e-Veterinary System for Diagnosis of Viral Infections in Poultry

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ABSTRACT

Poultry farming in Nigeria is one of the largest growing subsector in the agricultural sector and as such proper medical attention for poultry animals in Nigeria is limited as an average poultry farm experiences minimal and costly specialist attention in regards to the health of their farm animals, hence diseases and viruses such as Newcastle Disease, Avian bronchitis and Avian Influenza (and for the fact that Newcastle and Avian Bronchitis are often mistaken for Avian Influenza because of similarity in sypmtoms) can prove deadly to the farm population. This necessitate the need for a readily available, easily accessible medical health system for the early diagnosis of these deadly poultry diseases which has the capability to wipe out herd of poultry birds in a single strike. The system was implemented with Prolog which provides a knowledge base and Java programming language that provides an interactive interface for the user. The system was implemented to help poultry farmers who are out of reach of veterinary health care facilities and services to diagnosis their birds against Avian Influenza, Avian Bronchitis and Newcastle that will help in early detection of the disease, reduce the mortality rate in poultry farming, increase productivity and reduce the risk of the pandemic and boost revenue for the Nigeria economy.

Keywords : Viral Infection, Expert System, Knowledge Base, Diagnosis, System and e-Veterinary

1 INTRODUCTION

Poultry farming in Nigeria is one of the largest growing subsector in the agricultural sector. The poultry farming sector account for 3.35% growth rate annually and production of about 201,493 tons of meat [1]. Poultry production in Nigeria amounts up to 3.8 million eggs yielded yearly, with a total population of 180 million birds. A total of 80 million chickens are raised extensively, 60 million in semi-intensively and the remaining 40 million are raised intensively [2]. *The value of the Nigerian poultry industry at over N1.2 trillion according to* [3]. Poultry birds experience high mortality rate due to diseases such as Avian Influenza which is the infection of birds caused by avian influenza Type A viruses. These diseases spread easily amongst poultry birds due to the fact that they are kept closely together and share the same food and water bowls. According to [4] Influenza is affected by a variety of signs and symptoms that may vary such as age, underlying chronic disease, complications experienced, host immunity status and influenza type. The influenza virus is naturally occurring amongst wild aquatic birds and can infect domesticated poultry. However, the former (wild aquatic birds) are carriers of the viruses but once transmitted to the later (domesticated poultry), it can wipe out an entire flock. Some of its symptoms includes ecchymosis on the shanks and feet (giving it a purple discoloration), coughing, sneezing, lack of coordination, cyanosis of the comb and wattles, subcutaneous edema of the head and neck for chickens. Birds experienced an average mortality rates of 22.8-30% in 48-72 hours of the infection and 28.5-40% in vaccinated chickens and non-vaccinated [5]. In view of the aforementioned, the shortage of veterinarians has created a niche for a more effective and efficient veterinary diagnosis system for solving the diagnosis problems experienced by poultry farmers especially in the rural areas. This diagnoses are based on the available symptoms as indicated by the farmer and also recommend treatment [6]. This research proposed e-veterinary system for diagnosis of viral infection in poutry that will diagnose and provides remedy for three (3) viral diseases namely: Avian Influenza, Newcastle and Avian Bronchitis in poultry. This is

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because Newcastle and Bronchitis are often mistaken for Avian Influenza in their sypmtoms manifestation with slight variation in their sypmtoms and for the fact that the Laboratories for detecting the diseases are inadequate and beyond the reach of poultry farmers in developing countries particularly in Nigeria. The major aim of a veterinary diagnosis system is to provide care or assistance in emergency situations to improve the quality of life for the poultry. The proposed diagnosis system will be comprised of programs and veterinary knowledge base which can be used to diagnose diseases caused by invasion of a pathogen which subsequently grows and multiplies in the body of a host such as Avian Influenza, Newcastle and Avian Bronchitis. Information retrieved from such a system is similar to the one given by a veterinarian.

2 LITERATURE REVIEW

2.1 Expert System

Expert system is a special branch of Artificial intelligence which makes extensive use of specialized knowledge to solve problems at the human expert level. An Expert system is a computer system that emulates human decision-making ability and is programmed to solve complex problems by knowledge-based reasoning. Normally, such a system contains a knowledge base that contains accumulated experiences and a set of rules for applying the knowledge base to each particular situation. There are various types of expert systems, it includes: rule based expert system, fuzzy expert system, frame based expert system and hybrid expert systems. Hybrid expert system is a blend of two or more intelligent device forms [7].

