Developing an Expert System for Goat Disease Diagnosis and Treatment

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Abstract
Ethiopia has the largest livestock population of any country in Africa. Agriculture in Ethiopia is the foundation of the country's economy, accounting for half of gross domestic product (GDP), 80% of exports and 85% of total employment. Livestock is an important and integral component of agriculture, which is the pillar of the Ethiopia economy and Ethiopia is believed to have the largest livestock population in Africa. Goat and sheep productions are highly influenced by feed shortage, disease and parasites, market fluctuation, high predatory, genetically less productive breed, severe water shortage and high shortage of labor. Diseases of various origins (bacterial, viral, parasitic, etc.) are among the numerous factors responsible for poor production and productivity. In Ethiopia the goat mostly their productivity is hampered by prevalence of different diseases. Unluckily, agricultural specialist assistance may not always available and accessible to every farmer when the need arises for their help. In an effort to address such problem, this study presents the development of rule-based knowledge-based system for goat disease diagnosis and Treatment (KBSGDDT) that can provide advice for research centers and development agents to facilitate the diagnostic process. To this end, knowledge is acquired using both structured and unstructured interviews from domain experts which are selected using purposive sampling technique from health agents. Relevant documents analysis method is also followed to capture explicit knowledge. knowledge-based system is developed using SWI Prolog editor tool. The system was evaluated using visual interactive method; it was shown that the system agreed with human expert opinions in 81.25 percent of the decision.

Keywords: Knowledge-Based System, Knowledge representation, knowledge acquisition, Goat disease.

1. Introduction

Ethiopia has the largest livestock population of any country in Africa. Ethiopian possesses one of the largest goat populations in the continent that serves multiple functions to communities that herd them [1].

Agriculture in Ethiopia is the foundation of the country's economy, accounting for half of gross domestic product (GDP), 80% of exports and 85% of total employment [2]. Livestock is an important and integral component of agriculture, which is the pillar of the Ethiopia economy and Ethiopia is believed to have the largest livestock population in Africa. Ethiopia's livestock population, estimated as 59.5 million cattle, 30.70 million sheep, 30.20 million goat, 2.16 million horses, 8.44 million donkeys, 0.41 million mules, 1.21 million camels and 56.53 million heeds of chicken, and are widely distributed across the different agro-ecological zones of the country [3].

Goat productions are highly influenced by feed shortage, disease and parasites, market fluctuation, high predatory, genetically less productive breed, severe water shortage and high shortage of labor. In Ethiopia, almost all goats are produced in mixed crop-livestock and pastoral and agro-pastoral systems [1]. Small ruminants especially goats are among the livestock species that are densely populated in Ethiopia and mostly their productivity is hampered by prevalence of different diseases [4]. Diseases of various origins (bacterial, viral, parasitic, etc.) are among the numerous factors responsible for poor production and productivity [5] [6]. Ethiopia has the large size of the country's goat population, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low. This may be due to different factors such as poor nutrition, prevalence of diseases, lack of appropriate breed and breeding strategies and poor understanding of the production system as a whole [1]. In Ethiopia, 5-7 million sheep and goats die each year due to disease and the overall economic loss from meat industry due to parasitic diseases is estimated at 400 million annually [7].

Government veterinary clinics are the main service providers. However, the distance from the residence to the clinics is far. This study revealed that, accessibility to veterinary clinicsmeans of transportation, poor roads and distance to veterinary clinics were important challenges in the treatment of sick animals on top of scarcity of professionals and chemotherapeutic drugs. This problem needs sufficient and knowledgeable agricultural experts to identify the diseases and to describe the methods of treatment and protection at early stage of infestation. Unluckily, agricultural specialist assistance may not always available and accessible to every farmer when the need arises for their help.Moreover, there is a shortage of extension agents to provide quick and timely decision making as each agent has to serve on average 1090 farmers [8]. To address such problems the application of information technology is important to deploy in agricultural area. Knowledge based system is one aspect of information technology which provides the appropriate management for diagnosing diseases attacking crop [4]. Artificial intelligence has emerged after the introduction of the first computers. Currently, the concept of the artificial intelligence is understood as a branch of computer science, in which the computer programs have capability to simulate human behaviors [9].Hence, this study presents the development of rule-based knowledge-based system (KBS) for goat disease diagnosis that can provide advice for research centers and development agents to facilitate the diagnostic process. KBS can act as an expert on demand without wasting time, anytime and anywhere. With the proper utilization of knowledge, the knowledge-based systems make decisions, recommendations and perform tasks based on user input, increase productivity and document rare knowledge by capturing scarce expertise and enhances problem solving capabilities in most flexible way [10]. Knowledge based systems (KBS) has been developed for a variety of reasons, including: the archiving of rare skills, preserving the knowledge of retiring personnel, support in decision making and to aggregate all of the available knowledge in a specific domain from several experts and/or machines [11].

