INTERNALLY FUNDED STUDENT PROJECT- REPORT

FOREWARNING OF GOAT DISEASE DIAGNOSIS USING IOMT TO IMPROVE THE PRODUCTIVITY AND ECONOMY OF SMALL AND BIG FARMING

ABSTRACT:

This paper presents a proposed system aimed at developing an advanced forewarning system to assist small-scale farmers in managing the health of their goat herds. The primary objective of this system is to alert farmers about the potential onset of contagious diseases in goats before a significant portion of the herd becomes infected. Early detection allows farmers to take immediate measures to curb the spread of the disease, thereby preventing it from affecting the entire herd.

The system leverages a combination of wearable devices and image processing technologies to monitor and analyze the health of goats. Wearable devices are designed to continuously track vital signs such as body temperature, heart rate, and other physiological parameters. These devices are capable of collecting real-time data, which is then analyzed to identify early indicators of disease.

In addition to vital sign monitoring, the system employs an image processing model to detect visible symptoms of specific diseases, such as Goat Pox and Peste des Petits Ruminants (PPR). By analyzing images of the goats, the model can identify signs of these diseases, such as skin lesions, swelling, and other visual cues, which might indicate the presence of infection.

The integration of both physiological monitoring and image-based symptom detection allows the system to make meaningful predictions about the health status of the herd. When the system detects early warning signs of a disease, it promptly alerts the farmer. This proactive approach enables the farmer to implement preventive measures, such as isolating affected goats or administering treatments, thus significantly reducing the risk of a widespread outbreak.

Overall, this study proposes a comprehensive solution that combines modern technology with traditional farming practices to enhance the health management of small-scale goat herds. By providing timely warnings and actionable insights, the system has the potential to improve animal welfare, increase farm productivity, and support the sustainability of small-scale farming operations.

b. Definition of the problem

i. The major diseases such as Blue Tongue, Peste-des-Perits Ruminants (PPR), ORF, and Anthrax cause mortality in goats, which is associated with seasonal and climate variation in Tiruvallur district of Tamil Nadu.

ii. The diseases are the major cause of mortality in goats with kids and adults being almost equally affected. Adult females suffered higher mortality than males due to diseases.

iii. The mortality patterns were found similar in both the genders in the given time period. Gender had significant association with different age groups and diseases in terms of mortality pattern. Diagnosis of above diseases is made through appropriate laboratory investigations.

c. Objective

To improve the productivity and economy of small and big farming by forewarning the goat diseases and reducing the mortality rate

To make a wearable device that constantly monitors the possibility of disease in real time and alerts the farmers before the onset of the diseases.

1.Introduction:

Goat farming is a vital agricultural enterprise that supports the livelihoods of millions of farmers around the globe. Goats provide a wide array of products, including meat, milk, fiber, and hides, which are integral to the economies of many rural communities. However, the productivity and health of goats are often compromised by various infectious and non-infectious diseases. These diseases not only affect the well-being of the animals but also have substantial economic ramifications for the farmers and the broader agricultural economy.

The economic impact of goat diseases is multifaceted. Infected animals often exhibit reduced growth rates, lower milk yields, and poor reproductive performance, which directly diminishes the overall productivity of the herd. Increased mortality rates and the need for frequent veterinary interventions further escalate the costs for goat farmers. Additionally, outbreaks of contagious diseases can lead to trade restrictions and loss of market access, further exacerbating the economic burden.

Diseases such as Blue Tongue, Anthrax, Tetanus, and Orf Scab are particularly concerning due to their severe symptoms and high morbidity and mortality rates. These diseases can spread rapidly within herds and, in some cases, to other livestock or even humans, posing significant public health risks. The management and control of these diseases require substantial investments in veterinary care, biosecurity measures, and farmer education, which can strain the financial resources of small-scale farmers.

Understanding the epidemiology and impact of these diseases is crucial for developing effective prevention and control strategies. By mitigating the incidence and spread of diseases in goats, farmers can enhance animal welfare, improve productivity, and ensure the sustainability of their farming operations. Consequently, addressing goat diseases is not only essential for animal health but also for the economic stability and growth of rural communities that depend on goat farming as a primary source of income.

1.1 Symptoms of the chosen diseases:

Blue Tongue

- **Affected Species**: Sheep of all ages; goats rarely show clinical disease.
- **Clinical Signs**:
  - Transient fever.
  - Swelling of the face, muzzle, and ears.
  - Large amount of nasal discharge, potentially causing crusting around the nose.
  - Oral mucus membranes become dark pink; as the disease progresses, small hemorrhages and ulcers may form on the roof and corners of the mouth.
  - Possible, but not common, cyanotic (blue) tongue.
  - Laminitis due to inflammation of the coronary band and tissues of the foot, potentially leading to sloughing of hooves.
  - Diarrhoea and wool-break.
  - Reproductive issues including abortions, stillbirths, and weak lambs.

Anthrax

- **Affected Species**: Cattle, goats, and sheep.
- **Clinical Signs**:
  - Sudden death is the typical sign.
  - Fever.
  - Staggering.
  - Excitement or depression.
  - Incoordination and trembling.
  - Difficulty breathing, followed by rapid collapse, terminal convulsions, and death.
  - Bloody discharges from natural body openings (nose, mouth, ears, penis, and rectum).
  - **Human Infection**:
    - Handling infected animals or contaminated surfaces.
    - Entry through the skin, leading to a dark scab at the point of entry.
    - Potentially fatal infections if acquired by inhalation or ingestion and left untreated.

Tetanus

- **Signs of Illness**:
  - Muscle stiffness.
  - Unsteady gait.
  - Drooping eyelids.
  - Changed voice.
  - Erect ears and tail.
  - Inability to eat or drink.
  - Progressively worsening symptoms, potentially leading to convulsions.
  - Death occurs from asphyxiation secondary to respiratory paralysis.

Orf Scab

- **Clinical Signs**:
  - Approximately one week after infection, kids may develop a raised temperature.
  - Development of spots, pustules, and scabs at the infection site, typically the mouth, lips, and nose area.
  - Lesions can also appear on the tongue, gums, and palate (McElroy and Bassett, 2007).

2.Literature review:

There are various new methodologies for designing incubators recently. For example, Dive and Kulkarni designed an incubator that can detect the light luminance inside the incubator and the audio voice of the premature baby in the incubator [1]. The proposed incubator system can notify the doctor and nurse about the baby's condition. When the baby cries for any reason, the alarm is turned on and will go on until it is manually turned off.

In a study by Atul Kale, they had used GSM technology to send alerts about the baby's condition [2]. The Arduino board, in conjunction with a Sim 800 GSM Module as an information transmission submodule, delivers SMS to a medical expert the baby body's sensor data monitored by the system. In summary, this study provided new ways for designing a dependable baby hatchery using the UNO microcontroller.

In the paper an android application-based temperature and humidity monitoring and controlling child incubators paper by Mohaiminul Islam and Navila Rahman, preexisting dht11 had been used along with hc-06 and an interconnection of 2 incubators had been done wirelessly. (by means of the Bluetooth based android application)

Non-contact physiological monitoring of preterm infants in the Neonatal Intensive Care Unit Mauricio Villarroel1*, Sitthichok Chaichulee 1 , João Jorge 1 , Sara Davis2 , Gabrielle Green2 , Carlos Arteta3 , Andrew Zisserman 3 , Kenny McCormick2 , Peter Watkinson4 and Lionel Tarassenko1 In this paper no sensors were used for the determination of parameters rather a contemprery approach of camera image capturing and use of image analysis models like cnn,naïve bayes were used to determine the parameters(multi-task Convolutional Neural Network (CNN), time periods during which the infant was present or absent from the incubator were automatically detected from the video recordings. Regions of interest (ROI) corresponding to skin were segmented from each video frame. These ROIs were used to extract cardiac-synchronous Photoplethysmographic Imaging (PPGi) and respiratory signals, from which heart rate and respiratory rate were estimated.)[11]

[12]Multiple Fault Detection and Smart Monitoring System Based on Machine Learning Classifiers for Infant Incubators Using Raspberry Pi 4(using a microprocessor) Maryam A. Mahdi*, Sabah A. Gittaffa, Abbas H. Issa - The proposed system had used four temperature sensors that were later extended to monitor skin temperature and two humidity sensors,The infant was monitored.

[13] Shabeeb et al. [12] proposed a method by which the humidity levels and air temperature in the infant's incubator are remotely monitored as a result of using an Arduino microcontroller with various sensors (DHT11/DHT22) and Internet of Things (IoT) applications. Using a wireless (ESP8266Wi-Fi) connection, the system connects to a network and is linked to a smartphone or computer application.