2.1.1 Veterinary Expert System

A veterinary expert system is built up of programs and veterinary knowledge-base for animals. The information obtained from veterinary expert system is similar to the information given by professionals in that particular area. Medical Knowledge of specialized doctor is vital for the growth of medical expert system [8].

2.2 Classification of Programming Languages

The programming languages to be adopted for use in this project and the concept behind them are:

2.2.1 Prolog (Logic Programming)

Prolog is a programming language centred on a small set of basic mechanisms, including pattern matching, tree-based data structuring and automatic backtracking. This small set constitutes a surprisingly powerful and flexible programming framework. Prolog is especially well suited for problems that involve objects in particular, structured objects and the relationship between them. Features like this make Prolog a powerful language for artificial intelligence (AI) and non-numerical programming in general [10]

2.2.2 Java Programming Language

Java programming language is a high-level object-oriented language. Java programming language was originally developed by Sun Microsystems which was initiated by James Gosling and released in 1995 as core component of Sun Microsystems' Java platform. Unlike many other programming languages including C and C++, when Java is compiled, it is not compiled into platform specific machine, rather into platform independent byte code. This byte code is distributed over the web and interpreted by Java Virtual Machine (JVM) on whichever platform it is being run. With Java's secure feature it enables to develop virus-free, tamper-free systems. Authentication techniques are based on public-key encryption. Java's multithreaded feature makes it possible to write programs that can do many tasks simultaneously. This design feature allows developers to construct smoothly running interactive applications. It also provides a friendly user interface display which is simple and easy to understand. Java is guaranteed to be Write Once, Run Anywhere [11].

2.3 Related Concepts

[12] The extensive options for poultry farming technology, only a small number of approaches are specialized in applying machine-learning techniques to support and improve the decision-making process. Pragmatically, they implemented a machine-learning techniques to extract information from historical data of broiler management, provide human analysts with an action plan, and examine its behaviour in the decision-making process.

Unpublished [13] Implemented an expert system for diagnosing viral diseases such as measles, mumps and chicken pox in human

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using Prolog. He designed the knowledge base with Prolog but his work was limited to 3 viral diseases in humans as against poultry.

[14] Proposed a web-based data acquisition system developed by the Lab VIEW software program for environment monitoring for poultry management. The measurement error and uncertainty analysis was conducted accurately to maximize the reliability of this system. Therefore, because of its more reliable uncertainty analysis and data evaluation, the proposed web-based data acquisition system has considerable potential for ensuring correct decision-making when used in poultry production. The system was limited to data error and uncertainty analysis in poultry.

[15] Developed a diagnosis expert system that can help in identifying diseases in broilers. They went on describing methods of treatment to be carried out taking into account the user capability in order to deal and interact with expert system easily and clearly. This system has 25 symptoms and 6 diseases using certainty factor method to solve the problem of uncertainty. The result of the research is that Broiler Expert System has been successfully identifying disease. The certainty factor cannot be used on too many diseases hence it was limited to 6 diseases only.

[16] Proposed the improvement of health system for detecting Mumps in India. Training of all involved in the surveillance system to deal with outbreaks and prevent their occurrence is of utmost importance. The Essential Public Health Service framework has enabled them to categorize the deficiencies in the health system effectively. The identification of level of improvement needed in each of the service areas might further prompt appropriate intervention to strengthen the health system and reduce the number of occurrences of various outbreaks in the future. However, the success of such analysis remains to be seen.

[17] A study of the Transferabilty of influenza case syndromes between two health care systems- undertook a study to prove the transferability of influenza case detection systems between two large healthcare systems. This study evaluates the accuracy and transferability of Bayesian Case Detection systems (BCD) that made use of Natural Language Processing (NLP) to infer the presence or absence of clinical findings from the emergency department notes. The notes are fed into a Bayesain network classifier (BN) to infer patients' diagnoses. The researchers manually built a natural language processing and trained the classifier from 40,000 emergency department encounters. However, this system does not interact with user to diagnose the disease but only evaluated an already diagnosed disease.

