



DESIGN AND IMPLEMENTATION OF AN EXPERT SYSTEM FOR DIAGNOSIS, TREATMENT AND MANAGEMENT OF POULTRY DISEASES

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ABSTRACT

One of the major challenges in “poultry keeping” is how to diagnose, treat and manage different types of poultry diseases in the farm. Animal farmers and various poultry keepers run their businesses at loss especially when there is outbreak of poultry diseases which claims the life of millions of poultry birds. Unfortunately, enough efforts have not been made in terms of research, using Artificial Intelligence (AI) approach to solve or minimize this problem. This research work therefore made an attempt to develop an expert system to diagnose, treat and manage poultry diseases. In this research work, knowledge of experts - animal scientist, veterinary doctors and poultry keepers were used to develop a knowledge base for the system. Also, an inference engine was developed to relate with the knowledge base and the working memory. The system was implemented using C sharp (C#), and CLIP. The knowledge was finally made available to the users. The system was highly simplified and made user friendly. In fact, it was adjudged by the users to be better than the existing ones. Hence, the findings of this research will significantly help in reducing poultry mortality rate and thereby make poultry farming a viable business. This, in turn will encourage young school leavers to engage in poultry farming.

Keywords: Artificial Intelligent, Clip, Expert System, Knowledge base, Poultry, C Sharp

INTRODUCTION

One major branch of computer science is described as Artificial Intelligence (AI). A branch of Computer Science which makes use of machine to solve complex problems in more human-like fashion is called AI (Kana, 2011). This generally involves borrowing characteristics from human intelligence and applying them as an algorithm in a computer friendly manner to solve some real life problems.

Though AI emerged from the field of computer science but it has diverse applications. In fact, it is gradually becoming a universal field and this made it difficult to give a precise definition to a discipline like AI.

Broadly, AI is a computer based exploration of methods for solving challenging task that have traditionally dependent on people for solution. Such task includes complex logical inference, diagnosis, visual recognition, comprehension of natural languages, game playing, explanation and planning (Kana, 2011).

It is a part of computer science that is concerned with designing intelligent computer system that is, computer system that has the characteristics that could be associated with intelligence in human behaviour such as understanding, learning, reasoning and solving problem (Kana, 2011).

In this research work an attempt is made to apply AI tool (Expert System) to solve Agricultural (poultry) problem.

Expert system is one of the tools of AI that could be used to solve various types of real life problems. In ES, the knowledge of expert in a particular domain is transferred to computer machine using the appropriate computer code for the machine to apply the knowledge to solve problems in such domain in a humanlike manner. The machine therefore follows the footstep of the expert to arrive at reasonable solutions. Based on the acquired knowledge, the system is capable of explaining the reason or reasons for arriving at a particular solution. Therefore in an attempt to develop an expert system, a domain expert in a specific field has to be interrogated and the acquired knowledge is stored in a suitable form for solving specific problem using simple reasoning. Poultry refers to bird that people keep for human consumption. It generally includes chicken, turkey, duck, goose, quail, pleasant, pigeon, guinea fowl, peafowl, ostrich, emu and rhea.

Outbreak of diseases has claim life of uncountable number of poultry birds and this has been a source of concern as poultry farmers lose millions of naira from time to time. This has a negative effect

on the economy of the nation. Thousands of graduates that would have ventured into poultry farming were discouraged by this ugly development. Unfortunately, enough attempts have not been made especially in the area of Computer Science to solve this problem.

Each of the existing system reviewed in literature shows one weakness or the other. The existing systems are not comprehensive enough for proper diagnosis. Most of the existing systems were not properly evaluated since users were not involved in the evaluation process. So, it is very difficult for us to measure practically, the performance of the systems. This will not fall in line with the ethics of system development. An attempt is being made in this research work to improve on the existing system and come up with a better one.

The objectives of the study included the design of an expert system to diagnose, treat and prevent poultry disease, to implement such system using C# and Clip and to test such a system to ascertain its level of performance.

An expert system is a system that employs human knowledge captured in a computer to solve problem that ordinarily require human expertise (Turban and Aronson, 2006). It is always developed to solve problems in a specific domain. It has been applied to solve various real life problems. The Expert System is made of many components as shown in the figure 1 below