1.2 Statement of Problem

Ethiopian possesses one of the largest goat populations in the continent that serves multiple functions to communities that herd them. Goat productions are highly influenced by feed shortage, disease and parasites, market fluctuation, high predatory, genetically less productive breed, severe water shortage and high shortage of labor. In Ethiopia, almost all goats are produced in mixed crop-livestock and pastoral and agro-pastoral systems. large size of the country's goat population, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low. This may be due to different factors such as poor nutrition, prevalence of diseases, lack of appropriate breed and breeding strategies and poor understanding of the production system as a whole. In Ethiopia the goat mostly their productivity is hampered by prevalence of different diseases. This study revealed that, accessibility to veterinary clinics means of transportation, poor roads and distance to veterinary clinics were important challenges in the treatment of sick animals on top of scarcity of professionals and chemotherapeutic drugs. It is applicable and promising for assisting development agents who are working in rural areas where skilled health experts are unavailable for an early treatment to the infected patient before the condition get worse.

1.3. Objective

1.3.1. General Objective

The general objective of the study is to Develop Knowledge Based System for diagnosis and treatment Goat Disease.

1.3.2. Specific Objectives

The specific objectives of the study were:

- To understand the concept that can be helpful in designing knowledge-based systems for goat disease diagnosis of the pre-laboratory screening process.
- To extract knowledge from domain experts and manuals in the area of goat disease diagnosis in afar region.
- To design a system where the user can interact with the system to manage or diagnosis various goat diseases.

- To develop a knowledge base that consist information about goat disease diagnosis of the pre-laboratory screening process.
- To test and evaluate the performance and user acceptance of the developed system.

1.4. Methodology of the Study

In order to achieve the objectives of this research the following methods and techniques are employed.

1.4.1. Requirement Gathering

Both unstructured and structured interview were used to collect tacit knowledge from domain experts. In addition to evaluating the requirements elicitation methods are used to purify the collected knowledge. The acquired knowledge is refined with the consultation of the expert. Moreover, secondary sources of knowledge are gathered from the internet, tuberculosis diseases diagnosis and treatment guide lines, research papers and articles by using document analysis technique.

1.4.2. Requirement Gathering Techniques and Sample Size

Purposive sampling technique would be used to select domain experts for knowledge requirements acquisition. The selection criteria of domain experts for the study are based on the profession, educational qualification level, year of experience and their immediate position in the tuberculosis diseases diagnosis.