[18] Developed a sensitive surveillance system within the Integrated Disease Surveillance and Response (IDSR) framework. The system analyzed Measles surveillance data to determine the effectiveness of the Measles case-based surveillance system and estimated its positive predictive value in order to inform policy and practice. This system provided routine reports of suspected Measles cases as part of the general system of aggregate summary, reporting notifiable diseases and other health events. During passive surveillance, data was collected from suspected Measles patients during visits to health centres and then reported routinely using weekly, monthly and quarterly reports. This system however only kept data of reported victims but did not detect diseases.

Arising from the above literature reviewed, there is no research that uses Prolog and Java to diagnose the Avian Influenza, Newcastle and Avain Bronchitis. This is the gap that this gap that this research aim to bridge.

3 RESEARCH METHODOLOGY

3.1 Knowledge-Base of the Proposed System

The program works by having an in-depth knowledge of all symptoms of the viral infections under consideration (Avian Influenza, Newcastle and Avain Bronchitis). Each user is asked yes/no questions concerning the symptoms the bird is exhibiting, and the responses are subsequently recorded. The diagnosis works by matching symptoms of known infections with these recorded responses in a decreasing order of complexity. The Knowledge Base contains information about three (3) viral infections mentioned above which are represented as a set of if-then production rules. The knowledge base is analogous to the long-term human memory. The total ordering of production rules is

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done in the knowledge base.

Avian Influenza is a viral infection whose symptoms include fever, cough, nausea, sneezing and nasal discharge. So, it will be stored in knowledge base in the form of a rule which is as follows:

Hypothesis (Bird,avian_influenza) :-
Symptom (Bird, fever),
Symptom (Bird, cough),
Symptom (Bird, nausea),
Symptom (Bird, sneezing),
Symptom (Bird, nasal_discharge).

Avian Infectious Bronchitis is a viral infection whose symptoms include gasping, cough, sneezing, tracheal rales, nasal discharge and facial swelling. So, it will be stored in knowledge base in the form of a rule which is as follows:

Hypothesis (Bird, Avian_infectious_bronchitis):-
Symptom (Bird, gasping),
Symptom (Bird, cough),
Symptom (Bird, sneezing),
Symptom (Bird, tracheal_rales),
Symptom (Bird, nasal_discharge),
Symptom (Bird, facial_swelling).

Newcastle Disease is a viral infection whose symptoms include gasping, cough, twisting of head and neck, circling, complete paralysis and watery diarrhoea. So, it will be stored in knowledge base in the form of a rule which is as follows:

Hypothesis (Bird, newcastle_disease):-
Symptom (Bird, gasping),
Symptom (Bird, cough),
Symptom (Bird, twisting_of_head_and_neck),
Symptom (Bird, circling),
Symptom (Bird, complete_paralysis),
Symptom (Bird, watery_diarrhea).

3.2 Description of the Proposed System

System design is the process of designing the elements of a system such as the architecture, modules and components, the different interfaces of those components and the data that goes through that system. The purpose of the system design process is to provide sufficient detailed data and information about the system and its system elements to enable the implementation consistent with architectural entities as defined in models and views of the system architecture. The proposed system was designed using web technologies such as Hypertext Markup Language (HTML), Cascading Syle Sheet (CSS), JavaScript, Hypertext preprocessor (PHP) and Prolog. The front end is the web user interface where users can register, login, enter symptoms and view diagnosis result and treatment recommendations. While the Prolog is used to structure the knowledge base / Inference Engine for decision making by the system. The front end was developed using HTML, CSS and JavaScript. While the back end consists of a server which was locally hosted using XAMPP control panel, the database which was built using the MySQL. The backend uses Prolog for the inference engine and PHP for the registration.

3.3 Design of the Proposed System

Func 3.3.1 Functional Requirement

Functional requirements are requirements expected of the functional and operational aspect of the proposed system. These requirements refer to the services and functionalities which the software renders to the end users. They refer to the explicit features of the proposed system. The functional requirements of the intended system is shown in Figure 3.1. Use case diagram is a software design methodology used to visually depict the user's interaction and user's capability or privileges with a particular system.

