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IOT- Based Cattle Activity Monitoring

[1]K Chakra Saravan Varma, [2]B Varun Goud, [3]J Eshwar Chary, [4]M Rushikesh Reddy, [5]A AmaraJyothi

[1234]Student, [5]Assistant Professor,

[12345]DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING(AI&ML),

[12345]CMR ENGINEERING COLLEGE, Hyderabad, Kandlakoya

Abstract : A cattle health monitoring system is used to check the activities of the cattle that are taking place with the help of the Node MCU, pulse/heart sensor, temperature sensor, and accelerometer sensor. Approaches have been proposed to monitor cattle health, such as a deep sort algorithm to track the location of an animal, and an ANN algorithm is used to find the illness. However, there is a need to monitor cattle health closely so that farmers benefit from the supply of dairy products, financial benefits, economic growth, etc. To address this, we propose that there are three sensors used to detect the values given by the node MCU, which are connected to WIFI. The values will be sent to the THINGSPEAK. They will be stored in the CSV file. Here, XAPIER is used as a mediator to merge the CSV file and ML model, and then the output will be observed. The proposed approach is an IoT-based cattle activity monitoring system. For this, the proposed approach uses the KNN algorithm, logistic regression, and support vector machine algorithm. These algorithms are used to classify the data of cattle from Node MCU, pulse/heart sensor, temperature sensor, accelerometer sensor, and so on. This will be very helpful to the farmer to identify the health of the cattle, etc. By reading these data, the farmer can know which activity the cattle are taking place at a given time. Finally, an alert message will be sent to farmers when the cattle's health is abnormal through the THINGSPEAK, email, and GRADIO interface.

IndexTerms **- Farm automation, Health parameters, Feed- back, Cattle Activity Prediction algorithm**

I. INTRODUCTION

The Primary sector is having a vital role to the global frugality. Creatures like cows, buffaloes, sheep, goats, and others are crucial to rural life. Around 40% of India's population are employed in the animal husbandry [1] activities. Farmers are facing a very typical situation as a result of a variety of diseases that are affecting the farm's animals. However, farmers must spend more time and resources to cattle monitoring. Farmers cannot entirely rely on their ongoing visual observations for accurate and comprehensive agriculture management.

Since there are evolving new health diseases to ranch creatures and came more delicate to help. To address this issue, Veternarin are veritably limited in pastoral areas. This method introduced a new technology where it is benificial to the farmer. Farmer can observe the activities that are done by the cattle from any of the place. It is completely based on live stock management.

Traditional livestock monitoring depends heavily on homemade supervision, sophisticated skilled labor and time[2]. To observe cattle lifespan, it is more productive to automate this monitoring process in a economical way. This can be witnessed by utilizing different types of sensors[2], [3]. The growth of dairy farms has greatly decreased regular human cattle conversations, leading to the perpetration of automatic milking systems that replace conventional methods. Monitoring the behavior of daily cattle allows for comprehensive farm level assessments of their activities and comforts. Behavioral shifts serve as clear indicators of potential health and welfare issues, making them valuable for early warning systems. Cattle need substantial time for resting or eating to maximize milk production. Thus, tracking their movements is vital for managing their behavior and activities to collect data on their productivity.

Various IoT applications are being utilizes in the field of health monitoring including integrated health monitoring systems, movement tracking of cattle using Arduino and LabVIEW technologies,and non-invasive sensor technology[5], [6], [7].These advanced methods primarily focus on enhancing the efficiency and accuracy of monitoring livestockhealth.

- Sensors: They use various sensors for getting data about various parameters which makes the sensor node more complex. They don't mention or propose about building the sensor node in an understandable way.
- Disease: The main aim of many proposed systems is to detect particular disease using the sensor information.

The end user can't access the cloud or they are not notified on time.