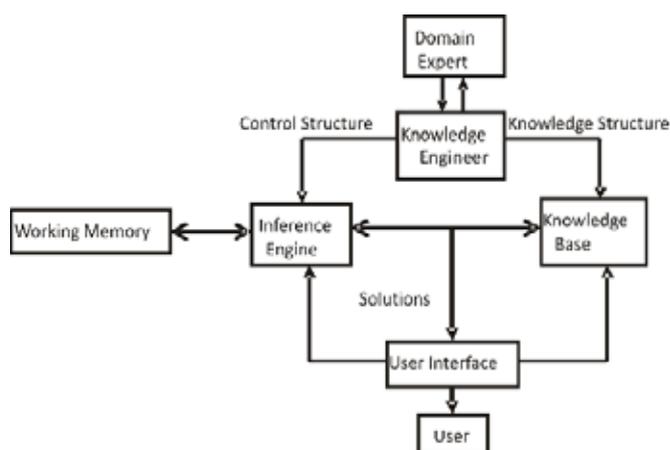


Figure 1: Structure of an ES

- Knowledge Acquisition: It could be obtained through two different sources- printed materials and domain expert. Different printed materials related to the concept could be consulted and the contents properly understood. Again, experts such as veterinary doctors, poultry farmers and poultry farm attendants could be consulted to seek for their professional

knowledge.

- **Knowledge Base (KB):** It is the knowledge that will be required by the system to have the basic understanding of the problem to be solved and to be able to propound or produce the correct solutions. It could be made available through the knowledge acquisition expressed in form of knowledge base rules. For the KB to have sufficient knowledge obtained from domain experts and documented materials could be combined.

- **Inference Engine:** This is described as the power house of the expert system. It made use of the rules available in the knowledge base to draw reasonable inferences or conclusions before arriving at a particular solution when attempting to solve a particular problem. Through the inference engine, the system will not just arrive at particular solution but will also give reasons why it arrives at such solution

- **User Interface:** It is the link between the expert system and its users. The users interact with the system and get response through the user interface.

- **Domain Expert:** One of the principles involved in the development of AI is that the system has to be restricted to a particular domain. An expert in the chosen domain is expected to have acquired enough knowledge and problem solving skill through its long years of training and experience. Such expert will normally be referred to as domain expert. It is the knowledge of the domain expert that will be converted to machine code in an expert system.

- **Knowledge Engineer (KE):** KE is responsible for transferring the domain expert knowledge to the form that non-experts can understand using computer codes. He should be conversant with the request of the users so as to build an expert system that satisfies the users' requirement.

- **User:** It could be anybody that uses or interact with expert system to solve a real life problem in a particular domain. A user may not necessarily be a computer scientist but should at least be computer literate.

There are also some related works in expert system in the area of diagnosis of poultry diseases with each of them with one deficiency or the other. Butcher *et al.*, (2012) identified different types of diseases with their symptoms and also suggested different methods of treating such diseases. Some preventive measures were also mentioned by the authors. This system is not restricted to poultry diseases and it is not an automated system.

Arowolo, *et al.*, (2012) developed an expert system for management of poultry disease using visual prolog 7.3. The work laid emphasis on management of the

poultry disease and it was developed for the use of poultry farmers. The weakness of this system is that it did not actually define enough rules for sufficient diagnosis of the diseases.

Also, Thammi and Sudhakar (2006) presented a research work titled "An Information Technology Enabled Poultry Expert System: Perception of Veterinarian and Veterinary Students, University, India". The major aim of the work was not to carry out diagnosis but rather to collect relevant information from students and veterinarians of the institution on the effectiveness of using expert system for diagnosis and management of poultry diseases.

"*Animal knowledge based system*" was also developed by Maryam and Alaa (2013). The article present different methodologies of developing knowledge base system and developed an animal knowledge base system in Egypt. The system was not particular about poultry diseases.

Andino and Mahmud (2012) developed poultry disease warning system using Dempster-Shafer theory and web mapping. Obviously, the method used is more of Statistics and Geographical Information System. The principle adopted looks different from that of Expert System. It was built to visualize map so as to identify the existence of poultry disease in a region by the district, regencies or municipalities. Andino and Hassan (2012) present a research work titled "Avian Influenza Expert System using Dempster-Shafer. The system was able to identify Avian Influenza disease and display the result of identification process. The system only made use of basic probability assignments of symptoms and not Expert System approach to build the knowledge base. The system was also restricted to Avian Influenza as the only type of disease and other common poultry diseases were not considered

Going by the literature, it can be observed that each of the existing system have one weakness or the other. This research work is expected to come up with a better system that works on the principle of AI (Expert System).

Again, Most of the existing systems were not evaluated. In the very few ones that were evaluated, experts in the field were not directly involved. The new system will come up with better evaluation method that that will involve expert from the field. This will help to really determine the actual performance of the system by the users.

MATERIALS AND METHODS

In this research work, efforts were made to consult literatures to obtain relevant knowledge from

secondary sources and in the process, veterinary doctors, animal scientist, poultry keepers, poultry farm technologists were consulted for the purpose of knowledge acquisition. A database, knowledge base and inference engine were developed.

The system was implemented using C# and CLIP. The C# was used for the implementation of both the input and output interface (i.e. user interface). The processing of knowledge base rules was handled with CLIP.