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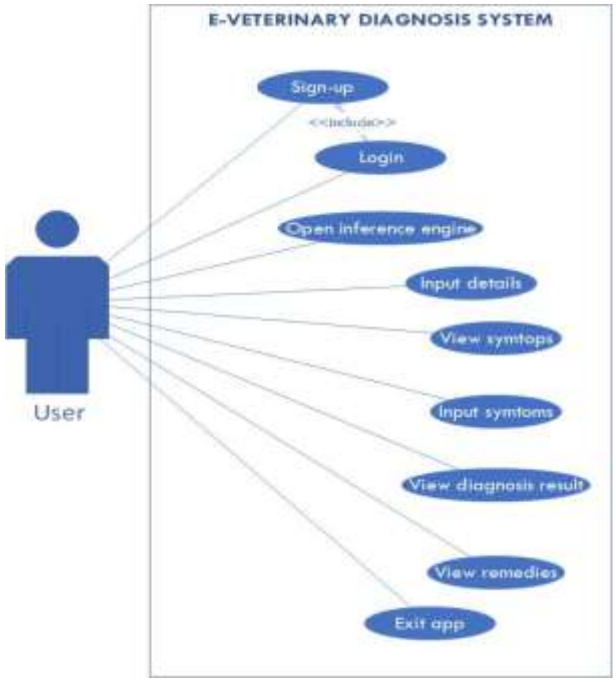

Figure 3.1: Use Case Diagram

3.3.2 Software Architecture

Architecture of any system is a logical model, structured in a way that defines the organization and behaviour of the system. That is, system architecture is a way for a formal representation of any given system. The architecture of the proposed system is shown in Figure 3.2 below.

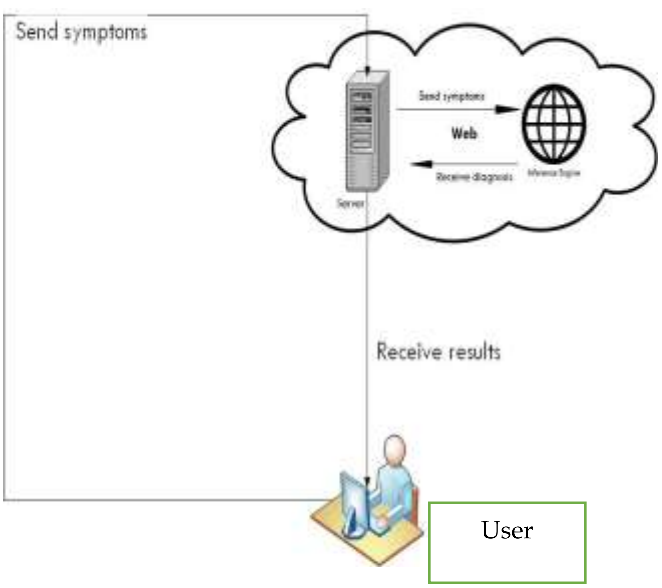

Figure 3.2: System Architecture of the proposed system IV

The system architecture above, shows how the user will interact with the user interface by selecting the appropriate symptoms, the inference engine will process the user query and an output will be displayed which will show the medical status of the affected bird and the possible medications to treat the diagnosed disease. The user sends the symptom of the bird via the computer interface to the local server. The server sends the input into the inference engine where all the symptoms sent will be processed. After processing the inference engine sends the diagnosis report back to the server and the server forwards the diagnosis report back to the user through the computer interface.

3.3.3 Workflow of the Use Cases

An activity diagram is used to represent the workflow of the use cases. Activity diagram is another important diagram in Unified Modelling Language (UML) used to describe the dynamic aspects of the system. Activity diagram is basically a flowchart to represent the flow from one activity to another. The activity can be described as an operation of the system. The control flow is drawn from one operation to another. This flow can be sequential, branched, or concurrent. Activity diagrams deal with all type of flow control by using different elements. The workflow of the use case is represented using the activity Figure 3.3 below.