II. RELATED WORKS

In [16], the author has introduced a system in which health parameters are taken into consideration and a piezoelectric sensor is used that will respond when cattle feels weak and informs the doctor but when coming to heartbeat, it will also increase when the cattle has done much work, but the doctor thinks that the cattle is unhealthy which is wrong in this case. If the activity of the cattle is known at the time then we can find that the raise in heartbeat is due to excessive work or tiredness of cattle. In [[17], there is an analysis for which different diseases can effect their cattle, but their activity is not taken into consideration. Heartbeat is one of the most important factors that needs to be taken into consideration while checking the health parameters which is missing in [7]. There is less accuracy in [10], [12], [14], [15], as there is no decision making model. Sometimes, though the health parameters like, Body temperature, Respiration, Humidity, Heartbeat and Rumination are fine, the cattle might feel weak due to inner health problems that cannot be known by just knowing the external health parameters. But we can get a rough idea whether it is good or not by observing its activities. In [13], only one health parameter i.e., only temperature is taken into consideration. Only rumination activity can be predicted in [8], but other activities are not predicted. Most importantly all the above mentioned works did not focus on making a collar belt so that data could be collected continuously for analysis.

A clear overview of the related research papers has been tabulated in Table I.

The main objective of the proposed work are the following:

- Replace existing traditional methods with IoT-based methodology.
- Create a wearable device that monitors the cattle’s health using wireless sensor technology.
- Predict the cattle’s activities by taking sensor readings.

The proposed solutions are novel and significant in the following ways:

- An automated system is proposed to monitor cattle’s health without human intervention.
- Behavioural changes in the cattle are observed by pre- dicting their activities.
- The CAP algorithm is proposed.
- The CAP algorithm predicts the cattle’s activities like stationary, walking, and eating.
- Health parameters like temperature and pulse will be monitored using a wearable collar device.

III. THE PROPOSED CATTLECARE SYSTEM

This proposed system consists of three main components sensor data collections, where all the data will be collected in the form of x,y,z values. Cloud data transmision the data will be transmitted to xml file using the big data. Storage, the data will be stored in the cloud and used for the further reference. Data analysis is used to predict the data. user prediction. Each section provides a detailed explanation of the systems implementation. An overview of the system is illustrated in figure 1.

A. Sensor Node

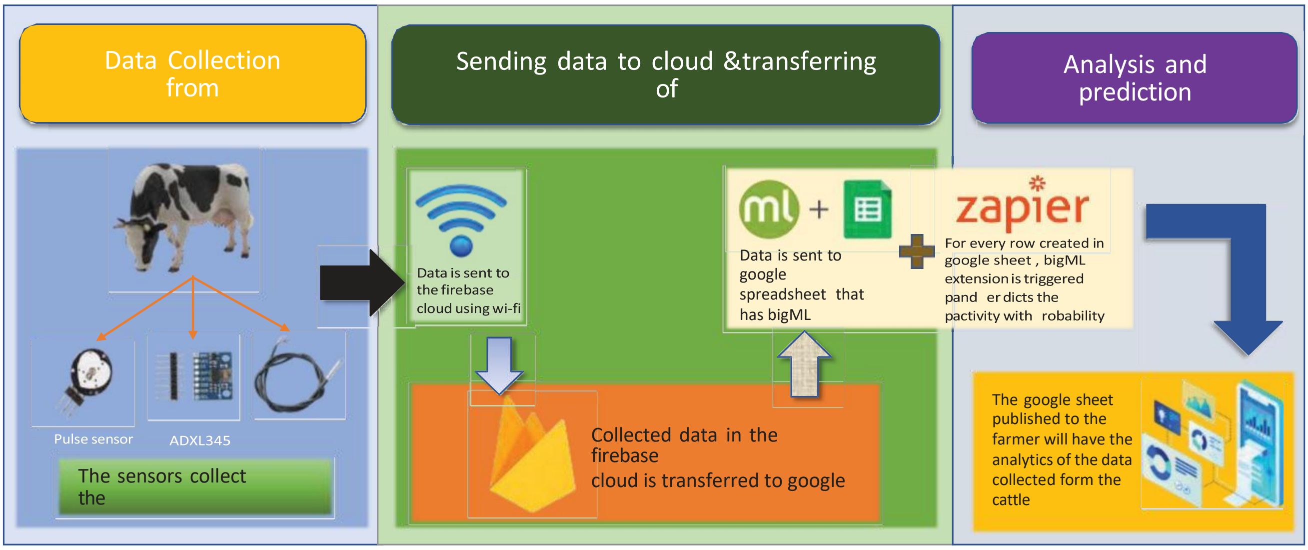
The prototype feature a 3D-printed enclosure designed to house a NodeMCU microcontroller, which integrated the ESP-8266 WiFi module is used to transfer the data from big data to xml file to store the values and for livestock management. We use accelerometer to measure the motion on which activity the cattle is going on, ADXL345 for acceleration values along the 3 axes, and a powerbank of 10000mAh capacity for power supply as shown in Fig 2.