1.4.3. Knowledge Requirement Representation Method

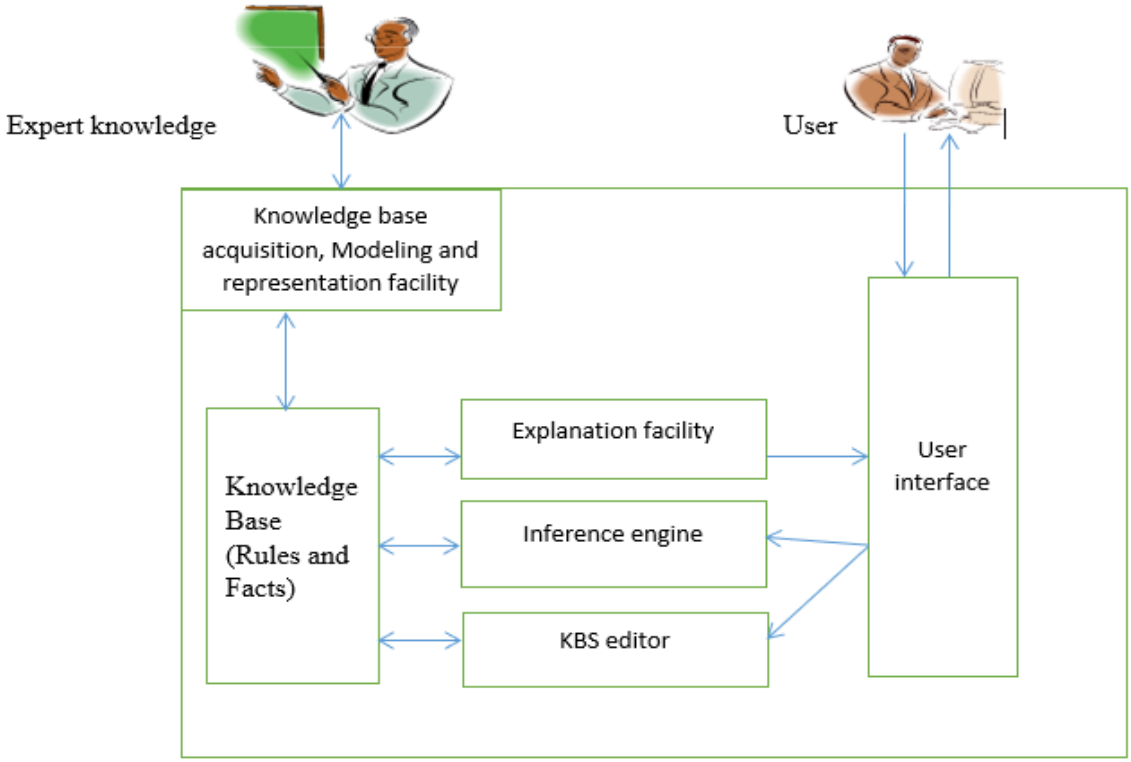
After the knowledge would be acquired, it was represented using rule-based knowledge requirement representation method. For this research the knowledge requirement representation method, rule based was chosen because it clearly demonstrates the domain knowledge. In rule-based system much of the knowledge was represented as a rule that is as conditional sentences (IF THEN) relating statements of facts with one another. As a result, rule-based representation method is more appropriate to represent and demonstrate the real domain knowledge in diagnosing goat diseases. Additionally, rule-based systems are the most commonly used knowledge representation language in health sector.

1.4.4. Software Requirements Tools

The programming languages and tools would be used to develop knowledge-based systems. In this study, SWI-prolog programming language would be used to build the knowledge base of the system. The reason of the selection of this programming language is the features and abilities of the language that incorporate it. Prolog is a declarative language (we specify what problem we want to solve rather than how to solve it) and has the capacity to describe the real world. It has flexible and fast interface. In addition, it is portable to many platforms including almost all UNIX/LINIX platform and window vista.

2. Proposed System architecture

This system was designed with the progression of conceptual design that refined the systems' architecture. Of course, the conceptual design was essential to stabilize the architecture of knowledge-based system for Goat disease diagnosis and treatment. Throughout design iterations, the design of knowledge-based system for Goat disease diagnosis and treatment was expended into system architecture to ensure that it supported the disease and treatments. The system architecture and the functional follow of the system are presented below.



2.1. System User Interface

KBSGDDT used a simple user interface to display the information. When KBSGDDT identified a possible type of Goat disease, the system would present descriptions, treatments and preventions of the disease on the screen. The user could view different type of disease problems, descriptions, and treatments for the goat disease. The first page of the user interface welcomes users and describes what the system does as shown in the figure 1.