The system was tested with different types of poultry diseases and the performance in terms of the result generated was quite impressive as it compete favourably with the result obtained by experts in the field.

System Design

Here, we present the architectural design of the system, Use-Case diagram, knowledgebase rules (including its English representation) which the expert system will rely on to carry out its activities as well as the input layout of the system. The knowledgebase was built based on the knowledgebase rules, obtained from the domain experts.

The system architecture is shown in figure 2 below.

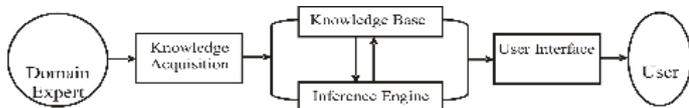


Figure 2: The system architecture

The use case diagram that explains the functional dependencies between the actor (users) and various use cases (activities) of the system is shown in figure 3.

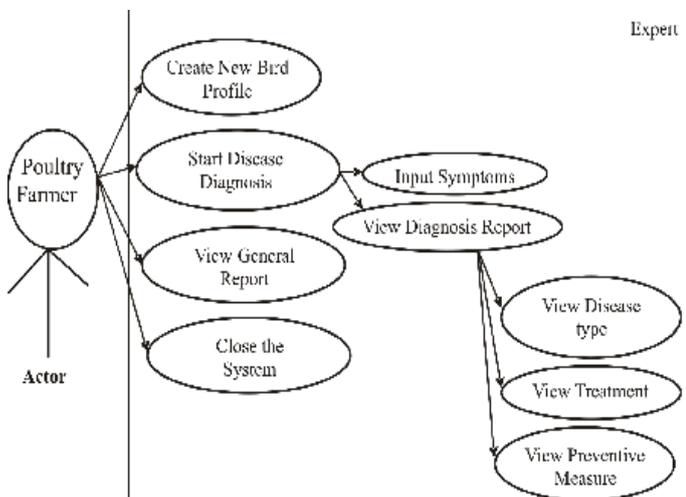


Figure 3: Use Case Diagram of the ES

Knowledge base Rules of the system are as follows:

Rule 1: Newcastle Diseases

IF the bird discharge from nostril
 AND there is labored breathing
 AND there is facial swelling
 AND there is sign of paralysis
 AND there is sign of trembling
 AND there is twisting of neck
 AND there is decreased feed
 AND there is decrease in water consumption
 THEN the disease is NEWCASTLE
 IF NEWCASTLE has been detected
 THEN there is no treatment

Rule 2: IF NEWCASTLE has been detected
 THEN give ANTIBIOTICS for 3-5 days to prevent secondary bacterial infection

Rule 3: IF NEWCASTLE has been detected
 THEN vaccination of small poultry and good sanitation are required in future

Rule 4: IF there is decrease in feed consumption
 AND there is decrease in water consumption
 AND there is watery discharge from nostril and eye
 AND there is labored breadth
 AND egg production dropped sharply
 THEN INFECTIOUS BRONCHITIS is confirmed

Rule 5: IF INFECTIOUS BRONCHITIS is confirmed
 THEN there is no treatment

Rule 6: IF INFECTIOUS BRONCHITIS is confirmed
 THEN use Antibiotics for 3-5 days to prevent secondary bacterial infection

Rule 7: IF INFECTIOUS BRONCHITIS is confirmed
 THEN run Biosecurity program and Vaccination

Rule 8: IF there is swelling around the face
 AND fowl smelling is noticed
 AND there is stick sticky discharge from the nostril and eye
 AND there is difficulty in breathing
 AND the eyelids sticked together
 THEN INFECTIOUS CORYZA is confirmed.

Rule 9: IF INFECTIOUS CORYZA has been diagnosed
 THEN use Sulfadimethoxine or erythromtcin or tetracycline for treatment

Rule 10: IF INFECTIOUS CORYZA has been diagnose
 THEN good sanitation will prevent future outbreak

Sample of the English representation of the knowledge based rules used in the implementation of the system is displayed in figure 4.

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Rule No. 8 Diagnosis
If the selection 1 "Run diagnosis"
If there is swelling around the face
AND fowl swelling is noticed
AND there is stick and sticky discharge from nostril and eyes
AND there is difficulty in breath
    
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Figure 4: English Representation of Rule8

The input layout for the developed system is shown in Figure 5.

Type of Bird:

Symptom 1:

Symptom 2:

Symptom 3:

Symptom 4:

Figure 5: Input Layout of the ES

SYSTEM IMPLEMENTATION

The system was implemented using clip and C# programming language. The CLIP representation of rules8 used as a sample is displayed in figure 6.

```

Rule no 8-Diagnosis of diseases
Defrule Rule 8
(Mouth Swelling)
(fowl smelling)
(nostril discharge)
(breadthy difficult)
(eyelidsticked together)
(printoutt"infectionsoryza is diagnosed"
(printoutt"Advise: use sulfadimthoxine/ Sulfamethazine
    
```

Figure 6: Clip representation of Rule8

Implementation of the user interface of the system using C# is shown in figure 7 and 8.



