International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

Mobile-based Cattle Infectious Disease Prediction System

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Abstract: ***It is not easy to notice the infectious disease that can spread among the herd of animals, such as cattle, sheep, etc without daily care and diagnosis. However, it is expensive to give daily care in detail by human to them due to large number of animals and expensive costs of veterinary. This paper presents a novel prediction algorithm for diagnosing cattle's infectious disease with mobile based information system. It mainly uses Naïve Bayes classifiers to classify the level of risk affected to cattle by observing six baseline syndrome patterns of animal health such as body weight, ambulatory lameness, decreased feed intake/milk production, respiratory, skin/ocular/mammary and gastrointestinal signs. The system firstly uploads the abnormal information detected from cattle to our mobile based system. It then analyzes them using Naïve Bayes classification algorithm to know what kind of diseases currently affect to them and give suggestion the method of cure for earlier protection to them. The paper then performs the experiments with the cattle baseline patterns surveyed from different five livestock area in Myanmar. The results show that our prediction algorithm produces accurate results (95.6% for almost each 600 data patterns obtained, from each area, about 3000 in total) and could help those who are thriving in need of human veterinary to analyze their cattle's health conditions.***

Keywords: cattle health, naïve bayes classification, veterinary, syndrome patterns

1. Introduction

Many infectious diseases are increasing in the herd of animals especially in low-income countries that mainly depends on human-based animal production system due to lack of smart diagnosing system using low-cost devices such as mobiles, computer, etc [1]. In Myanmar, device-based animal's caring system has been urgently demanding to aid the animal production industries as well as the local farmers. We need more dairy farms and products for the people of Myanmar with low prices and also need to help the local farmers to nurture their cattle and bulls by themselves without going to veterinary whenever something happens to cattle.

Cattle production industry is not only important to dairy food industry and also to socioeconomic empowerment of households in Myanmar. However, they mainly depend on human labors for nurturing them with human eyes that leads to expensive and laborious production and ends with inaccurate and ineffective diagnosing results to fast infectious diseases among cattle [2,3].

In order to transform human-based cattle production to smart devices-based ones, mobile technologies are a promising solution for obtaining, transmitting and analyzing animal health information in a timely fashion. Recent popularity of mobile usages in Myanmar, anyone who even are in low-income, can effortlessly use a mobile phone. So as to take advantage of it, to confront the challenges mentioned in above paragraphs, we focus on cattle diagnosing system using mobile phones as well as motivation of other web or mobile-based animal health information system [4][5][6].

In this paper, we propose a mobile-based cattle disease detection and prediction system depending on the cattle's six symptoms uploaded by the user. Naïve Bayes classification algorithm is mainly used to analyze the diagnostic data of the user against the data pre-stored in the veterinary database in the system. The system then detects the potential diseases and suggests the possible medication to corresponding diseases.

The rest of the paper is organized as follows. The related works regarding information technology based veterinary studies are reviewed in Section 2 while all materials and methods used by this system is studied in Section 3. The detailed explanation about system structure and solutions are explained in Section 4. The paper is concluded in Section 5 with future works we intend to extend this proposed work.

2. Literature Review

The objective of the study proposed by Giorgio Marchesini et al [2], was to measure the level of activity and rumination in young bulls and to obtain the data to determine their health status using average daily weight gain (ADG), the dishomogeneity index of rumination (DR), and the daily dishomogeneity indices of activity (DDA) and rumination (DDR), were calculated. They used individual sensors to watch early diagnosis of disease in beef cattle in order to develop improved herd management system.

A pilot study for cattle diseases was made by Tariku jibatBeyene et al [1] using smartphone-based technology in estimating disease probabilities of cattle by observing various clinical signs and remedies records. They mainly used multiple variable logistic regression analysis in order to indicate the positive or negative results of the cattle health conditions. They then demonstrated that the use of smartphone-based cattle diagnosis system with modified Delphi protocol to capture the likelihood of a diagnostic match and analyze the confidence level associated with the prediction made by VetAfrica—Ethiopia.

