Design Predictive Model for RFID Tag Based Livestock Identification and Monitoring System

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Abstract: In the last recent years, the level of automation in the farming process has increased significantly. The key component of these new techniques is live-stock identification and monitoring. As it is known, Ethiopia is rich in its livestock sector but has never gained adequate profit from it. The basic problem is farm management issues, attention given to it, and the livestock value chain inharmoniousness. The research aimed at automating the traditional farm management practice using analytical processes. This paper uses an individual identification of cattle intended for any farm using an ear tag embedded with radio frequency identification (RFID) technology, where each cattle is tagged with an identifying number as a reference. The data was collected from Alfa fooder & Dairy Farm P.L.C of years 2015 to 2020. The data then faded to a data mining software to make a prediction based on the input data set. In this research work, an at-tempt has been made to apply the comparative classification model predictive data mining techniques in the cattle livestock sector for the milk, meat, and skin and hide quality yield products. Machine learning classification algorithms such as Naïve Bayes, decision tree classifier and J48 classifier have been practiced. The overall model accuracy of Naïve Bayes Net (94.24%) shows it has a better prediction.

1 INTRODUCTION

In Ethiopia, the government prioritized agricultural production to promote economic growth overall, minimize poverty, and ensure food security. The agricultural part of Ethiopia accounts for about 42% of the GDP, more than 80% of the export, and 85% of the employment opportunities (Ministry of Finance and Economic Development, 2012). The largest population of animals in Africa is currently in Ethiopia. There are about 54 million cattle, 25.5 million sheep, and 24,06 million goats estimated in the country (Bekele et al., 2017). From the year 1995/96 to 2012/13, the cattle and shoat populations raised from 54.5 million to over 103.5 million, with an average yearly growth of 3.4 million (Central Statistical Authority, 2013). In 2026/27, the cattle, sheep, and goat populations in the sedentary (people that do not travel from place to place) areas of Ethiopia are estimated to reach 75, 42.8, and 39.6 million heads, respectively. The livestock sector majorly makes a significant contribution to the economy as a whole. The sector represents 19% of GDP and generates 16-19% of the country's foreign exchange earnings. It also accounts for approximately 35% of agricultural GDP (or 45% if indirect contributions are taken into account) (Central Statistical Authority, 2013). Soon, domestic demand for meat, milk, and skin and hide yield is expected to rise substantially with the speedily growing population, increasing urbanization, and rising incomes.

Livestock identification in terms along the lines of RFID and traceability are hot topics in today's discussions among livestock's productivity. Let's take one sample type of RFID which comes with Livestock show online software. First to identify an animal we need to use a series of numbers that are unique which are not used for another animal. This requires enough digits to guarantee such uniqueness. now that we have a unique number we can encode it to a metal chip which is then embedded inside the plastic button that is readable by a radiofrequency scanner called an

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RFID reader these RFID readers typically comes in the form of the hand wand or pocket device or smartphone applications capable of reading the Electronic Identification (EID) number were brought near to this button, this button can now be fixed to an animal in the form of ear tag to make things easier EID ear tags are often combined with the more user-friendly, human-readable and much shorter value called visual ID or tag ID these short combination of letters and numbers is easier to humans to read and refer to than much longer and unique EID number.

2 LITERATURE REVIEW

Some newly upcoming mobile phones can also function as an RFID reader by their application software installed where they can type in the information to acquire. However, according to Cherinet Amsalu (Cherinet Amsalu, 2015) just in case if the above materials could not be available in the Ethiopian market, the barcode can also substitute since the working mechanism of RFID and barcodes are related else prototype can also be implemented as a simulation of these physical devices. By developing an application that provides RFID read event at a different location and send the read event value to the application continuously while the Livestock Identification and Traceability System (LITS) prototype is running on a different machine. A list of programming, communication, databases and operating environments which are appropriate for use in the implementation of a prototype is provided below: two separate laptop or computers, one for server and database storage and one for client, SQL server 2010 and Microsoft Visual Studio 2008. The simulator function along the lines of a chip or reader, even if the RFID chip device is not located. The database (numeric, alphanumeric, length, address and cattle full information) subsequently be built and recorded on a coded and format basis. The data dictionary then be compiled.(Electronic identification for sheep and goats, 2024)

According to Cherinet (Cherinet Amsalu, 2015) to fulfill a master's thesis he designs and develops an electronic cattle identification and traceability system in Ethiopia, Borena Zone using a simulator as one PC, which serves as a client and another PC as a server. But this has not been implemented and tried to addresses the prediction of dairy quality products. Design predictive model for RFID tag-based livestock identification and monitoring system is a title chosen after researching for similar papers and works done in the different countries. The agriculture sector and academic areas have indicated far more related issues however, there was no such research done in our country. The related works were done concerning indicating the benefit of having a traceability and monitoring system concerning RFID tags. No predictive model using data mining techniques with RFID tags has been designed.(Dogan, 2016)