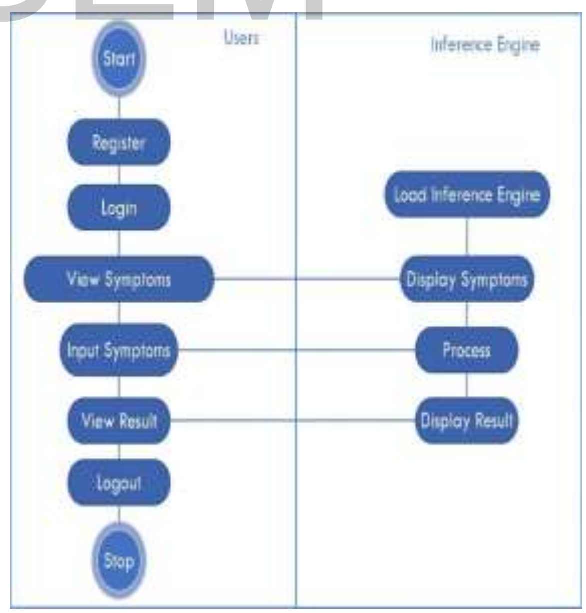

Figure 3.2 Activity Diagram

4 SYSTEM MENUS IMPLEMENTATION

4.1 The Knowledge Base

The Knowledge-Base contains information about three (3) viral

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infections under consideration which are represented as a set of if-then production rules. The symptoms of each infection are stored in the knowledge base of each disease. Figure 4.1 shows the knowledge base of all the three (3) infections (Avian Influenza, Newcastle and Avian Brochitis) respectively.

Figure 4.1: Knowledge Base of the System

In Figure 4.1 each disease is stored in the knowledge base with their individual symptoms. The system diagnosed disease based on the symptoms in the knowledge base and the input of the user.

4.2 SWI Prolog Interface

Prolog uses SWI interface to start the applications written in prolog. The system begins with the command "start." Writing in the SWI interface. Figure 4.2 below shows the SWI interface to initiate the system.

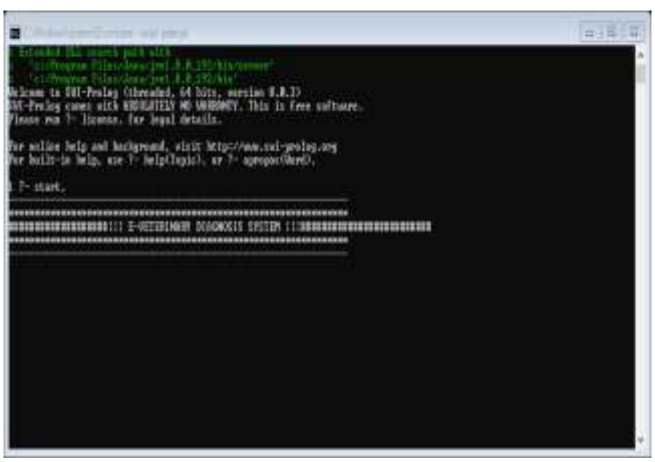

Figure 4.2.: SWI Interface to Initiate the System

The SWI Prolog applications checks to see if java is installed in that particular system so as to enable it compatibility with java for graphical user interface. It displays the application version and its licence legal details.

4.3 User Registration Page

The system provides graphical user interface for easy interaction with the users. The system displays a form for the user to register before the system can recognises the user with the login credentials pre-registered in the database for that particular time. This is shown in Figure 4.3. The first page will guide the user to navigate seamlessly through the system.

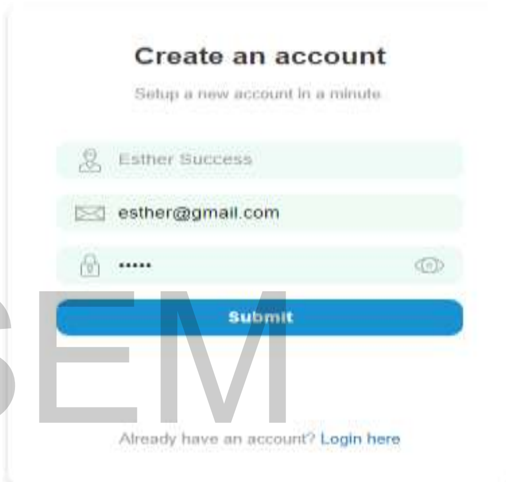

Figure 4.3: The Registration Page

4.4 User Login Page

The system provides graphical user interface for easy interaction with the users. The system displays a login page to authenticate authorised users and reject unauthorised users. This is shown in Figure 4.4. The first page will guide the user to navigate seamlessly through the system.