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Combination of veterinary process with information technology helps novel uses of Web and pocket personal computer applications to provide speed, efficiency, interactivity, and security to animal production processes [3]. A approach and tools to clinically detect the potential disease in livestock animals were developed through two prototype information system namely veterinary practitioner aided disease surveillance system (VetPAD, New-Zealand) [3] and the rapid syndrome validation project-animal (RSVP-A,USA) [4]. The first one was developed by cooperating seven pilot veterinarians with information technologists whereas 17 veterinarians involved in second one.

The detailed explanation and comparison of above two prototypes were performed by Gwenaelvourch [5] et al. Ayodele et al [7] executed a participatory epidemiology survey to diagnose and treat bovine disease of animals. They discussed levels of ethno- and bio-veterinary knowledge and their application within pastoralist livestock healthcare practices.

Suharjito et al [6] used fuzzy Tsukamoto method to diagnose the reproductive disorders in cattle farming business based on six clinical symptoms. They developed android based application system targeted to cattle producers and farmers with validate prediction results.

Joseph et al [8] studied the major diseases that hinder poultry and cattle production in Uganda. The data generated by central diagnostic laboratory (CDL) were used to determine prevalent diseases in Uganda with surveillance, monitoring and designing strategic interventions for control of spread of diseases.

3. Cattle Disease Detection and Prediction

In this section, we explain in detail about how our system works. We first explain the overall architecture of proposed system. The detailed theory we use is then explain with example calculation as subsection of this section.

3.1 Overall system architecture

There are five major steps in our cattle disease detection and prediction system.

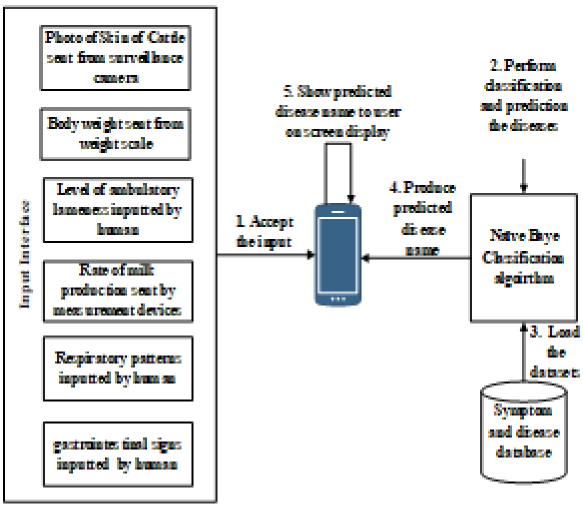

Figure 1: Overall System Architecture

The first step is about getting the input via the mobile. In this case, there are two ways of getting inputs, such that, accepting the input from manually inputted by human, and the input from mobile, which are automatically sent to mobile by the devices such as surveillance camera, scale, lactometer. The data getting from devices are in different forms depending on device types such as image from surveillance camera for analyzing the characteristics of skin, data accessed from weight scale to measure the weight of the cattle when they arrive back to the camp after skipping out to grass of open field, and lactometer to measure the level of milk production.

The other input metrics are manually inputted by the human after analyzing the corresponding data regarding respiratory patterns of cattle, ambulatory lameness, gastrointestinal signs.

The system then arranges the input data corresponding to their types, in this case, the image obtained from surveillance camera, is obtained and analyzed to know what kind of specific features are happened to cattle using Bayes classifier by translating the pixel information of the image.

The detailed work about skin pattern classification of an image file is left for further paper because this paper just focuses only on analyzing the disease and give the predicted results.

The second step is using Naïve Bayes classification algorithm to classify the disease name depending on input data. In this step, pre-stored disease symptoms and disease name pairs are loaded from the database to predication algorithm.

The step 4 produces the result to the mobile after calculating the predicted results after performing prediction tasks upon inputs and raw data from database. The system then finally produces the results to the user via screen display to let the user know what caution should be made about cattle's health situation and what kind of treatment should be given to them.