Review and status of Research and Development in the subject:

a. International status

[REF] / YEAR	PROBLEM	METHODOLOGY / COUNTRY
[1] / 2020	The welfare of animals be continuously monitored in a real-time way	Collecting on-farm videos / School of Information and Computer Sciences, Anhui Agricultural University, Hefei, China

[2] / 2016	Recent advances in wearable sensors	Nano biosensors and advanced molecular biology diagnostic techniques for the detection of various infectious diseases of cattle / Bio-Nano Laboratory, School of Engineering, University of Guelph, Guelph, Canada
[3] / 2011	Analytic function of disease rate and guide goat immunization	Goat medical records subsystem / Coll. of Animal Husbandry & Veterinary Med. Shenyang Agric. Univ. Shenyang, China
[4] / 2009	Human-animal interaction	Health status of animals in terms of body condition scoring, skin and hair conditions, lameness and injuries, and management practices in relation to cleanliness, animal handling and moving, milking procedures and abnormal behaviours, are proposed as potential animal-based indicators / Italy

b. National status

[REF] / YEAR	PROBLEM	METHODOLOGY / COUNTRY
[5] / 2012	Web-based software to predict livestock diseases	Project Directorate on Animal Disease Monitoring and Surveillance (PDADMAS) under ICAR has developed a Web-based interactive software to predict livestock diseases two months in advance in the country / India
[6] / 2019	Spread and impact of goat pox	A detailed description of the clinical disease and the spread of the outbreak in the locality are provided. Awareness of the disease with reference to farming practices will provide opportunities for future disease control to enhance animal welfare and rural prosperity / India
[7] / 2016	Different endemic infectious diseases causes significant economic loss	Prevalence, diagnosis, management and control of important diseases of ruminants with special reference to Indian Scenario / India

3.Block diagram:

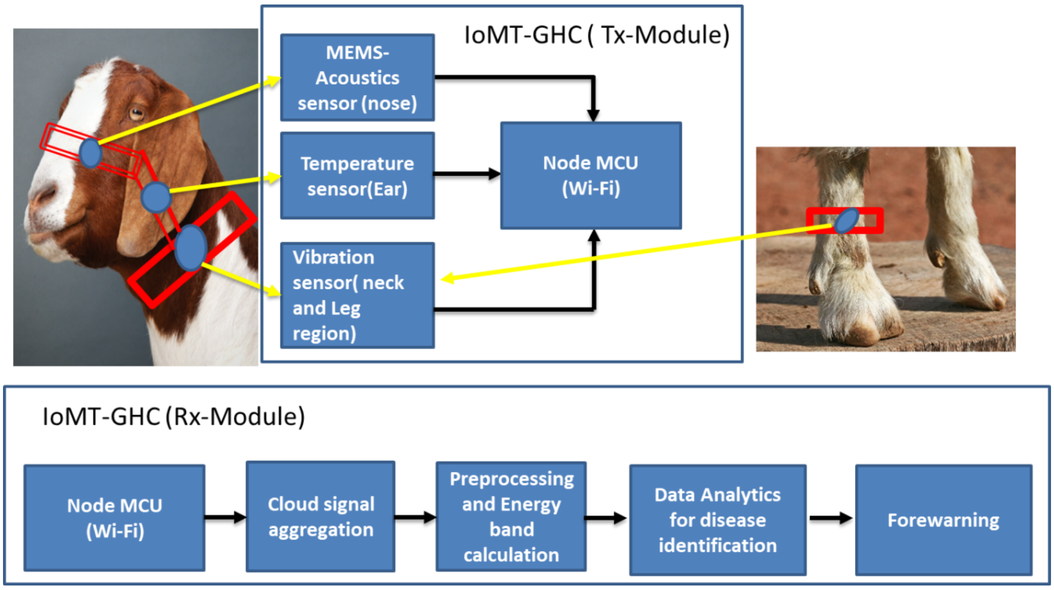


Figure 3.1. Proposed IoMT- GHC block diagram

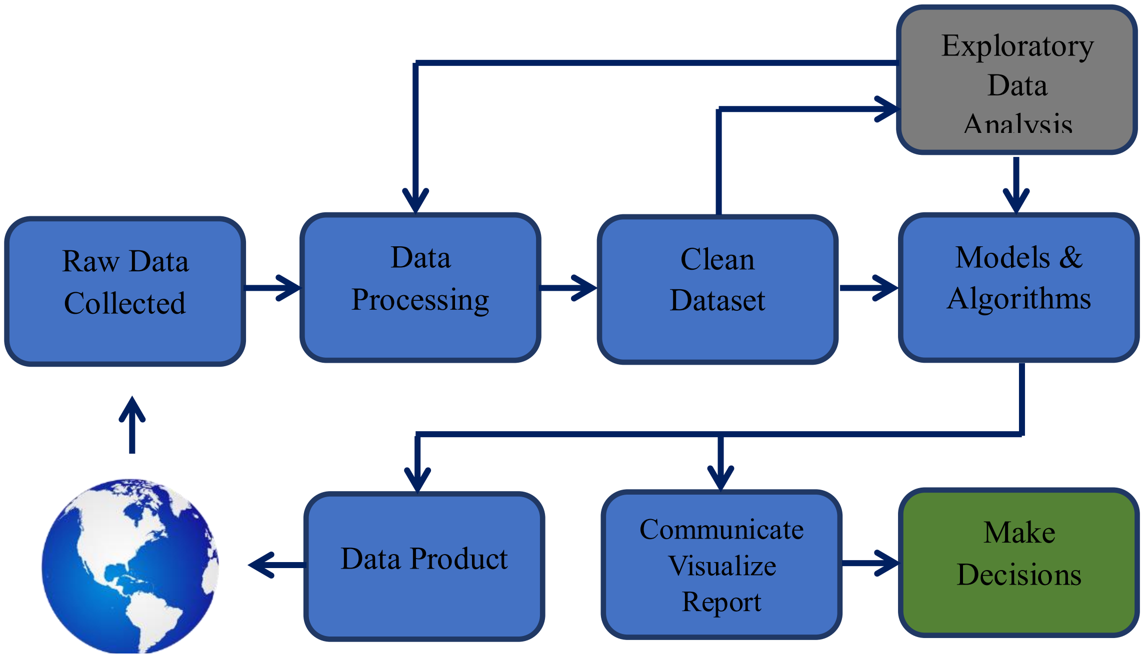


Figure 3,2. IoMT-GHC Data analytic process for Goat disease identification based on geolocation

3.1 Workflow Diagram Description:

1. **Sensor Layer (ESP8266):**
   - **DHT11 Humidity Sensor:**
     - Measures temperature and humidity around the neck region and heat from the nostrils of the goat.
     - Outputs the temperature and humidity data to the ESP8266.
   - **Pulse Sensor:**
     - Positioned near the neck, it monitors the heart rate of the goat.
     - Sends analog data to the ESP8266 for initial processing.
   - **Temperature Sensor:**
     - Captures the temperature of the exhaled air from the goat's nostrils.
     - Sends data to the ESP8266.
   - **PIR Sensor:**
     - Detects motion or inactivity of the goat.
     - Provides data on goat activity level to the ESP8266.
2. **Communication Layer (ESP8266 to Raspberry Pi):**
   - **MQTT Protocol:**
     - Transmits sensor data from the ESP8266 to the Raspberry Pi.
     - Ensures real-time data transfer for processing and analysis.
3. **Processing Layer (Raspberry Pi):**
   - **Data Collection:**
     - Receives data from the ESP8266 via MQTT.
   - **Data Processing:**
     - Processes temperature, humidity, pulse rate, and motion data.
     - If scabs are detected in the image frames, classifies the goat as infected with PPR using the YOLOv8 model.
     - Evaluates data for signs of anthrax (high temperature, humidity) and tetanus (high pulse rate, lack of movement).

- **Onnx Model Running:**
    - Runs the YOLOv8 object detection model, identifying PPR based on the nostril and mouth region images.
- **Decision Making:**
    - If disease indicators (PPR, anthrax, tetanus) are detected, triggers alerts for veterinary intervention.

4. **Output Layer:**
    - **Flask Site:**
        - The detected disease and notification about the diseases detected is given out as in a flask site with login and signup for account creation.

