of aortic and mitral VHDs from DHS signals. For this purpose, computer simulations were carried out and statistical validation indexes were used for determining the performance of the proposed methodology.

[11] Monitoring Designing of this system with fuzzy base in comparison with classic designed improves results. Results have been shown from this system in compression with past time system are logical and more efficient. This system simulates the manner of expert-doctor. This system is designed in a way that patient can use it himself.

[12] Monitoring Recent years have seen an enormous development in medical expert systems, and the systems now available are mature enough for targeted adoption in practice. In order to deliver health-care even more effectively, expert systems will be increasingly integrated into hospital information systems (HIS).

[34] Diagnosis constructed a rules-based nutritional expert system which contains 50 different nutritional diagnosis rules. It allows professional dietetics to record the data collected from nutritional assessment and perform nutritional diagnosis by evaluating the patient's data with each rule and outputs a diagnosis report for each patient. From this experiment results, we found that our nutritional diagnosis expert system can help dietitians to make their nutritional diagnosis more accurate as well as helping them to make nutritional diagnosis faster.

[15] Diagnosis This method is suitable for expert systems to diagnose something uncertain. Certainty Factor expressed confidence in an event or factual hypothesis based on evidence or expert judgment. The results of the research are in the form of an expert system application that can diagnose diseases of red pepper plants with enough accuracy and can help in overcoming the problem of crop failure. Based on the data taken from tests performed in this study, the system can diagnose red chili plant disease with high accuracy.
[16] Design
The experience and lessons learned from the development of an expert system suggest that the system is still useless for many farmers in its present form. Many farmers in the country are illiterate and knowledge of computers in rural areas is still a problem. The system needs to be developed in many regional languages.

[17] Diagnosis
There is little doubt that many current agricultural practices, and especially the almost exclusive reliance on chemicals to combat diseases and pests, are not sustainable in the long run, and agriculture has therefore seen the emergence first of integrated pest management and later the integrated management of pests and pesticides. Unfortunately, both require access to the knowledge of experts in different fields and such access is often simply not available for small farmers, especially in developing countries.

[18] Interpretasi
The system integrates a structured knowledge base that contains knowledge about symptoms and remedies of diseases in the rice plant appearing during their lifespan. An image database is also integrated with the system for making the decision support more interactive. The pictures related to disease symptoms are stored in the picture database and the intelligent system module prompts these with the interface based on rule-based decision-making algorithms. The system has been tested with domain dataset, and results given by the system have been validated with domain experts.

[19] Design
The knowledge base of the system contains knowledge about symptoms and remedies of 14 diseases of Indian mango tree appearing during the fruiting season and non-fruiting season. The picture base of the system contains pictures related to disease symptoms and are displayed along with the query of the system. The result given by the system has been found to be sound and consistent.

[20] Diagnosis
The result of the research is an application that can be used to diagnosis pest and disease horticulture plant, that are red onion and chili. By this application, the farmer can determine quick action should be taken if the farm pests and diseases, without waiting for a consultation with an expert to do the handling. The application result also could be a learning system to the farmer about pest and disease horticulture plant.
3.2 Type Of System

![Circle Diagram Type of System](image)

Figure 1 Circle Diagram Type of System

Most of the expert systems have been developed with the interpretation method via a system concept that resulted in a description of the situation based on the data sensor. With the data sensor, the data that generated are more consistent due to the best of stood in the system. Whereas the next type of system that is in demand is Diagnosis with the concept of concluding system errors based on symptoms. In several other cases, it was found ES with the Design method that composes objects based on constraints. An ES with a prediction type, predicts the possible consequences of a given situation.

3.3 The Summary Of Descriptive Of The Paper

Some areas of expert systems are divided into object classification as well as disease detection as per presented in table 2 below.

| Table 2. The summary of descriptive of the paper |
|-----------------------------------------------|
| Author | Subject                  | Object    | Data analysis |
|--------|--------------------------|-----------|---------------|
|        |                          | Analysis  | Analysis      |
|        |                          | vector    | diagnosis     |
| [3]    | Breast Cancer            | Human     | ✓             |
| [4]    | Breast Cancer            |           |               |
| [5]    | Foot Diseases Diagnosis  |           | ✓             |
| [6]    | Chest-Pneumonia,         |           | ✓             |
|        | Bronchitis, and Asthma   |           |               |
| [7]    | heart valve diseases     |           |               |
| [8]    | cystic and alveolar      |           |               |
|        | echinococcosis           |           |               |
| [9]    | Hypertension             |           | ✓             |
| [10]   | valvular heart diseases  |           | ✓             |
| [11]   | Heart Diseases           |           | ✓             |
| [12]   | Thyroid                  |           | ✓             |
| [13]   | Pig-Disease              | Animal    | ✓             |
| [14]   | Fish Disease             |           | ✓             |
| [15]   | Pepper                   | Plants    | ✓             |
Data Analysis on Expert System

Generally there are 2 type of data analysis on the input system use in the diagnostic analysis method. In the table 2 (above), these data analysis categories shown as (1) analysis vector, (2) analysis diagnosis. The analysis categories as the author [5-6] to humans, and author [12-20] for animals and plants. While the vector analysis method is an input method that is widely used in expert systems for humans, vector analysis technology is also considered as the newest method that is more practical and accurate which will be discussed in table 3.