B. Vital Monitoring

There are some of the equipment which are surounded by the neck of the cattle.In this we use accelerometer to measure the values and they will be sent to the google cloud. An email will be sent to cattle owner to make owner alert. It is completely based on the acceleration values x,y,z. The data that is collected by the firebase cloud will be updated into the google sheets for every 5 minutes. Here we use the threshold values as that of normal body temperature (36°C-40°C) and pulse value (76-96 beats/min) [4] of a cattle.

C. Cattle Activity Prediction

The components which are attached to the cattle around the neck it reads the acceleration values with the help of NodeMCU. The collected values will be in the firebase cloud and it will be transferd to the google sheets.It will convert the google spread sheet to XML file where the data will be in the form of rows and coloums. This activity can be predicted by using the algorithm called CAP(CATTLE ACTIVITY PREDICTION) algorithm 11. We have used the machine learning schemes like Logistic regression and KNN.



Here, an action will be taken when there is a trigger that happens to a cattle. We use a third party application for the experiment to automate the result of the cattle and it will be uploaded in the google sheet for the future reference. We use a zapier extension when a new row is generated. Activity will be performed for 1hr and it will be divided for 60 to calculte which activity has performed more.We use One vs all Logistic Regression with the help of BigML extension which is found in the google sheet. To record the values in the google sheet and that will be converted to xml with the help of Big ML.

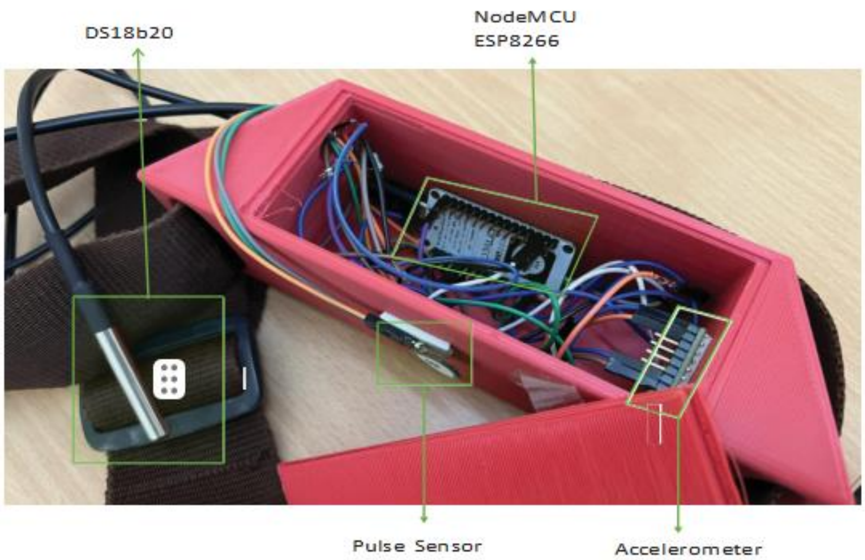


Fig. 2. Components of the sensor node

The google sheet which contains all the data from the cattle will be shared to the cattle owner through its link.