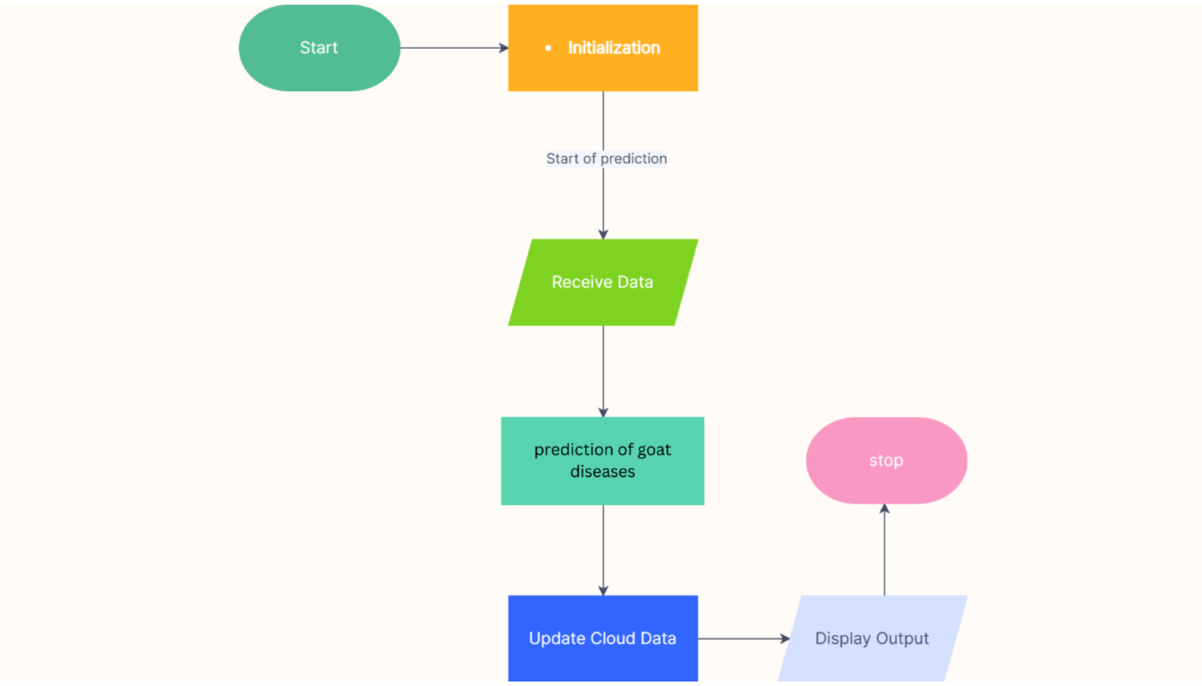
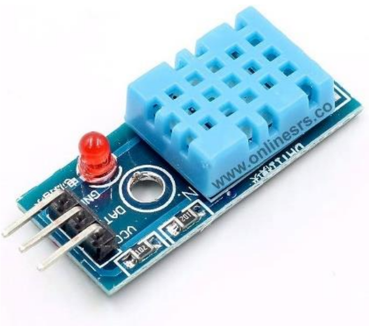


Fig 3.1.1 Flow diagram

4.Components used :



4.1 DHT11 Humidity sensor (humidity reference): The DHT11 sensor, characterized by its economical nature, makes it a versatile and cost-effective solution. It serves the purpose of assessing both humidity and temperature values. Within the experimental configuration, it was employed to get the temperature in the neck region and measure the heat given out from the nostrils of the goat.

Fig 4.1.1 dht11

The DHT11 sensor utilizes a capacitive humidity sensor and a thermistor to gauge the ambient air's humidity and temperature, respectively.

The capacitive humidity sensor is responsible for determining the humidity level by measuring the changes in capacitance resulting from the absorption or release of water vapor by a hygroscopic material.

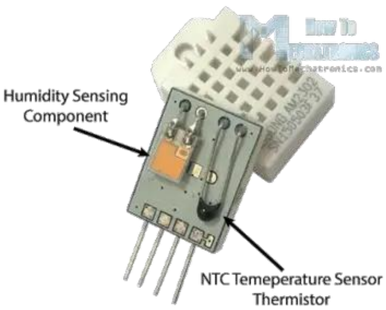


Fig 4.1.2 Internal structure of dht11

Concurrently, a thermistor, a temperature-sensitive resistor, is employed to measure the temperature of the surroundings. The thermistor's resistance changes with variations in temperature, and this alteration is then utilized to derive the corresponding temperature value.

These internal components are integrated within the sensor's housing, creating a compact and efficient unit.

4.2 Raspberry Pi : for the running of onnx model and the processing of input image frame

Overview

The Raspberry Pi is a series of small single-board computers developed by the Raspberry Pi Foundation. Designed to promote computer science education, it has grown to be widely used in various applications, including home automation, robotics, and IoT (Internet of Things) projects.

Key Specifications

1. **Models**: Various models including Raspberry Pi 1, 2, 3, 4, and Zero.
2. **Processor**: ARM-based CPUs, ranging from single-core to quad-core processors.
3. **Memory**: Typically ranges from 512MB to 8GB of RAM.
4. **Storage**: Uses microSD cards for storage, with some models supporting USB boot.
5. **Connectivity**:
    - **Wireless**: Wi-Fi and Bluetooth (available in newer models).
    - **Wired**: Ethernet port (speed varies by model), multiple USB ports.
    - **GPIO**: General-purpose input/output pins for interfacing with other hardware.
6. **Video Output**: HDMI ports for video output, supporting various resolutions.

7. **Operating System**: Primarily runs Raspberry Pi OS (formerly Raspbian), a Debian-based Linux distribution, but also supports other OSes like Ubuntu, Windows 10 IoT Core, and various lightweight Linux distributions.

Applications

- **Educational Use**: Ideal for learning programming and computer science concepts.
- **IoT Projects**: Used as a hub or edge device in IoT applications.
- **Home Automation**: Powers smart home applications.
- **Media Center**: Can be used to build home media centers (e.g., using Kodi).

4.3 NodeMCU (ESP8266 and ESP32)

Overview

NodeMCU is an open-source firmware and development kit that helps developers build IoT products. It runs on the ESP8266 and ESP32 Wi-Fi modules, which are microcontroller units with integrated Wi-Fi capabilities.

Key Specifications

ESP8266

1. **Processor**: 32-bit RISC CPU running at 80 MHz.
2. **Memory**:
   - **RAM**: 160 KB (for data)
   - **Flash**: Typically 4MB (varies by model)
3. **Connectivity**:
   - **Wi-Fi**: 2.4 GHz Wi-Fi capabilities.
   - **GPIO**: Several general-purpose input/output pins.
4. **Programming**: Can be programmed using the Arduino IDE, Lua, MicroPython, etc.
5. **Operating Voltage**: 3.3V
6. **Dimensions**: Compact form factor suitable for integration into various projects.

ESP32

1. **Processor**: Dual-core Xtensa LX6 microprocessor, running at up to 240 MHz.
2. **Memory**:
   - **RAM**: 520 KB SRAM
   - **Flash**: Varies, typically 4MB
3. **Connectivity**:
   - **Wi-Fi**: 2.4 GHz Wi-Fi capabilities.
   - **Bluetooth**: Dual-mode Bluetooth (Classic and BLE).
   - **GPIO**: Multiple general-purpose input/output pins, including capacitive touch sensors, ADCs, DACs, UART, SPI, I2C, and more.
4. **Programming**: Compatible with Arduino IDE, ESP-IDF, MicroPython, etc.
5. **Operating Voltage**: 3.3V
6. **Additional Features**: Integrated Hall sensor, temperature sensor, and secure boot features.

Applications

- **IoT Devices**: Widely used in IoT applications due to its wireless connectivity and versatility.

- **Home Automation**: Powers various smart home devices and systems.
- **Wearables**: Used in wearable technology for its compact size and low power consumption.
- **Prototyping and Development**: Ideal for rapid prototyping and development of connected devices.

4.4. MQTT (Message Queuing Telemetry Transport)

- **Overview**: MQTT is a lightweight messaging protocol designed for small sensors and mobile devices, optimized for high-latency or unreliable networks. It's ideal for IoT applications where devices need to send small amounts of data over low-bandwidth, high-latency, or unreliable networks.
- **Key Features**:
    - **Low Bandwidth**: Efficient use of bandwidth, making it suitable for IoT environments.
    - **Publish/Subscribe Model**: Devices (publishers) send messages to a topic, and other devices (subscribers) receive those messages. This decouples message producers from consumers.
    - **QoS Levels**: Three levels of Quality of Service (QoS) to ensure the message delivery level appropriate to the application.
- **Application in Project**: MQTT can be used to transmit sensor data from the goats to a central server or cloud platform, allowing real-time monitoring and alerting for potential diseases.

4.5. Pi Sensor (Raspberry Pi-based Sensor Integration)

- **Overview**: The Raspberry Pi is a low-cost, credit-card-sized computer that can be connected to various sensors to gather data for IoT projects.
- **Capabilities**:
    - **Sensor Compatibility**: Can interface with a wide range of sensors (temperature, humidity, motion, pulse) via GPIO pins.
    - **Data Processing**: Capable of processing sensor data locally before transmitting it.
    - **Networking**: Supports Ethernet, Wi-Fi, and Bluetooth for network connectivity.
- **Application in Project**: A Raspberry Pi can collect data from different sensors attached to the goats (e.g., pulse sensors) and process it for disease detection and prediction. This data can then be sent via MQTT to the central monitoring system.