3.2 Disease prediction using Naïve Bayesian Classifier

This step mainly uses Naïve Bayesian classifier that mainly uses Naïve Bayer rules as shown in (1).

$$P(Y|X_1,\dots,X_n) = \frac{P(X_1,\dots,X_n|Y)P(Y)}{P(X_1,\dots,X_n)} \qquad \text{Eq (1)}$$

It predicts membership probabilities for each class such as the probability that given record or data point belongs to a particular class. The class with the highest probability is considered as the most likely class for current cattle symptoms. Using that probability, we can calculate the probability of an event using its prior knowledge. This is known as Maximum A Posteriori (MAP) and its formula is as follows.

$$MAP(P(H|E)) = \max(P(E|H) * P(H)) \qquad \text{Eq(2)}$$

where PE is evidence probability, and it is used to normalize the result. In this paper, for each symptoms of a cattle, we use multiple evidence probability using Eq (2) as follows.

$$P(H|MultipleEvidences) = P(E_1|H) * P(E_2|H) \ldots * P(E_n|H) * P(H)/P(MultipleEvidences)$$ Eq(3)

To give a clear explanation, we demonstrate short hypothesis for three disease types, namely Highly pathogenic avian influenza (H5N1virus), Nipah virus disease (Paramyxoviurs) and Blue tongue(Reoviridae) depending on our six symptoms as S1, S2, …S6 respectively. We give a short time to three diseases for a short presentation as H5N1, NVD and BT respectively.

For H5N1 disease, we calculate its probability as following Eq (4).

P(H5N1, S1,S2,…S6) = P(S1|H5N1) * P(S2|H5N1)*…P(S6|H5N1) * P(H5N1) / P(S1,…S6) Eq (4)

For NVD disease, we use following hypothesis to know its probability as Eq (5).

P(NVD, S1,S2,…S6) = P(S1| NVD) * P(S2| NVD)*…P(S6| NVD) * P(NVD) / P(S1,…S6) Eq (5)

For BT disease, the following calculation in Eq (6) is performed to predict its probability.

P(BT, S1,S2,…S6) = P(S1| BT) * P(S2| BT)*…P(S6| BT) * P(BT) / P(S1,…S6) Eq (6)

The final decision regarding to what kind of disease might occur to cattle is determined their higher probability level in each calculation. The symptoms found in each cattle is analyzed, transformed them into data and calculate them with Bayes classifier to know what they are suffering and which treatments should be given in earlier time without discussion with veterinarians.

4. Comparison and discussion

4.1 Development setting

The dataset for animal symptoms is collected as aforementioned and put them into database (MySQL). The system then develops a system with Java programming and perform several tests for different groups of disease with various levels of symptoms conditions. After each testing results, we accumulate them and, compare them with actual disease occurrence determined by human experts. For each group of disease, we give 60 trial for each different symptom by alternatively giving 10 different levels. The experimental results are then organized and listed in next section.

4.2 Experimental results

Depending on the comparison made between the result of our system and human expert's made decision, we calculate an accuracy level using traditional accuracy measurement formula as shown Eq (7).

$$accuracy = \frac{number\ \ of\ accurate\ \ data}{number\ \ of\ all\ tested\ \ data}$$ Eq (7)

In order to prove the efficiency of our proposed system, not only to compare with expert decision, we also compare our results with contemporary approach of Diana et al [6]. We then listed all of the results in Table 1 depending on group size of tested disease (eg. 3 groups in example). According to the data in Table 1, we can claim that our system achieves competitive results against with other popular approach, Diana [6] although its accuracy is slightly lower than human expert's prediction.

Table 1: Accuracy Comparison

Dataset size	Our system	Expert's Decision	Diana et al [6]
5 disease group	94.2%	98%	90.8%
8 disease group	90.3%	93%	87.6%
10 disease group	86.5%	91%	85.3%
15 disease group	90.3%	94%	84.1%

5. Conclusion

Mobile based cattle healthcare system is effective for disease detection without the needs of human expert and without delay to give earlier treatment. It helps the people with low-cost setting and resources only with mobile-devices. In this paper, we propose a mobile based disease detection system for cattle, a valuable livestocks in Myanmar to use in the farms and dairy products. We prove that our system achieves better results than other approaches although it still needs to compete with human expert. In the future, we intend to extend this system that can work with different kinds of surveillance devices so as to achieve more precise and accurate prediction results just like human experts.

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