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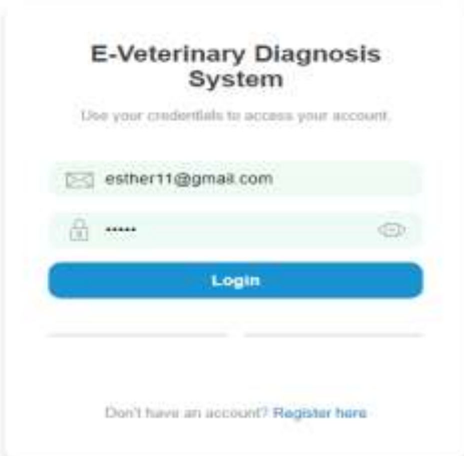

Figure 4.4: The Login Page

4.5 Main Menu

The system provides graphical user interface for easy interaction with the users. The system implements a main menu where only authorised users have access to the system. This is shown in Figure 4.5. This page will guide the user to navigate seamlessly through the system. This page allows users to start the inference engine and carry of diagnosis on birds.

Figure 4.5: The Main Page

4.6 Graphical User Interface

The system provides graphical user's interface for easy interaction with the users. The system displays an input for the users to input name, the system then recognises the user with the name inputted for that particular time. This is shown in Figure 4.6.

Figure 4.6: The Index Page

This page collects the user's name and then direct the user to the next interface for diagnosis. Asking various questions pertaining to the viral infections stored in the system knowledge base.

4.7 Diagnosing the Viral Infections

The system follows a matching pattern to diagnose each disease, the system determines its result based on the inputted symptoms by the user. The system asks a yes/no questions, the user responds by typing in 'y' for yes and 'n' for no any other letter is taking as void. The system displays questions based on previous questions answered by the user. Therefore, the system eliminates the time for displaying all questions and displays questions related to the previous one having same symptoms with a particular disease.

4.7.1 Bird Result for Avian Influenza

For diagnosis of Avian Influenza, the system detects common symptoms stored in the knowledge base for Avian Influenza. The Figure 4.7 below show the system questions asked and result displayed for Avian Influenza and recommended treatment for all infections.

Figure 4.7: Displays Question for Fever

The Figure 4.7 above shows the user input for the question "is the bird having fever". The user inputted y (yes), the system displays

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the next question in relation to all the disease as fever as its symptom. Figure 4.8 below shows the next question.

Figure 4.8: Displays Question for Cough

The Figure 4.8 above shows the user input for the question "is the bird having cough". The user inputted y (yes), the system displays the next question in relation to all disease that as fever and cough as it symptoms. Figure 4.9 shows the next question.

Figure 4.9: Display Question for Nausea

The Figure 4.9 above shows the user input for the question "is the bird having Nausea". The user inputted y(yes), the system displays the next question in relation to all disease as fever, cough and nausea as its symptoms. Figure 4.10 below shows the next question.

Figure 4.10: Display Question for sneezing

The Figure 4.10 above shows the user input for the question "do you have runny nose". The user inputted y (yes), the system displays the next question in relation to all disease as fever, cough, nausea and sneezing as its symptoms. Figure 4.11 below shows the next question.

Figure 4.11: Display Question for Nasal Discharge

The Figure 4.8 above shows the user input for the question "is the bird having nasal discharge". The user inputted y(yes), the system displays the next question in relation to all disease that as fever, cough, nausea and sneezing as it symptoms. The system detects if a particular disease as all the symptoms, if yes it then displays the result but if not, the next question is asked. Figure 4.12 below display the result base on the user input.

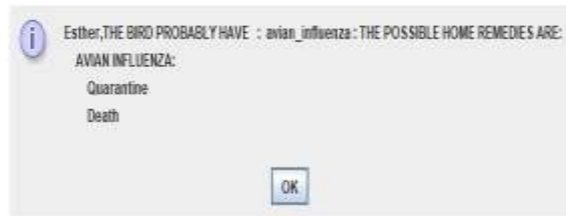

Figure 4.12: Display Result for Disease Diagnose and Possible Home remedies (Avian Influenza)

4.8 Bird Result for Avian Bronchitis

For diagnosis of avian bronchitis, the system detects common symptoms stored in the knowledge base for avian bronchitis. The system displays the question "is the bird gasping" as shown Figure 4.13, the bird input yes(y) the next question is display "is the bird gasping" the users input n(no) as shown in Figure 4.13 below.