4.6. Servo Motor

- **Overview**: A servo motor is a rotary actuator that allows for precise control of angular position, velocity, and acceleration. It is typically used in applications that require precise movement control.
- **Key Features**:
    - **Precision**: Provides accurate control over rotation, ideal for applications requiring precise movement.
    - **Feedback Mechanism**: Built-in feedback to correct the motor position.
    - **Control**: Typically controlled by PWM (Pulse Width Modulation) signals.
- **Application in Project**: Servo motors can be used for automated feeding mechanisms, opening and closing gates, or other physical interventions based on sensor data (e.g., isolating a sick goat based on health metrics).

4.7 Pulse Sensor

- **Overview**: A pulse sensor is a bio-sensor that measures the heart rate by detecting the pulse through the skin. It usually operates by measuring the change in light absorption due to blood flow.

- **Key Features**:
  - **Accuracy**: Provides real-time heart rate monitoring.
  - **Wearability**: Can be easily attached to the body or embedded in wearable devices.
  - **Data Output**: Typically outputs analog signals that can be processed to determine the pulse rate.
- **Application in Project**: Pulse sensors can monitor the heart rate of goats. Abnormal pulse rates can be an early indicator of illness, allowing for timely intervention to prevent the spread of disease.

5 EXTERNAL CIRCUIT CONNECTED:

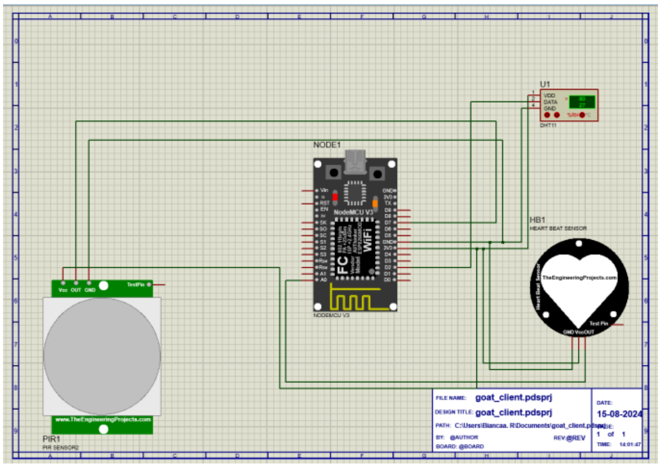


Fig 5.1 External circuit client

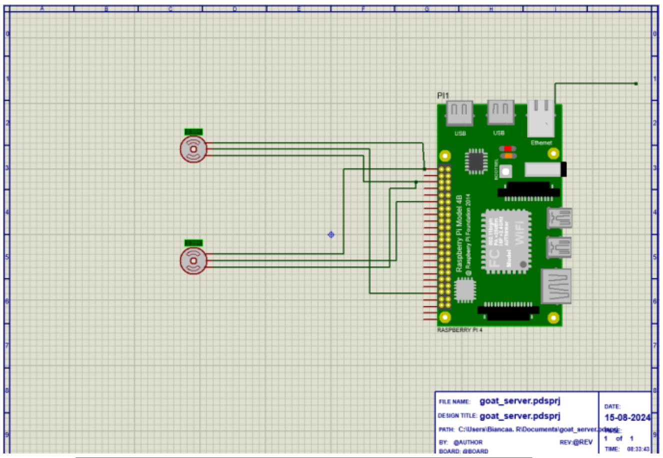


Fig 5.2 External circuit server

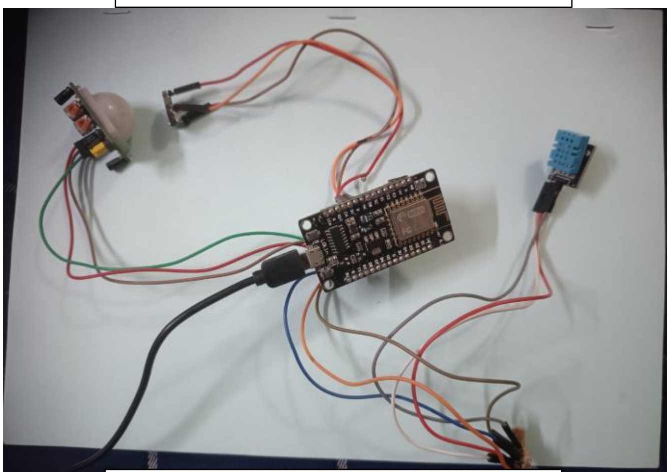


Fig 5.3 External circuit client

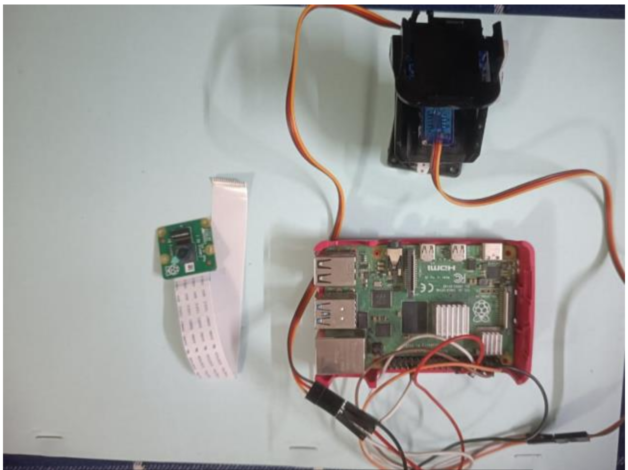


Fig 5.4 External circuit server

Fig 5.5 External circuit client frame

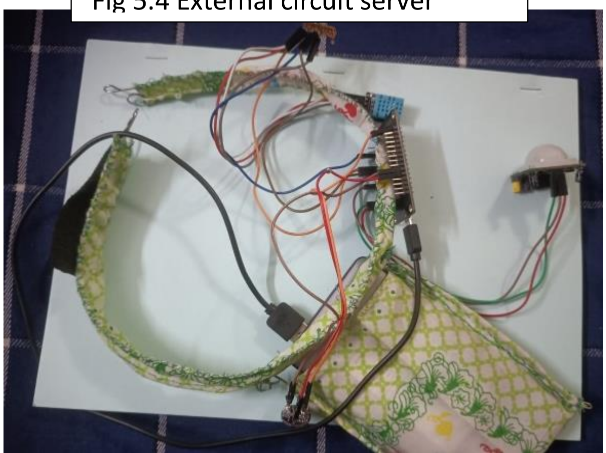
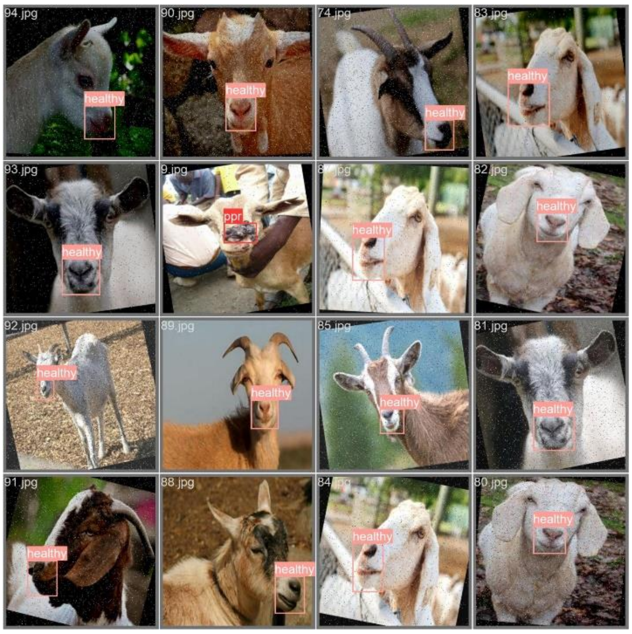


Fig 5.6 External circuit client full structure

6.Results and discussion:

The Machine Learning model based on YOLO v8 for identification of ppr:
In this image processing model the image data was annotated with xml files which highlighted the regions of interest essentially the nostrils and the mouth regions of the goat, if scabs are detected the model classifies it as ppr (scabby mouth) a disease which can be transmitted to other goats as well and should be avoided. Once the disease is detected by the yolo model attached to the continuous surveillance, forewarning is done.