For tracking and tracing of animals' databases are used. In these databases, individual animal identification is linked to owner information and possibly other information. The owner of the database can be a government or private oriented organization (or even it is possible to maintain databases on owner e.g. farmer level). A country may use several databases e.g. one for companion animals, one for pigs, one for sheep, one for goat, another for cattle, etc. Different organizations can be responsible for different databases. (ECDGHC, 2009)

There are four identification methods for cattle in Botswana: ear markings, warm-iron branding, traditional ear markings (usually plastic) and bolus rumen, which were introduced more than 11 years ago. These methods of recognition are used concurrently. LITS using rumen bolus had many problems, leading the Botswana government resolve on 1 January 2013 to replace it with electronic ear tags. It appears that most of the challenges to LITS implementation are internal processes that should have been addressed instead of dumping the bolus system which offers some degree of greater security than electronic ear tags. In different researches, it has been shown that bolus has a high retention rate and is tamperproof compared to electronic ear tags which can be easily removed, lost, or tampered with.

Research Questions:

- What are the major determinants factors that are used for constructing the predictive models?
- How machine learning models can be implemented as predictive models for milk, meat, and skin and hide quality yield products prediction.

3 STATEMENT OF THE PROBLEM

Ethiopia exports a large number of livestock products to the middle east and other international markets. However, the absence of an automated cattle management system poses a great risk for further growth and sustainability of the livestock trade. Some of these challenges include not recording the cattle information appropriately and timely such as the age of the cattle, the owner of the cattle, breed of the cattle, sex of the cattle, body weight, blood level, health status, and so on. So, need RFID like technique to monitor and capture information from the cattle farm. Also, analysis of livestock data that are captured through RFID devices enables the farmers and agricultural decision makers to utilize the benefit of the emerging technologies and betterment in agricultural field.

4 OBJECTIVE

The general objective of this research is to design a predictive model for RFID tag-based livestock identification and monitoring systems that enable better management of livestock milk, meat, and skin and hide product.

- **Specific Objectives**
  - To prepare a data set which are gathered with the use of RFID technology to make predictive system.
  - Develop a predictive model using the dataset of cattle and evaluate the proposed design.
  - Develop a suitable classification machine learning models for cattle meat, milk, and skin and hide yield prediction.

5 MATERIALS AND METHODOLOGY

In this paper, a predictive model for RFID tag-based for cattle in Ethiopia was designed. Mainly this is quantitative research in that data about livestock specifically cattle without RFID tags are collected. And since this technology is new to our country and yet no cattle had been tagged with RFID, we analyzed the data by assuming the cattle's data is collected with the enhancement of RFID, then that data is analyzed using data mining techniques, particularly python to come up with a predictive model to understand the effectiveness of the RFID tags in increasing the cattle milk, meat, and skin and hide quality yield products. The main source of the data used to undertake this research was cattle's actual data taken from Alfa fooder & Dairy Farm P.L.C which is collected with the use of RFID technology. In this regard, the datasets were found in softcopy which includes many more attributes to be taken, and some are hardcopy format with 7000 records and 17 variables. As we discuss with different veterinarian experts, we identified the basic problem domain and factors which can identify to predict. The researchers first encoded all the data in an Excel format and each record contains the most relevant information about the cattle.

The processes like data cleaning, data preprocessing and attribute selection was done using the software python. The data set after the initial data collection is as shown in the table 1.

Out of the 17 attributes of the original data set, attributes (including the class attribute) which are believed by the domain experts to have significant contribution in predicting milk, meat, and skin and hide yield product of cattle's, which is the focus of this research, have been selected.

Table 1: Set of attributes

S.No	Attribute Name	Data Type	Description
1	ID	Alphanumeric	The key that identifies the cattle uniquely
2	Year	Number	The year of the data captured
3	Place	Text	Exact residence of the data collected
4	Owner Name	Text	Name of the cattle owner
5	Sex	Text	Identifies whether the cattle are male or female
6	Breed	Text	Identifies originality (ancestors) of the cattle
7	Age in Years	Number	The exact age of the cattle
8	Body Weight	Number	The weight of cattle in kilograms
9	Blood Level	Number	The level of blood pressure
10	Feeding	Text	Grazing type of the cattle whether in the house only or field grazing

11	Health	Text	Health status of the cattle
12	Farm size	Text	The scope of the farm
13	Farm Sanitation	Text	The cleanness of the farm
14	Use Drug	Text	The use of medication regularly for the cattle
15	Farm Management	Text	The modernity of the farm management
16	Farm Housing	Text	The general farm housing standard
17	Number of Calves	Number	The number of calves female cattle has

The following are the parameters to extraction and selection of features.