3.4 Method and algorithm performance of System

| Method Classification of ES | Author | algorithm performance of the system |
|-----------------------------|--------|-------------------------------------|
| association rules (AR)      | [3],   | The correct classification rate of the proposed system is 95.6% |
| and neural network (NN)     | [3][11][14][10] | 97% specificity, 76% sensitivity, 96% positive diagnosis of the system is correct in 94% [11] |
| Adaptive Neuro-Fuzzy Fuzzy logic | [7][4][5][12] | 97.3% sensitivity and 92% specificity [7] |
| Rule Base                   | [9][17][19] | 96% predicted negative [4] |
| Certainty Factors           | [15]   | 81% predictive value [6] |

In this study, an automatic diagnosis system for detecting breast cancer based on association rules (AR) and neural networks (NN) was presented. Pattern recognition and classification are based on feature extraction. The best classifier will not work well if not selected as needed. The feature extractor reduces the vector at a level lower than the original vector. So, AR is used to reduce the dimensions of the breast cancer database and NN is used as a classifier [3]. whereas in the research conducted by keles [4], expert systems were built using neuro-fuzzy methods. Heuristic learning algorithm method is used in Neuro-fuzzy which makes high performance proven in medical diagnosis and classification. Thus, the Ex-DBC system has a powerful inference engine that contains fuzzy rules that can detect hidden relationships in cases that are not recognized by human experts. Ex-DBC can diagnose with 96% negative predictive value and 81% negative for breast cancer. In addition, another study [5], the Ex-DBC system developed a high positive predictive rate (96%) and specificity (97%)
for breast cancer. Thus, in preventing biopsies that are not needed in the diagnosis of breast cancer this model can make a significant contribution. The predictive value obtained with fuzzy logic is still considered low compared to the use of AR and NN methods, while the other three methods do not explain the level of algorithm performance.

3.5 Finding and Gaps of Expert System on Human, Animal, and Plants

| Author | Result | Gaps |
|--------|--------|------|
| [3]    | A feature extractor should reduce the feature vector to a lower dimension, useful information from the original vector | unspecified |
| [4]    | the system will be an innovative approach to the diagnosis of breast cancer | Sample size |
| [5]    | The Proposed expert system is very useful for a Podiatric physician, patients with a foot problem and newly graduated physician | using methods for selecting data |
| [6]    | Criteria selection division is more valid by using calculation | System description is not explained clearly |
| [7]    | The proposed system has some advantages of automation. It is rapid, easy to process, non-invasive and cheap for clinical application | However, the position of the ultrasound probe, which is used for data acquisition from the heart valves, must be taken into consideration by the physician. |
| [8]    | The data used is very complete | No explanation of validation |
| [9]    | Specific classification | More fuzzy rules will be developed in order to get a better result and determine the risk factor of hypertension |
| [10]   | The proposed system has some advantages of automation. It is rapid, easy to process | expert considerations are still in need very high |
| [11]   | This system simulates the manner of expert-doctor. This system is designed in a way that patient can use it himself | the system doesn't have any logical combination of inputs with AND/OR because antecedent part of all rules has one section. |
| [12]   | The system is very user-friendly and complete | the process of system fuzzification is not adequately described |
| [13]   | The interface with symptoms in the context of an image only | The system used is not very user-friendly |
| [14]   | It has an online data and KA | Unspecified |
The method can be applied to expert systems to provide solutions that match the symptoms of illness. Can be developed with other methods in order to produce a good level of accuracy.

The problem demands presented in the system are well constructed. A general objective of an expert system is to provide expert knowledge to non-experts.

This system gives correct, credible recommendations that small farmers would find valuable as it can result in significant savings.

The architecture presented an integrated system with an interactive user interface, control and coordinating units, shells, and structured knowledge representations. Unspecified

The picture base of the system contains pictures related to disease symptoms and are displayed along with the query of the system. Spoken language technology is still in infancy and is not advanced enough to provide such interfaces.

User-friendly system. The system is still simple and not complex.

Based on table 4, it can be concluded that the interface, methods, and data in expert systems are things that will affect system performance. User-friendly interface makes the expert system more interesting and easy to use by all users. The use of appropriate methods in classifying the criteria into the diagnosis (so that the diagnosis becomes precise) as to emphasize the accuracy of the expert system. The method of selecting the data must also be adjusted to the field of the system and on the other hand, the data used must be valid with field conditions and recommendations from experts, so the ES function can work optimally.

4. DISCUSSION AND CONCLUSION

This review focuses mainly the extensive of the expert systems which have been applied in life by taking data in humans, animals, and plants. Then it will be focusing on the diagnosis of the disease. The right classification method and system input method in the system application will affect the level of system accuracy. Talking about system input methods, there are many ways to do it and of course from all methods there are different processes take place.

The manual input method from the user is a method that is widely used, and commonly relevant to the diagnosis for expert system plants and animals, in certain case if a particular disease diagnosis is irrelevant, this input method will be tailored to the disease data to be diagnosed. Not only the input method, the classification process and the diagnosis is also influenced by the data classification method. Then some simply use the fuzzy inference method, but in certain cases with many input data criteria, this method is, of course, irrelevant and are lowers the accuracy.

To develop an expert system, one should determine the object, recognize the symptom, in other to create a better system expert. In other for a system with manual input by the user to run well, the right method chosen needed for the diagnosis of diseases in a living organism as in plants and animals according to their needs.
For the diagnosis of human disease using the ES, the system will be based on data application input from users to determine the use of the method in the data reference system and allow system expert run better.

For the best advancement in technology using neural networks with vector analysis that can assist to expedite the diagnosis processes work quickly in diagnosing.

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