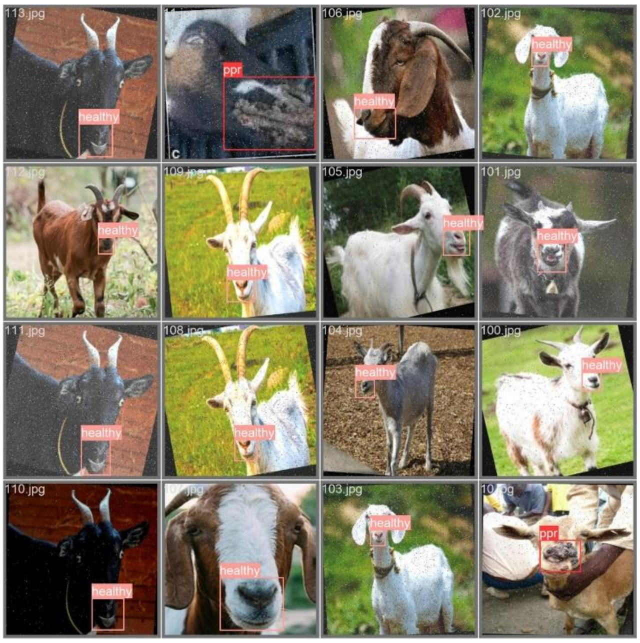


Fig 6.1 ,6.2 Bounding boxes for detection

6.1 Precision confidence curve

The Precision-Confidence Curve visualizes the relationship between the confidence level of a model's predictions and the precision of those predictions.

Key Elements of the Graph:

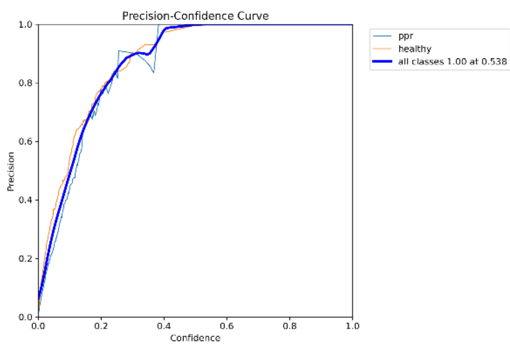


Fig 6.1.1 Precision confidence curve

- X-axis: Confidence - This represents the model's confidence in a prediction.
- Y-axis: Precision - This represents the proportion of positive predictions that are actually correct.
- Lines:

○

○ ppr: Represents the precision-confidence curve for the "ppr" class.

○ healthy: Represents the precision-confidence curve for the "healthy" class.

- all classes 1.00 at 0.032: Indicates that all classes achieve perfect precision (1.0) at a confidence threshold of 0.032.

  Interpretation:

- Ideal Curve: A curve closer to the top-right corner indicates better performance. This means the model achieves high precision even at lower confidence levels.
- Class Comparison: The relative positions of the "ppr" and "healthy" curves show how well the model performs for each class. A higher curve indicates better precision.
- Confidence Threshold: The "all classes 1.00 at 0.032" point suggests that if you only consider predictions with a confidence level above 0.032, all predictions will be correct. However, this might be overly restrictive and reduce the number of predictions.

6.2 Losses involved:

Implications:

- Model Performance: The shape of the curves can reveal the model's strengths and weaknesses. For example, a steep drop in precision for one class might indicate difficulty in distinguishing that class from others.
- Threshold Selection: This graph helps in choosing an appropriate confidence threshold for classifying predictions. A higher threshold generally leads to higher precision but lower recall (number of correct

- positive predictions out of all actual positives).

  The provided image showcases the behavior of various loss functions during the training and validation phases of an object detection model, likely a YOLO-based system.

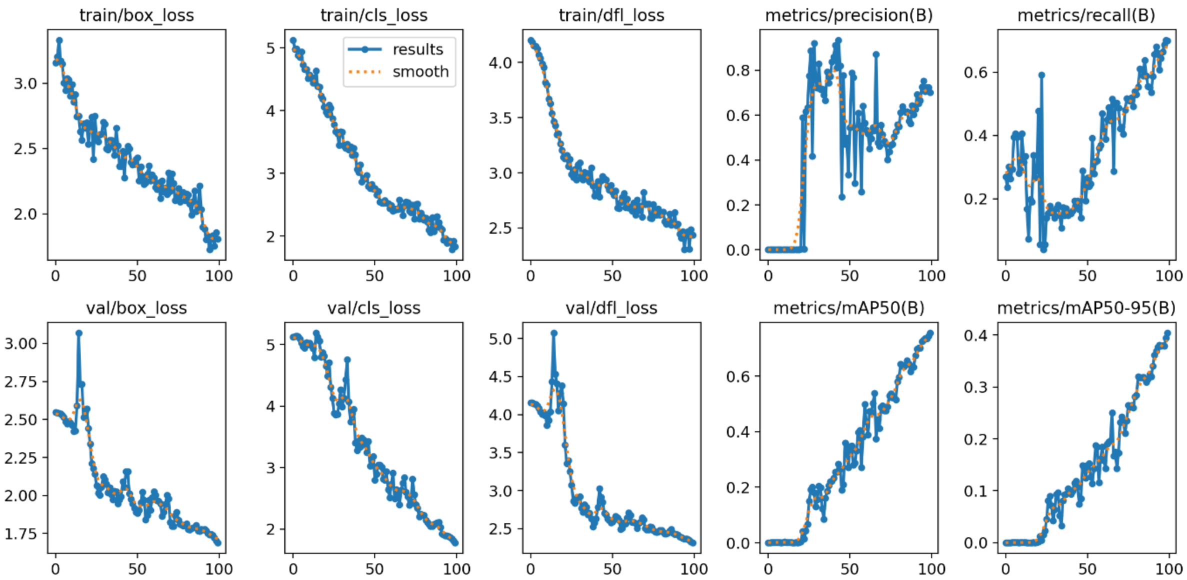


Fig 6.2.1 Losses involved

Loss Types:

- **box_loss:** This loss function quantifies the error in predicting the bounding box coordinates of detected objects. Lower values indicate better localization accuracy.
- **cls_loss:** This loss function measures the error in predicting the correct class for detected objects. Lower values imply improved classification accuracy.
- **Training vs. Validation:**

- **train/box_loss, train/cls_loss** These curves represent the respective loss values during the training process. Ideally, they should decrease over time, indicating improved model performance.
- **val/box_loss, val/cls_loss, val:** These curves depict the loss values on a validation dataset. They help monitor overfitting. Ideally, they should follow a similar trend to the training losses but with slightly higher values.

Observations:

- **Decreasing Trend:** All loss curves exhibit a decreasing trend during training, suggesting that the model is learning.
- **Gap Between Training and Validation:** The difference between training and validation losses can provide insights into overfitting. A significant gap indicates potential overfitting, where the model is performing well on the training data but not generalizing well to unseen data.

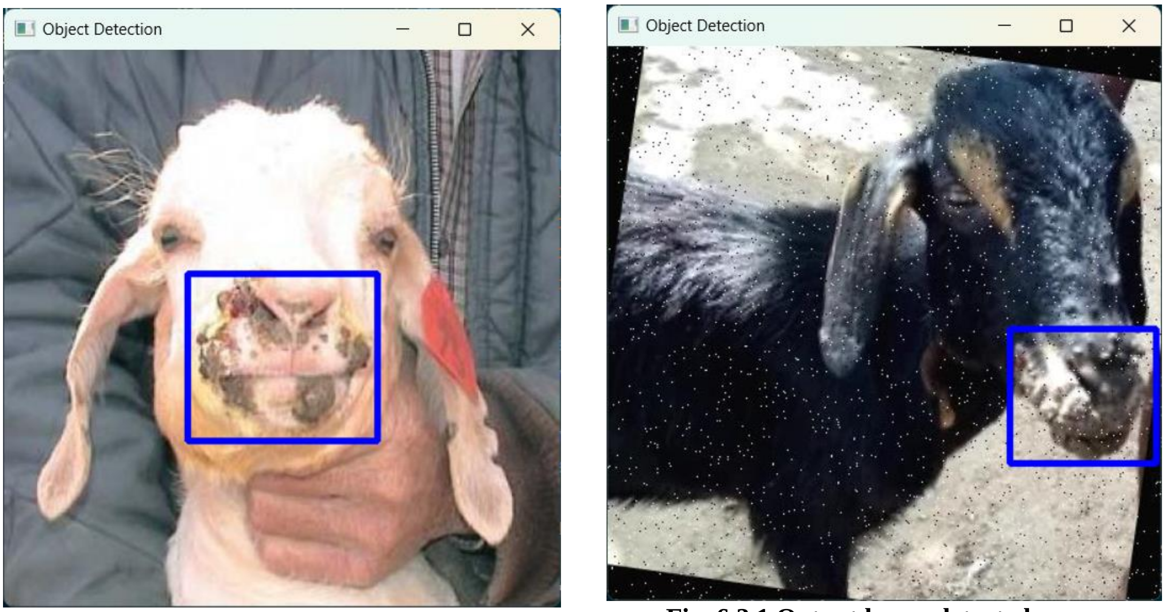


Fig 6.3.1 Output boxes detected

6.3 OUTPUT OF REAL TIME DATA:

- The direct output of real time data through camera feed is as follows. The performance when passing the camera frames were lower but when passing in images or videos of the images the response was good and the accuracy of the bounding boxes were very high.