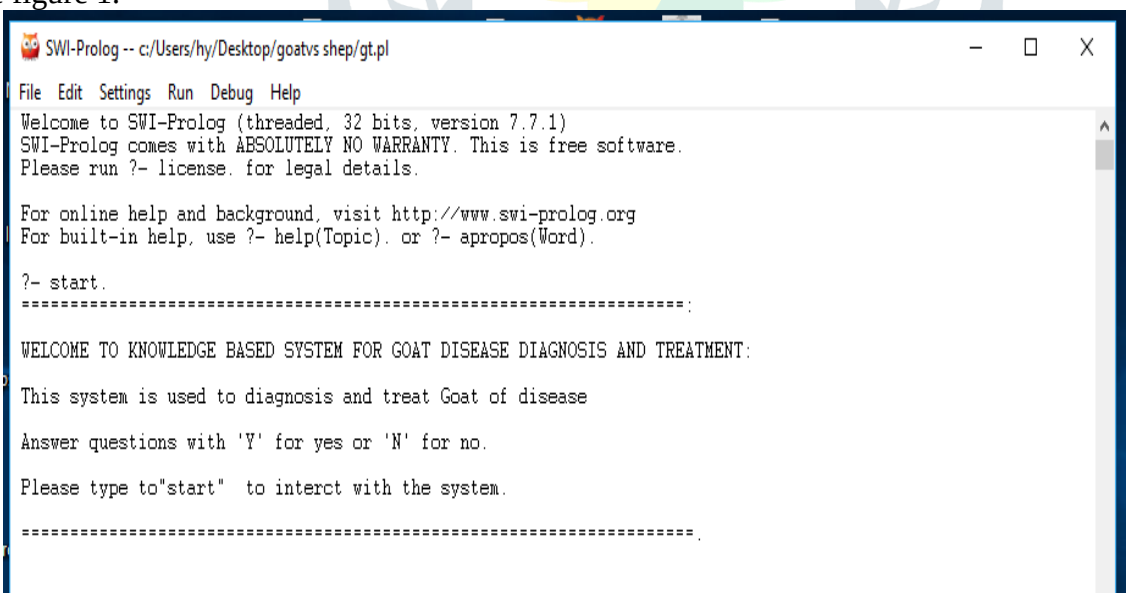


Figure 2 Welcoming windows of KBSGDDT user interface above

After the prototype displays the greeting page a user can interact directly with the system by answering the question “yes or no” followed by dot. The following figure shows the sample dialogue windows between the user and the system to identify the types of goat disease.

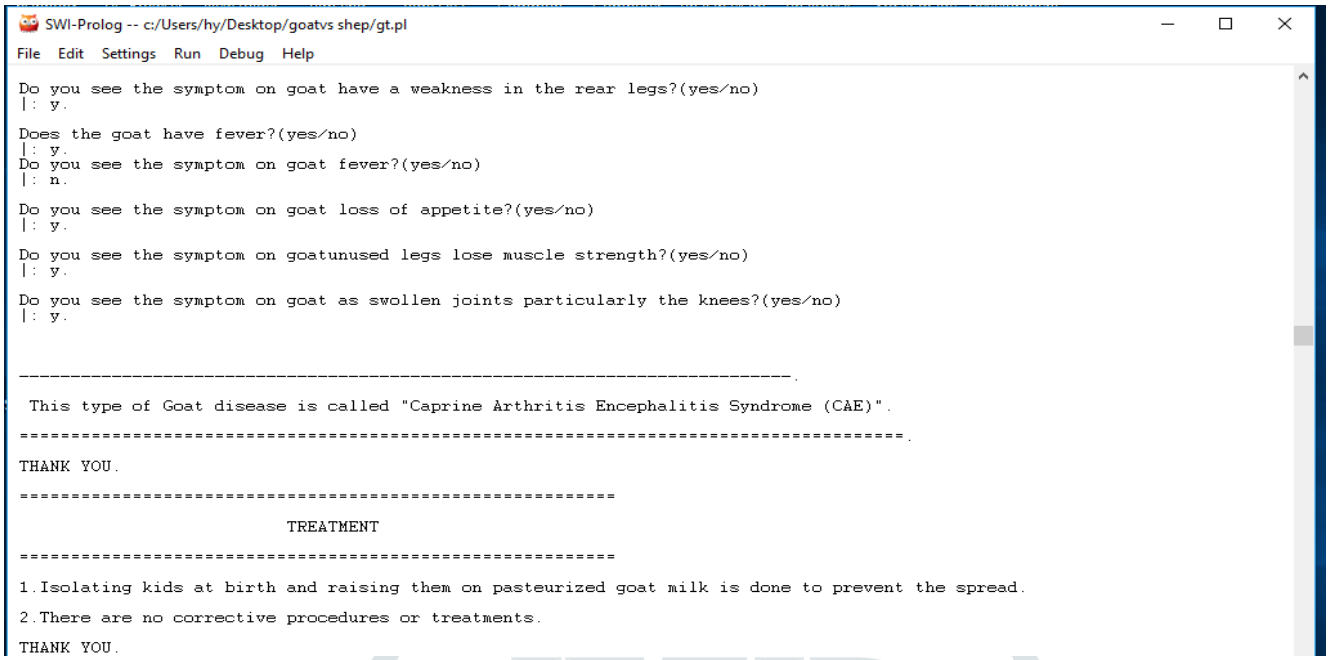


Figure 3 sample dialogue windows between the user and the system to identify the types of goat disease

2.2. System Evaluation and testing

Evaluation of the prototype knowledge-based system is an important phase that helps to measure the performance of the developed system. In this study, GDKBS is evaluated to recognize accuracy and efficiency of description and treatments provided by the system in diagnosing Goat disease. It also helps to check whether the objective of this research work is achieved. All seven closed ended questions answered as excellent, very good, good, fair and poor. Therefore, for the ease of analyzing the relative performance of the system based on users evaluation the researcher assigned numbers for each criteria as excellent=5, very good= 4,good=3, fair=2, poor=1. The system evaluators give the value for each closed ended question.