Records are evaluated and classified based on the values of their attributes. Of course, some of the attributes of a record may be irrelevant to the process of classification and thus should be excluded. With the help of area expertise the basic parameters we choose that influence the prediction system is that ID, year, place, owner, sex, breed, the cattle age in years, body weight, blood level, feeding status, health status of the cattle, farm size, farm sanitation, use drug/medication, farm management, farm housing, and number of calves the cattle has. The selection of attributes includes searching for the most successful sub-set of attributes for prediction across all possible combinations of attributes in the data.

The following are some parameters to extraction and selection of features.

Milk:

- If sex is Male, print None.
- If sex is female, breed <> local, age in years = 10, body weight >= 255, blood level >= 60, feeding is indoor, health status is excellent, farm size is large, farm sanitation is yes, use drug is yes, farm management is intensive, farm housing is good, number of calves is 4, print excellent milk.
- If sex is female, breed <> local, age in years 12, body weight >= 255, blood level >=60, feeding is indoor, health status is very good, farm size large, farm sanitation yes, use drug yes farm management is intensive, farm housing is good, number of calves is 5, print very good milk.
- If sex is female, breed <> local, age in years 8, body weight >= 255, blood level >=60, feeding is indoor, outdoor, health status is good, farm size medium, farm sanitation yes, use drug yes farm management is intensive, farm housing is good, number of calves is 3, print good milk.
- If sex is female, breed is local, age in years 6, body weight <= 255, blood level <=60, feeding is indoor, health status is good, farm size small, farm sanitation yes, use drug yes farm management is semi intensive, farm housing is good, number of calves is 2, print satisfactory milk.
- If sex is female, breed is local, age in years <=6, body weight >= 255, blood level >=60, feeding is outdoor, health status is good, farm size small, farm sanitation no, use drug no, farm management is extensive, farm housing is poor, number of calves is 2, print poor milk.

Meat:

- If sex is Male, breed is Holiston, age in years 10, body weight >= 255, blood level >=60, feeding is indoor, health status is excellent, farm size large, farm sanitation yes, use drug yes, farm management is intensive, farm housing is good, number of calves is 0, print Excellent Meat.
- If sex is Male, breed <> local, age in years 12, body weight >= 255, blood level >=60, feeding is indoor, health status is very good, farm size large, farm sanitation yes, use drug yes, farm management is intensive, farm housing is good, number of calves is 0, print very good Meat.
- If sex is Male, breed <> local, age in years 8, body weight <= 255, blood level >=60, feeding is indoor, health status is good, farm size large, farm sanitation yes, use drug yes, farm management is semi intensive, farm housing is good, number of calves is 0, print good Meat.
- If sex is Male, female, breed is all type, age in years = 8, body weight <= 255, blood level <=60, feeding is indoor, outdoor, health status is satisfactory, farm size small, farm sanitation yes, use drug yes, farm management is semi intensive, farm housing is good, number of calves is <=4, print satisfactory Meat.

- If sex is female, breed is local, age in years <=8, body weight >= 255, blood level >=60, feeding is outdoor, health status is satisfactory, farm size small, farm sanitation no, use drug no, farm management is extensive, farm housing is poor, number of calves is 4, print poor Meat.

Skin and hide:

- If sex is Male, Female, breed is all type, age in years <=10, body weight >= 255, blood level >=60, feeding is indoor, health status is excellent, farm size large, farm sanitation yes, use drug yes, farm management is intensive, farm housing is good, number of calves is 0, print Excellent Skin and hide.
- If sex is Male, Female, breed is all type, age in years <=10, body weight >= 255, blood level >=60, feeding is indoor, health status is Very good, farm size large, small, farm sanitation yes, use drug yes, farm management is intensive, farm housing is good, number of calves is 0, print Very Good Skin and hide.
- If sex is Male, Female, breed is all type, age in years =10, body weight >= 255, blood level <=60, feeding is indoor, outdoor, health status is Good, farm size large, small, farm sanitation yes, use drug yes, farm management is intensive, farm housing is good, number of calves is <=4, print Good Skin and hide.
- If sex is Male, Female, breed is all type, age in years <= 10, body weight <= 255, blood level <=60, feeding is indoor, outdoor, health status is satisfactory, farm size large, small, farm sanitation yes, no, use drug yes, farm management is semi intensive, farm housing is good, number of calves is <=4, print satisfactory Skin and hide.
- If sex is Male, Female, breed is all type, age in years <8, body weight <= 255, blood level <=60, feeding is indoor, outdoor, health status is satisfactory, farm size small, farm sanitation no, use drug no, farm management is extensive, farm housing is poor, number of calves is <=4, print poor Skin and hide.