Figure 7: The Main Menu of the System Using C#

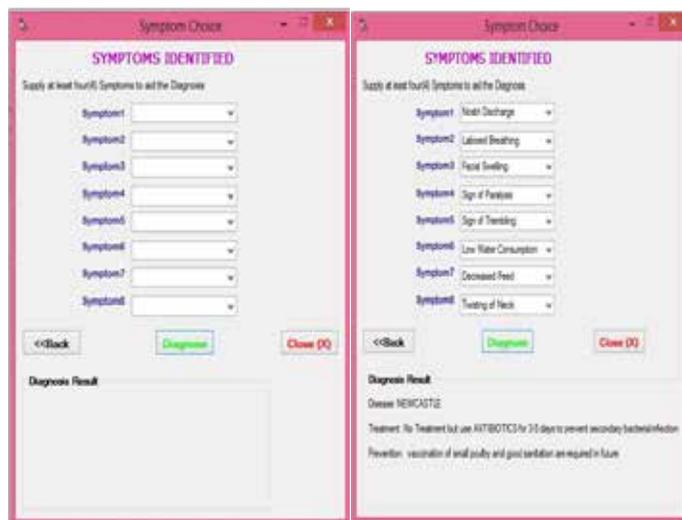


Figure 8: The Input / Output Interface Using C#

RESULTS AND DISCUSSION

Expert Systems are best evaluated by the users who are directly involved in the usage of the developed system. Hence, the developed system was evaluated by poultry farmers, veterinary doctors and poultry farm attendants based on the following parameters:

- i. Simplicity of user interface
- ii. Flexibility of the system
- iii. System response rate
- iv. Relevancy of the system to the desired environment
- v. Importance of the system to the user
- vi. Simplicity of its navigation
- vii. Ability of the knowledge based to diagnose diseases
- viii. Ability of the knowledge to prescribe the appropriate treatments

Table 1: System Evaluation Table

SN	EVALUATION PARAMETERS	RATING SCALES					
		Poor	Fair	Good	Very Good	Excellent	Mean
1	Simplicity of user interface	0	0	2	2	4	4.25
2	Flexibility of the system	0	0	1	2	5	4.50
3	System responses rate	0	0	2	2	4	4.25
4	Relevancy of the system to the desired environment	0	0	2	1	5	4.38
5	Importance of the system to the user	0	0	1	3	4	4.38
6	Simplicity of its navigation	0	0	0	3	5	4.63
7	Ability of the knowledge based to diagnose diseases	0	0	1	1	6	4.63
8	Ability of the knowledge to prescribe the appropriate treatments	0	0	1	2	5	4.50
	Performance evaluation (5%)	4.44					
	Performance evaluation (100%)	88.80					

Table 2: Comparism of the System with the Existing Ones

SN	Authors and year of Publication	Title	System Evaluation	Efficiency of the System	Overall Assessment
1	Butcher et. al (2012)	A review of expert system in animal health care	Not evaluated	Could not be determined	Could not be determined
2	Arowolo et. al (2012)	An Expert System for Management of poultry Diseases	Not well evaluated	C Nilai method was used and the value obtained was 8.37	Good
3	Saurkar and Watane (2012)	An Expert System for diagnosis of PET	Not evaluated	Could not be determined	Could not be determined
4	Andino and Hassan(2012)	Avian Influenza(H5N) Expert System using Dempster Shafer Theory	Not thoroughly evaluated	Could not be clearly stated	Could not be determined
5	New System	An Expert System for Diagnosis, Treatment and Management of Poultry Diseases (New System)	Thoroughly evaluated	The system is rated as 88.8% efficient	Excellent

Result shown in table1 shows that the mean performance of the system is 4.44 out of 5 and the overall system performance is 88.8 out of 100.This means that the system is 88.8 % efficient. It also follows that the level of acceptability is high. Table 2 reveals that the existing systems were not evaluated or they were poorly evaluated. So, the newly developed system is better.

CONCLUSION

A system for diagnosis, treatment and management of poultry diseases has been developed using AI (Expert System) approach. For the implementation of the system C Sharp (C#) and Clip were used. The system was tested with series of symptoms collected from experts in the field. The results generated or produced were quite impressive and shows a lot of improvemt over the existing ones. This research work will serve as an eye opener to expert system developers to give the concept of system evaluation enough attention. It is believed that this research work will go a long way to assist poultry farmers for effective management of their farms. It will also encourage young school levers to venture into poultry farming. At overall level, the research work will contributes to the improvement of the nation economy.

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