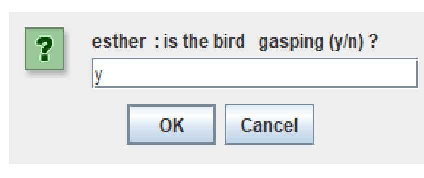

Figure 4.13: Display the User Negative Input for Gasping

The Figure 4.13 above shows the user input for the question "is the bird gasping". The user inputted n (no), the system displays the next question in relation to all disease that as fever, but not gasping as its symptoms. Figure 4.14 below shows the next question.

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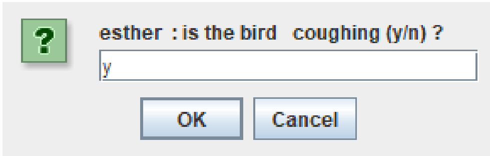

Figure 4.14: Display User Input for Coughing

The Figure 4.14 above shows the user input for the question “is the bird coughing”. The user inputted n (no), the system displays the next question in relation to all disease that as cough, but not cough and gasping as it symptoms. Figure 4.15 below shows the next question.

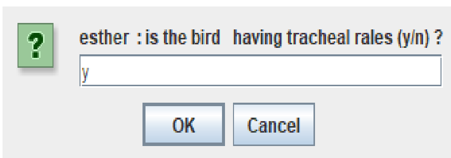

Figure 4.15: Display User Input for Tracheal rales

The Figure 4.15 above shows the user input for the question “is the bird having tracheal”. The user inputted y (yes), the system displays the next question in relation to all disease that as fever, cough and tracheal but not sneezing or nausea as its symptoms. The system detects avian bronchitis as result of the diagnosis. Figure 4.16 shows result of diagnosis.

V

Figure 4.16: Display Result for Disease Diagnose and Possible Treatment (Avian bronchitis)

4.9 Bird Result for Newcastle Disease

For diagnosis of Newcastle disease, the system detects common symptoms stored in the knowledge base for Newcastle. The system displays the question “is the bird twisting it neck” as shown Figure 4.17, the users input yes(y) the next question is display “is the bird cycling” the users input y (yes) as shown in Figure 4.18, the next question display is “is the bird experiencing paralysis” the users input y(yes) as display in Figure 4.19.

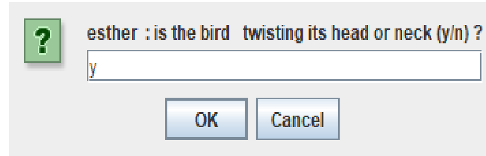

Figure 4.17: Display User Positive Input for Twisted neck

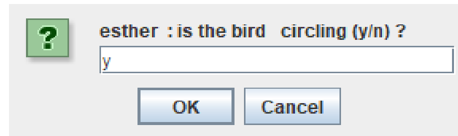

Figure 4.18: Display User Positive Input for cycling

Figure 4.19: Display User Positive Input for paralysis

The system detects Newcastle disease as result of the diagnosis. Figure 4.19 below shows result of diagnosis.

Figure 4.20: Display Result for Disease Diagnose and Possible Treatment (Newcastle Disease)

5 CONCLUSION

An e-Veterinary system for the diagnosis of viral infections in poultry that is efficient and effective in diagnosing and remedy of the following viral infections: Avian influenza, avian bronchitis, and Newcastle Disease in poutry was implemented. The e-Veterinary Diagnosis System is handy in sharing the much-needed expert knowledge in diagnosis and remedy of the viral infections entioned above. The system was implemented with the capability to receive birds’ symptoms through a graphical user interface, process it using an inference engine comprising of the knowledge base and display the bird’s status, based on the as-

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sessment or evaluation of the inputted symptoms. The system is user friendly, easy to navigate and highly interactive. The implementation consists of a good user interface that is fool proof thereby it requires little expertise to use the system.

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