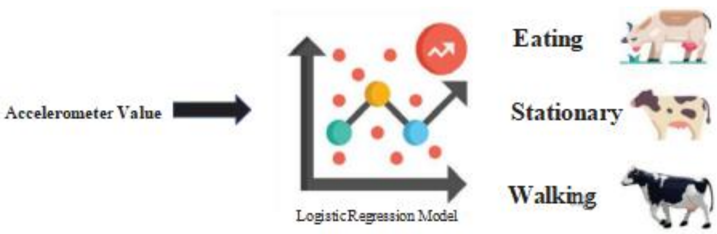
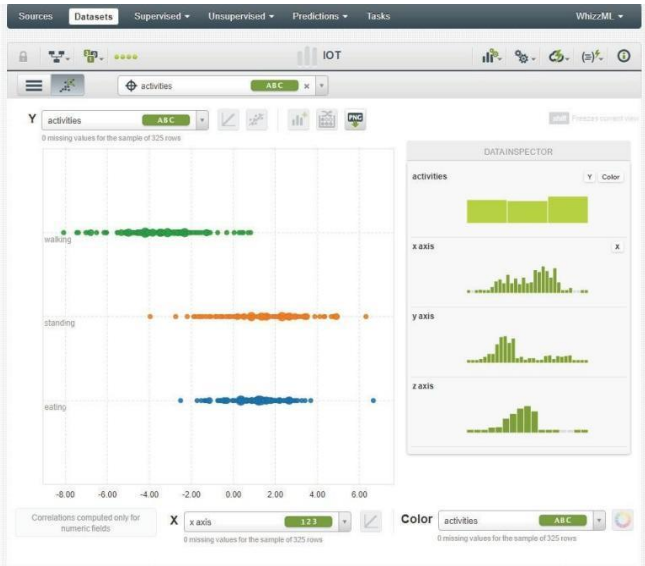


Fig. 3. Activity is predicted from the above classes

D. Preparation of data

The 3D printed case is wound over the neck of the cattle. The dataset will be prepared by observing each activity for 30 days and each avitity will be measured for 1 hour daily. This will be stored in the google sheet and it will be converted into XML sheet and it will be stored in the cloud It can be used for future reference. Shown in Fig 7.



Let us have a delve deeper into the mechanics of logistic regression in this context:

Logistic retrogression is a supervised literacy algorithm is employed for double bracket by estimating the probability that a given point set belongs to a specific class. If the prognosticated probability exceeds 0.5, the affair is classified as 1; else, it's classified as 0. In this script, we're dealing with three activities; eating, stationary, and walking. Since logistic retrogression is innately designed for double bracket, we use the one-vs-all strategy. This approach involves calculating the probability of each class against the other two combined and prognosticating the exertion grounded on the class with the loftiest probability.

Logistic uses a function:

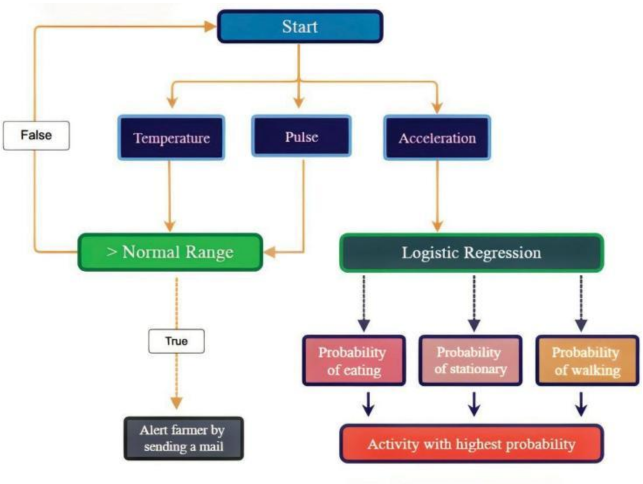


Fig. 5. Proposed CattleCare process flow for health and activity monitoring

Logistic regression cost function:

$$\text{Want } \min_\theta J(\theta):$$

$$\text{Repeat } \{$$

$$\theta_j := \theta_j - \alpha \sum_{i=1}^{m} (h_\theta(x^{(i)}) - y^{(i)}) x_j^{(i)}$$

$$\text{(simultaneously update all } \theta_j)$$

$$\}$$

The above equation will calculate the accelerometer values to find the activity of the cattle. Based on the three activites it will display the highest value this will done on the probability. The values will be displayed on the google sheet. Fig 3.

Algorithm 1 Cattle activity prediction Algorithm

Start
Taking inputs
A = probability of eating
B = probability of walking
C = probability of stationary
if $A \geq B$ and $A \geq C$ **then**
    print(Activity = "Eating")
else if $B \geq C$ and $B \geq A$ **then**
    print(Activity = "Walking")
else if then
    print(Activity = "Stationary")

The flow of data from sensors to alerting the cattle owner when temperature and pulse values are above set threshold and predicting the cattle activity is as shown in the Fig 5.

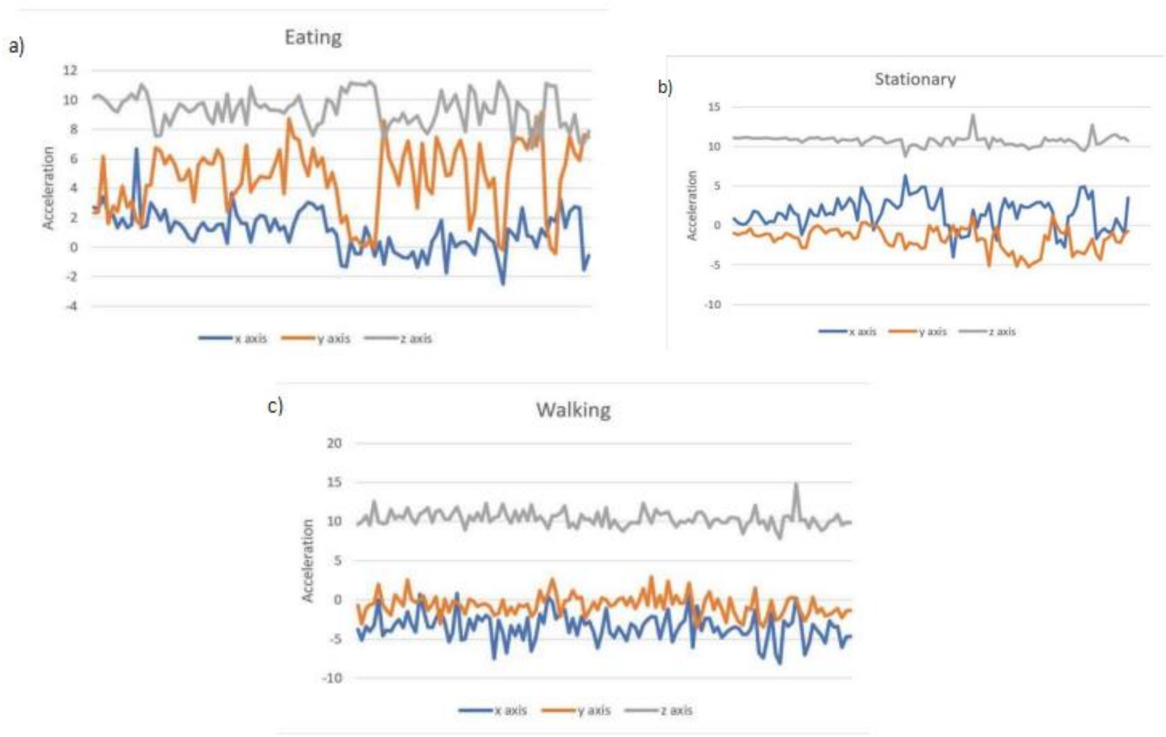