A comparative model algorithm is a powerful class of machine learning algorithms that compare the predictions from multiple models. The benefit of using python for applied learning machine is that it makes available so many different comparative machine learning algorithms. A popular advantage of a comparative model is that they allow one to compare the prediction dairy qualities of multiple models. Thus, with different models, we can calculate the milk, meat, and skin and hide products.

The 10-fold cross-validation is the data is divided randomly into 10 parts in which the classes are represented in approximately the same proportions as in the full dataset (stratification). In turn, each part is retained and the algorithm is trained on the other nine parts, and the error rate on the holdout set is determined. Finally, the sum of the 10-error yield is an approximation of the total error. The quality of the data measured in data mining is the error rate. This error rate measured in classification accuracy, the standard accuracy measurement in data mining is precision and recall.

The machine learning models like Naive Bayesian classifiers, J48 Algorithm, and Decision Tree & statistical model Bayesian classifiers were used as a predictive model.

The following figure 1 depicts the workflow of this research work.

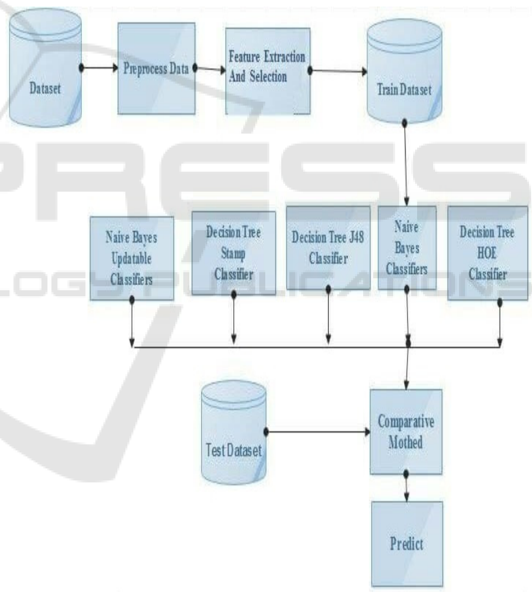

Figure 1: Shows the steps of a comparative classification model

The models were implemented and it shows that Naïve Bayes Net classifier outperformed other models with the highest accuracy of 94.24%. The following table shows the performances of different classifier models.

Table 2: Summary of Performances by different Classification Models

Performance Testing	Naïve Bayes Updatable	Naïve Bayes Net	Decision Tree (HOE)	J48	Decision Stump
Accuracy %	85.95	94.24	92.87	94	21.61
Av. Precision	0.9	0.94	0.92	0.94	0.21
Av. Recall	0.9	0.94	0.92	0.94	0.21
Av. True Positive	0.9	0.94	0.91	0.94	0.21
Av. False Positive	0.025	0.14	0.02	0.015	0.19
Sensitivity	0.9	0.94	0.92	0.94	0.21
Specificity	0.9	0.94	0.92	0.94	0.21

6 CONCLUSION

In this research, an attempt has been made to apply the comparative classification model predictive data mining techniques in the cattle livestock sector and the milk, meat, and skin and hide quality yield products. To achieve this goal, the KDD standard data mining methodology has been adopted and the python data mining tool has been used to implement the classification algorithm such as Naïve Bayes, decision tree classifier and J48 classifier has been practiced. The data for this research is the cattle data of the year from mid of 2015 up to mid of 2020 collected from Alfa fooder & Dairy Farm P.L.C university research center bureau. After pre-processing out of 7,000 records, 7000 cattle records are remaining for the particular reason for this circumstance we have used the replication method and used it for building the models. But 20 attributes were minimized to 17 attributes after pre-processing. Various experiments are made iteratively by making adjustments to the parameters and using a different number of attributes to come up with a meaningful output. The comparison of the models using python's experimenter showed that there is a relatively better model prediction in the case of Naïve Bayes Net of Naïve Bayes correctly identifying the dataset. The overall model accuracy of Naïve Bayes Net (94.24%) shows it has a better prediction. The relatively better performance of the Naïve Bayes Net algorithm can be attributed to the nature of the data such as the handled missing values; the data consistency etc. we also gained the information that the majority class of excellent meat quality was 3082, the class of satisfactory meat quantity was 2196, the class of poor meat quality was 537 and the minority class of very good meat quality was 531. From our total dataset of 6 Year (7000datasets), the majority of cattle livestock was mid of the 2015 Year up to mid of 2020 years, 1181, 1167, 1142, 1195, 1158, and 1157 respectively. As we see from this to sum up everything that has been stated so far, more numbers were used in 2018 and the last one is 2017.

Thus, the results obtained in this research have proved the applicability of data mining in cattle livestock identification and monitoring system. More specifically it provides valuable help in developing new methods to increase dairy products, particularly in the milk, meat, and skin and hide products.

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