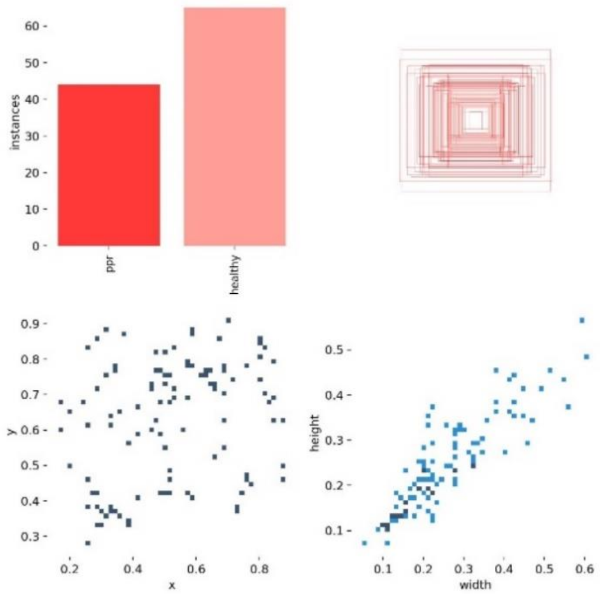
7. YOLOv8 Model Overview:

YOLO (You Only Look Once) is a popular real-time object detection system. YOLOv8, the latest version, brings several improvements in speed and accuracy, making it suitable for applications in various fields, including veterinary diagnostics.

Dataset Description:

The dataset consists of images of goats with annotations indicating their health status:

- **Healthy**: Goats without any visible signs of PPR.
- **PPR**: Goats showing clinical signs of PPR, particularly scabs on the nostrils.



Top Left: Instance Count

- **Bars represent:** The number of instances for classes "ppr" and "healthy."
- **Interpretation:** There's a significant class imbalance with "healthy" instances being much more frequent than "ppr" instances. Which is due to the fact that the percentage of infected goats are very less compared to healthy ones, so it prevents false positives for the identification of the disease ppr.

Top Right: Scatter Plot with Boxes

- **Axes:** X and Y coordinates.
- **Interpretation:** This plot shows the distribution of data points in the X-Y plane. The boxes likely represent ground truth bounding boxes for objects.

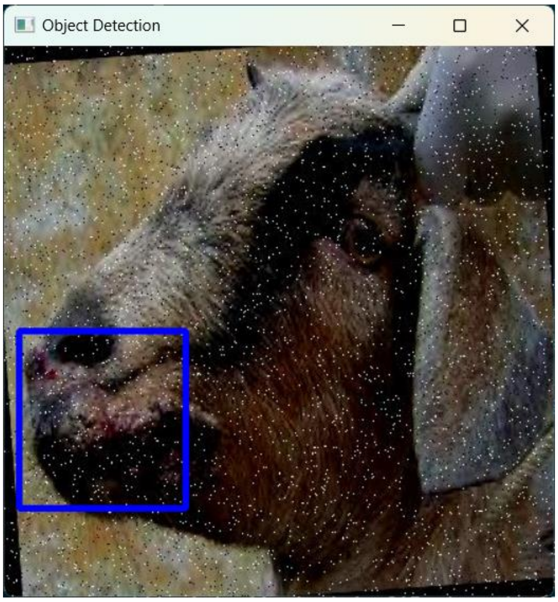
Bottom Left: Scatter Plot

- **Axes:** X and Y coordinates.

- **Interpretation:** Another scatter plot of data points, related to x and y coordinates of the bounding boxes in the image. It shows how widely the location of the nostrils and nasal area of the goats are located.

  Bottom Right: Scatter Plot

- **Axes:** Width and Height
- **Interpretation:** This plot shows the distribution of object sizes based on their width and height. The concentration of points towards the lower left corner suggests that many objects are relatively small and occupy a small portion of the entire image .
- **It is better as the model is trained with such data as in realtime the goats image would occupy a small area when the camera for capturing the image is placed at a particularly reasonable height.**



Generally though the performance of the model was high only when the picture of the goat occupied the entirety of the screen for the processing of the image to extract features.

Fig 7.1 output response

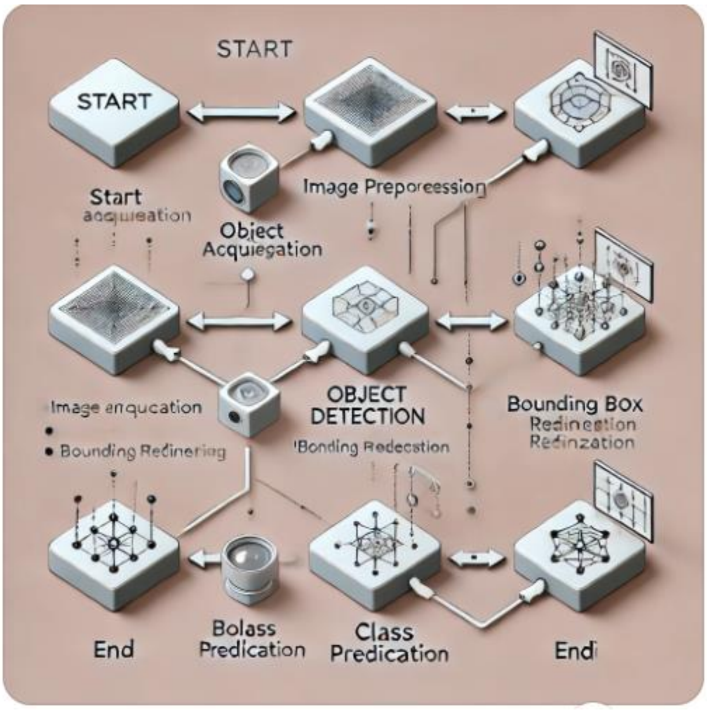


Fig 7.2 image prediction

7.1 Image Analysis

Each image is analyzed by the YOLOv8 model, which identifies and labels regions of interest (ROIs) as either "healthy" or "PPR". The labels are enclosed in bounding boxes with confidence levels indicating the model's certainty. In YOLO the bounding box is described by (x,y,h,w).

Key Observations

- **Healthy Goats**: The majority of the goats in the dataset are labeled as healthy. These images typically show goats with clean, scab-free nostrils.
- **PPR-Infected Goats**: A smaller subset of images shows goats with visible scabs on their nostrils, correctly identified by the model as having PPR.

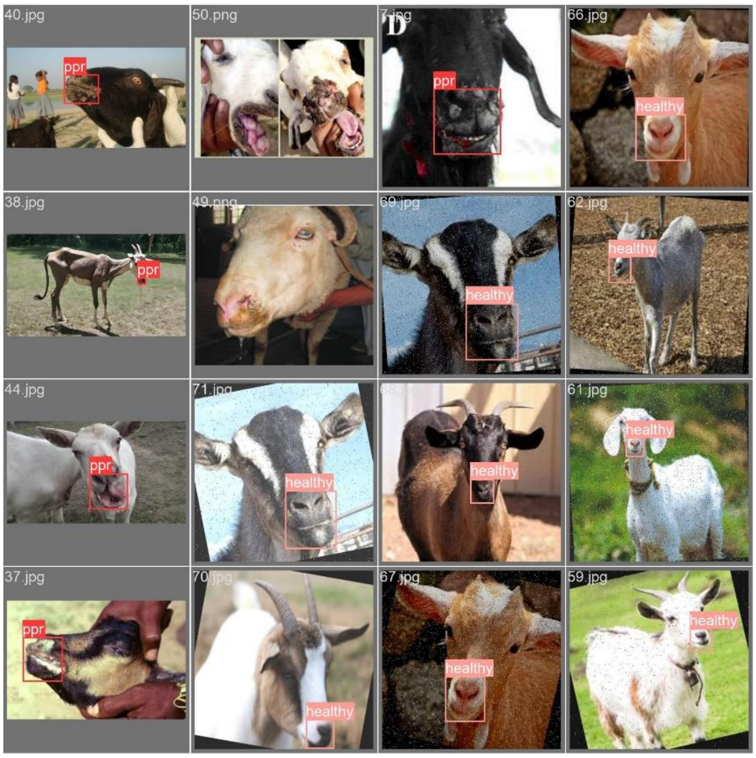


Fig 7.1.1 Annotated data

7.1.1The prediction of PPR is based on:

4.1.1 The prediction is based on the scabs located at or near the nostrils of the goats, which are the sensitive areas where the goat can be affected.