Fig. 6. Acceleration plots for a)Eating b)Stationary c)Waliking along 3 axes

IV. PEXPERIMENTAL RESULTS AND ANALYSIS

The graphs produces the readings from the field given in fig 7. The readings collected from the accelerometer sensors that gives the cattle is in which activity. This consistsof a field belt where it is attached to a neck of the cattle. We also uses the CAP algorithm to find the probability of the cattle on which of the major activity that the cattle has been performed. These predictions are plotted in the form of bar graph for better understanding of number of hours spent by the cattle in each activity as shown in Fig 9. To get more accuracy we also used the KNN and SVM algorithms.

TABLE II
COMPARISION WITH OTHER ALGORITHMS

Algorithm	Accuracy	Precision	F1 score
Logistic Regres-sion	94.46%	0.97	0.93
Support Vector Machine	90.80%	0.92	0.88
K nearest neigh-bours	91.02%	0.94	0.89

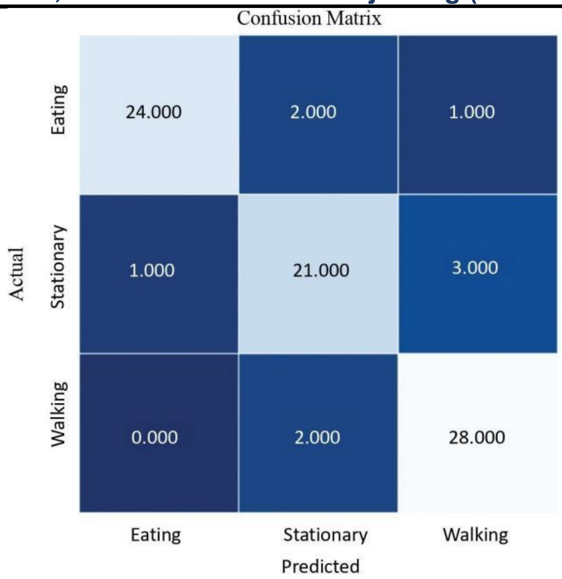
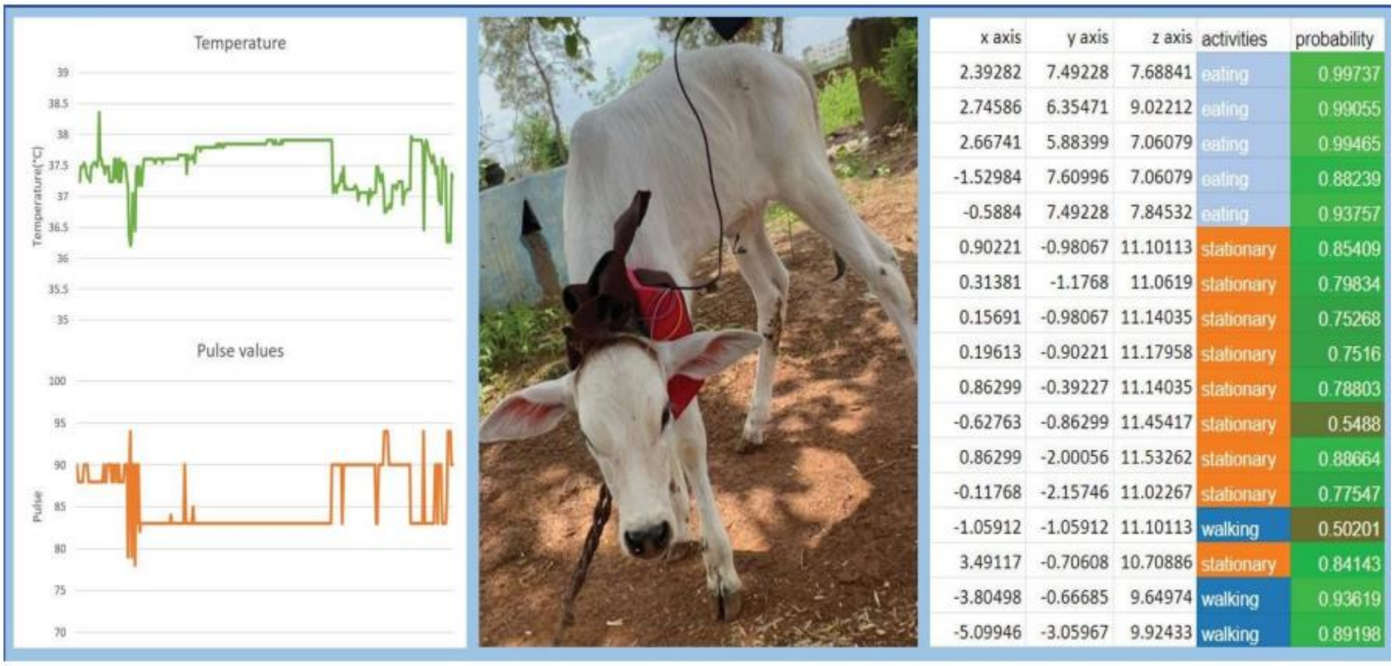