The following table indicates the results obtained. The user acceptance of the system is computed manually using Equation (1) [10].

$$AveS = SV1 * \frac{nr1}{tnr} + SV2 * \frac{nr2}{tnr} + \ldots\ldots\ldots \sum_{i-1}^{n} SV_i * {nri}/{tnr} \qquad (1)$$

Where, AveS average score, SV scale value, tnr total number of respondent and nr is number of respondents. To get the result of user acceptance average performance is calculated out 100%.

$$Avp == {AveS}/{NS} * 100$$

Where, **NS** is number of scale and **Avp** is average performance.

		Criterions					
No	Questions	Poor(1)	Fair(2)	Good(3)	V. good(4)	Excellent(5)	Average
1	The easiness of the system to use and interact with it is	0	0	1	2	1	4.0
2	Attractiveness of the system is	0	0	2	2	0	3.5
3	The efficiency of the system in time is	0	0	1	2	2	4.2

4	The accuracy of the system to reach the decision about goat disease identification.	0	0	1	2	2	4.2
5	The sufficiency of the knowledge does the system incorporate to diagnosis goat disease	0	0	2	2	1	3.8
		Total average					4.06

Table 1 KBSGDDT user performance evaluation results

As shown in table above (Table 1) 25% of the respondents rated easiness to use and interact with it as good,50% of the respondents rated easiness to use and interact with it as very good, while the remaining 25% respond the same question as excellent. In the same way, for question 'attractiveness of the prototype' 50% of the respondents evaluated as very good 50% of them as excellent and none of them rate it as good. Similarly, 20% of the respondent rated the efficiency of time as good, 40% of respondent as very good and the remaining 40% of them as excellent. Additionally, 20% of them responded as good, 40% of them as very good and the rest 40% as excellent for the criteria "system's ability to identify type of infections". Likewise, for the criteria 'The sufficiency of the knowledge does the system incorporate to diagnosis goat disease' 40% of them respond as good, 40% of them rated as very good and the rest 20% as excellent. Based on the results obtained the overall average performance of the prototype with user's point of view is 4.1 on a scale of 5. This result indicates that the overall average performance of the prototype knowledge-based system is about 82%. This implies that the modeled prototype was performs well in making right decisions on the diagnosis of disease affected.

3. Results and Discussion

The evaluation and testing procedures help to address the question of user acceptance and accuracy of the prototype. Visual interaction and questionnaire methods are used to assess user's acceptance issues and applicability of the prototype. Based on the evaluation results obtained from visual interaction with closed ended questions none of the evaluators respond as poor or fair. On the other hand, evaluators reply good eight times (15%), very good fourteen times (35%) excellent ten times (31.25%) the following table summarizes the results obtained on close ended questions.

Table 2 Users evaluation result summary on closed ended questions

Respondents who respond as	Poor (1)	Fair (2)	Good (3)	Very good (4)	Excellent (5)	Average
Total number	0	0	8	14	10	4.06
%age of 100%	0	0	15	35	31.25	81.25

As shown in the above Table 4.13 the overall average user acceptance evaluation of the prototype Knowledge based system is about 81.25%, this means the prototype is accepted by 81.25% of respondents. Therefore, above 81.25% of users are satisfied with the easiness, attractiveness, speed, accuracy, adequacy problem solving ability and the significance of the prototype knowledge-based system in the domain area. This implies that the prototype modeled relevance and satisfactory domain knowledge in useful way and it performs well in making right decisions on the diagnosis of Goat disease.

Conclusion

The knowledge engineer to develop KBS for diagnosis and treatments of goat disease performed basic tasks: first the knowledge engineer assessed the problem area and the problem is considered feasible, then a statement of requirements is created and the development process continued as follows, knowledge was

acquired using both structured and unstructured interviews with domain experts and from relevant documents by using documents analysis method to get concepts and facts of goat diseases. The acquired knowledge focuses on concepts and facts of goat diseases. Knowledge based system coded by using SWI Prolog tool to form the knowledge-based system. Finally, the evaluating and testing result shows that, the overall performance of the prototype system registered 81.25% accurate result.

Recommendation

This rule-based system is not self-learning, in the future learning component should be integrated that reasons and remembers when new circumstances and unknown facts are asked by users to suggest solutions. In order to make the system applicable in the domain area for diagnosis of goat disease, the user interface should support local languages to meet the needs of local users and more research work must be done to incorporate high quality pictures which depict the symptoms in order to identify the disease.

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