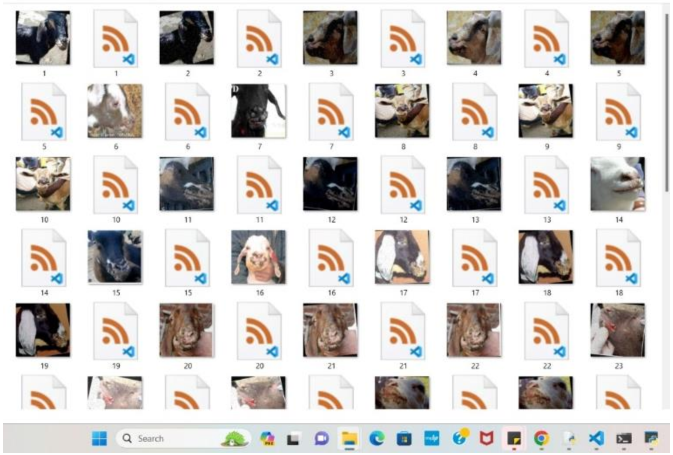


Fig 7.1.1.1 xml annotation of image files

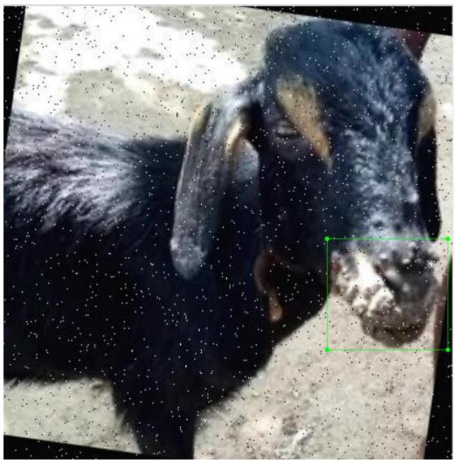


Fig 7.1.1.2 xml annotation of image

4.2 The detection of antharax and tetanus:

1. The detection of antharax and tetanus is solely based on the employed temperature sensor and the pulse/heart rate sensor . The temperature sensor positioned near the nose captures the temperature of the air exhaled by the goat which can be used to monitor the onset of fever which generally means antharax in goats.
2. The pulse sensor placed near the neck and throat region of the goat monitors its heart beat. In case of increased heart beat , it could easily indicate tetanus.
3. Other symptoms like erect posture detection for tetanus was considered by using image processing and use of mediapipe framework ,but since a goat laying down can be approximated in a similar fashion ,the number of false positives were large ,so the idea was aborted.
4. Pir sensor for the monitoring of motion ,if the goat happens to be still for long periods of time , along with increased heart rate , it can be confirmed that it had contacted tetanus.
5. Initially the use of humidity sensors in the nostrils of the goats for identifying liquid that would indicate antharax was considered, but since it would be impractically difficult and disturbing for the goat ,it was not implemented, furthermore any other cause of humidity like from food or water can cause a wrong prediction of antharax.

8 APPLICATION:

8.1 Deploying the model in raspberry pi os :

The .pt model generated by the best weights in YOLO is converted to onnx form so it can be easily deployable in raspberrypi debian OS.

```
conversion.py > ...
#conversion.py
from ultralytics import YOLO
model=YOLO("C:/wtf/runs/detect/train3/weights/best.pt")
success=model.export(format="onnx")
```

```
PS C:\wtf> python -u "c:\wtf\conversion.py"
Ultralytics YOLOv8.0.134  Python-3.11.1 torch-2.0.1+cpu CPU
YOLOv8n summary (fused): 168 layers, 3006038 parameters, 0 gradients

PyTorch: starting from C:\wtf\runs\detect\train3\weights\best.pt with input shape (1, 3, 640, 640) BCHW and output shape(s) (1, 6, 84
00) (6.0 MB)

ONNX: starting export with onnx 1.16.0 opset 17...
============= Diagnostic Run torch.onnx.export version 2.0.1+cpu =============
verbose: False, log level: Level.ERROR
======================= 0 NONE 0 NOTE 0 WARNING 0 ERROR ========================

ONNX: export success  1.0s, saved as C:\wtf\runs\detect\train3\weights\best.onnx (11.7 MB)

Export complete (1.6s)
Results saved to C:\wtf\runs\detect\train3\weights
Predict:         yolo predict task=detect model=C:\wtf\runs\detect\train3\weights\best.onnx imgsz=640
Validate:        yolo val task=detect model=C:\wtf\runs\detect\train3\weights\best.onnx imgsz=640 data=config.yaml
Visualize:       https://netron.app
PS C:\wtf>
```

8.2:The external circuit connected prototype:

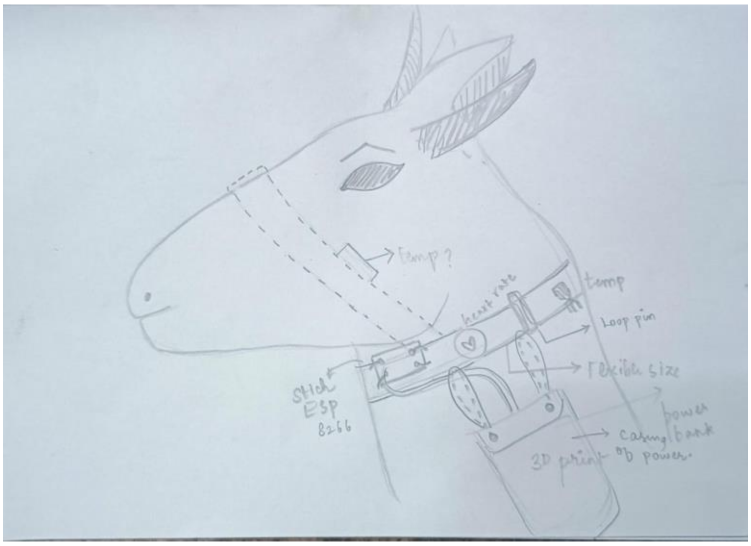


Fig 7.3.1 Planned prototype of the model

8.3 Application Development:

The developed application is a flask application which runs on the local host 5000

4.3.1 Features in the Application:

1. **Record Register:** The application incorporates a record register, which archives and retrieves all historical data from the cloud. This feature ensures accessibility to previously added and stored data through the application.
2. **Authentication System:** A secure signup and login mechanism is implemented, integrating with a database to restrict unauthorized access and safeguard sensitive information.
3. **Real-time Prediction:** The application provides a functionality to monitor,predict and forewarn farmers about a potential threat in their farm so appropriate action could be taken to protect the farm animals.
4. **Customized Dashboard:** Each user is endowed with a personalized dashboard tailored to individual preferences and requirements, enhancing user experience and facilitating efficient data management.
5. **Cloud Integration (ThingSpeak):** The application ensures seamless and immediate transmission of added values to the cloud. The chosen cloud service for this purpose is ThingSpeak, facilitating robust and glitch-free data storage and retrieval. This cloud integration enhances data accessibility and facilitates remote monitoring.

4.3.2: The user interface:

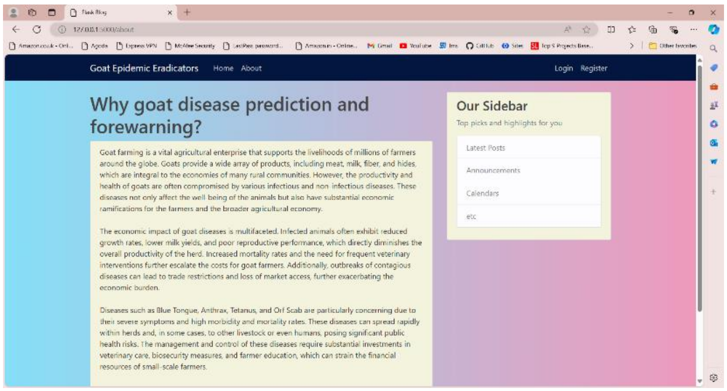


Fig 1 :The about page

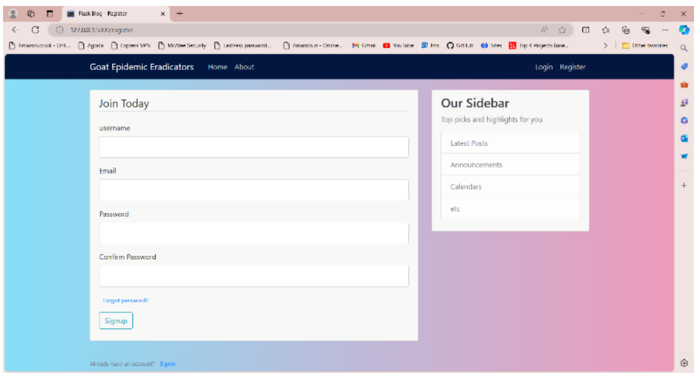


Fig 2: The sign up page to join the community

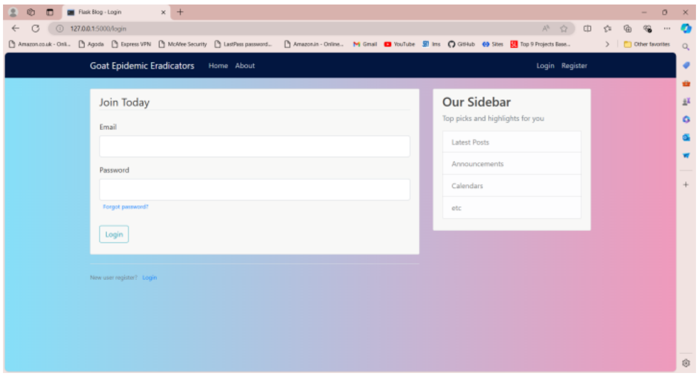


Fig 3 :The login page ,for logging into the account

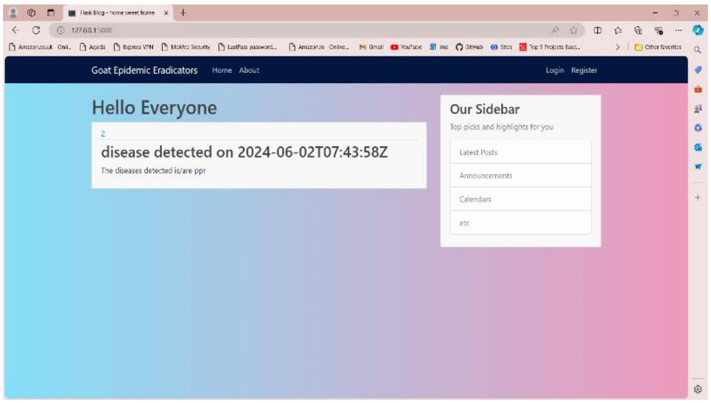
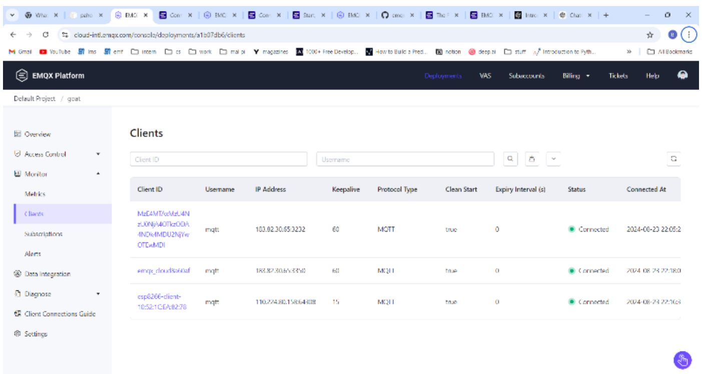


Fig 4: The notifications screen displaying the diseases.

8.4 EMQX Platform -MQTT:



8.5 CLOUD INTEGRATION: THING SPEAK:

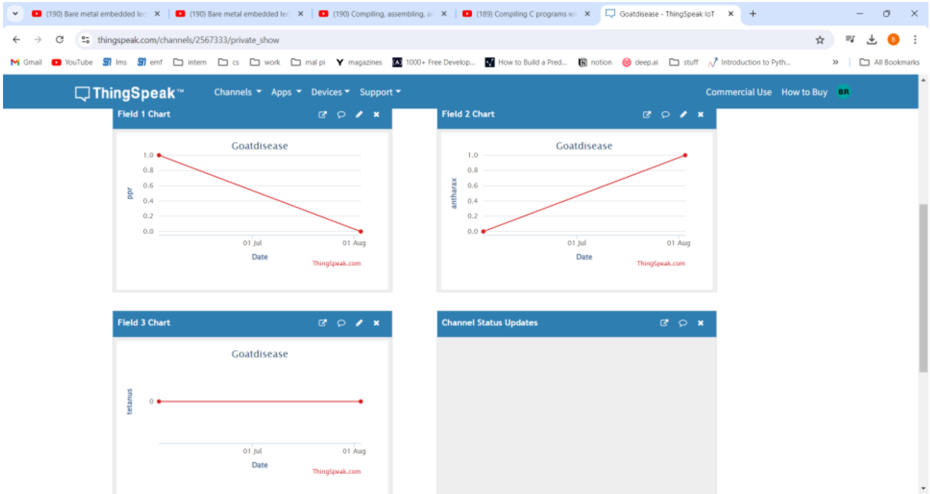


Fig 8.5.1A separate channel for monitoring if the disease is present or not in the heard of farming animals

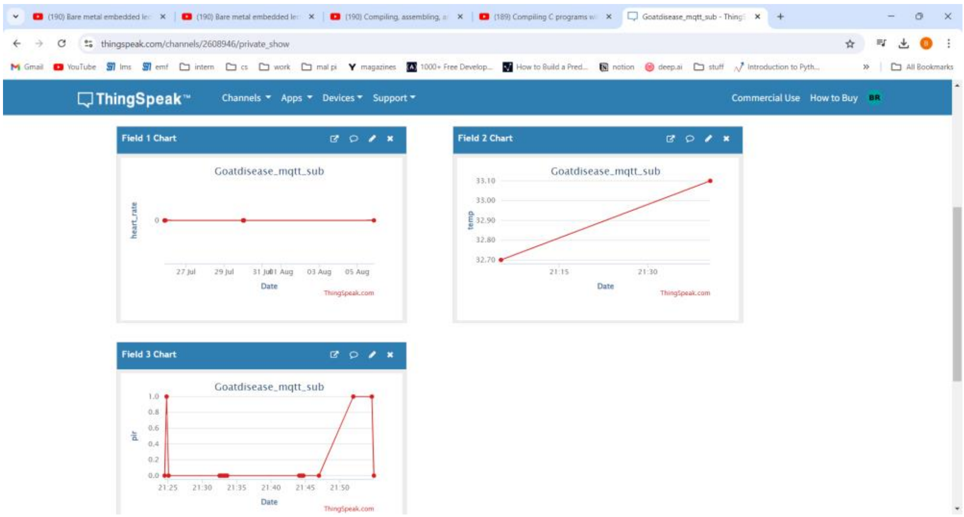


Fig 8.5.2A separate channel for monitoring the vitals and the values recorded for each goat in a unique channels

ThingSpeak is a popular IoT analytics platform that allows you to collect, store, analyze, and visualize data from your IoT devices. It's commonly used with microcontrollers like the ESP8266 or ESP32 because it provides a simple interface for interacting with sensor data over the internet.

1. Data Storage and Logging:

- Persistent Data Storage: ThingSpeak provides cloud storage for your sensor data. You can log data over time, which is particularly useful for monitoring long-term trends.
- Historical Data Access: With ThingSpeak, you can retrieve and analyze historical data, allowing you to observe trends and patterns over time.

2. Real-Time Data Visualization:

- Charts and Graphs: ThingSpeak automatically generates visualizations for your data, such as line charts, bar graphs, and gauges, making it easy to see what's happening with your sensors in real-time.
- Custom Dashboards: You can create custom dashboards to monitor multiple data streams simultaneously, making it easier to get a comprehensive view of your system.

9:Implications and Applications

1. **Early Detection**: Early identification of PPR can help in isolating infected animals, thereby preventing the spread of the disease within a herd.
2. **Automated Screening**: Deploying such a model in farms can automate the health monitoring process, reducing the need for constant human surveillance and allowing for timely intervention.
3. **Economic Impact**: By controlling the spread of PPR through early detection, farmers can minimize losses due to reduced productivity and increased veterinary costs.
4. **Training and Accuracy**: The effectiveness of the model depends on the quality and quantity of the training data. Continued improvement and training on diverse datasets will enhance the model's accuracy.

10 .CONCLUSION:

This research presents a novel approach for early detection and prevention of contagious diseases in goats, a critical step towards enhancing the productivity and sustainability of goat farming. By integrating wearable sensors, image processing, and machine learning, the proposed system offers a robust solution for monitoring goat health and identifying potential disease outbreaks. The YOLOv8 model, trained on a dataset of goat images, demonstrates promising results in accurately detecting PPR, a significant disease affecting goats. While the study provides a strong foundation, further research is necessary to expand the model's capabilities to encompass a wider range of diseases and to refine the system's sensitivity and specificity. The successful implementation of this technology has the potential to revolutionize goat farming practices, leading to improved animal welfare, reduced economic losses, and increased farmer resilience.

7.REFERENCES:

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