Fig. 8. Confusion Matrix for the activities predicted



x axis	y axis	z axis	activities	probability
2.39282	7.49228	7.68841	eating	0.99737
2.74586	6.35471	9.02212	eating	0.99055
2.66741	5.88399	7.06079	eating	0.99465
-1.52984	7.60996	7.06079	eating	0.88239
-0.5884	7.49228	7.84532	eating	0.93757
0.90221	-0.98067	11.10113	stationary	0.85409
0.31381	-1.1768	11.0619	stationary	0.79834
0.15691	-0.98067	11.14035	stationary	0.75268
0.19613	-0.90221	11.17958	stationary	0.7516
0.86299	-0.39227	11.14035	stationary	0.78803
-0.62763	-0.86299	11.45417	stationary	0.5488
0.86299	-2.00056	11.53262	stationary	0.88664
-0.11768	-2.15746	11.02267	stationary	0.77547
-1.05912	-1.05912	11.10113	walking	0.50201
3.49117	-0.70608	10.70886	stationary	0.84143
-3.80498	-0.66685	9.64974	walking	0.93619
-5.09946	-3.05967	9.92433	walking	0.89198

Fig. 7. Graphical plot of Sensor Readings

V. CONCLUSION AND FUTURE SCOPE

The final analysis of this paper is that the prototype is user - friendly and effectively monitors cattle activity parameters, sending email alerts to the owners if temperature and pulse values exceed predefined thresholds. This allows the owner to take timely and appropriate care of their cattle. Future enhancements can include:

Database Management System Implementing a robust database to store daily data in a structured format. Providing access to everything in the webpage information for each cattle.

Webpage Creation: Developing a dedicated webpage for cattle owners to know and manage all information related to their cattle in one place.

Advanced Visualization Techniques: Employing improved visualization tools and techniqque to present data in a more further scrutable and stoner friendly director.

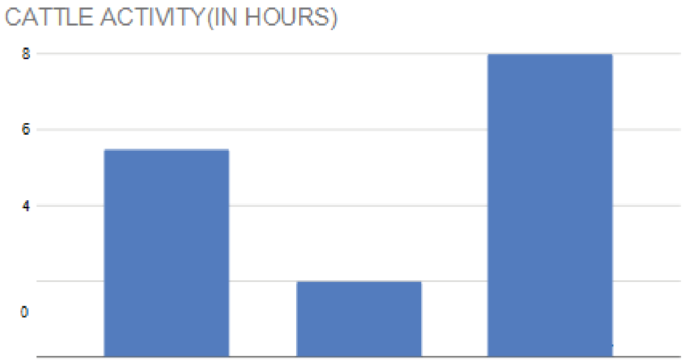


Fig. 9. Bar Plot of Cattle Activity in 15 Hours

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