Etoile: IoT based Sustainable Health Monitoring of Life-stock

A project report submitted in the partial fulfillment for the award of Degree of Computer Science in computer Science Department

(Academic Session 2017-2021)

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CERTIFICATE

We accept the work contained in the report titled “Etoile based sustainable health monitoring of livestock”, written by **KANWAL NAZ** and **AROOBA SEHAR** as a confirmation to the required standard for the partial fulfillment of the degree of Bachelor of Science in Computer Science.

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June 22, 2021

Acknowledgments

We like to share our appreciation to all them who help us in completion of this project During the work we faced many challenges due to covid-19 but we tried to get over from all the difficulties and in final compilation of our idea to a shaped sculpture.

We would like to thanks Dr. Naveed Anwar Bhatti for his governance and guidance, because of him we were able to learn the minute aspects of a project work.

We would also like to show our gratitude to our Project Co-Supervisor Ma'am Sobia Rasheed for continuous help and monitoring during the project work.

In the last we would like to thank the faculty of Computer Science Air University for providing us such an opportunity to learn from these experiences.

We are also thankful to our whole class and more of all to our parents who have inspired us to face all the challenges and win all the hurdles in life

Thank you All

Kanwal Naz, Arooba Sehar
Islamabad, Pakistan

June22, 2021

"We think someone else, someone smarter than us, someone more capable, someone with more resources will solve that problem. But there isn't anyone else."

Abstract:

As we know Pakistan is an under developing country and we need to develop such a system that will not only increase the milk productivity but also ensure the health of dairy farm animals with sustainable expenditures that's why we take this project for the betterment of Pakistan. Traditional farming and agricultural industry should use smart technology for better result. We propose **sustainable health monitoring of livestock** which will not only monitor the cows but will help predicting the occurrence of diseases as well.

Livestock health monitoring equipment has been developed, which uses various sensors to obtain physiological parameters such as body temperature, heart rate, and their relationship (rumination) with environmental temperature, humidity, and movement etc.

IoT device are mounted on the neck of animal(cow) gives information about health status by relating different parameters. we use esp32s as basic controller which have inbuilt Wi-Fi. After getting and processing the data send/forward to cloud real time display on web and android.

It accurately predicts the health of cattle before its illness so that necessary action should be taken.it make sure efficient system with energy harvest. By implementing superior designs, the work necessary to get the intended output can be reduced effectively and inexpensively.

The health of the cattle has a significant impact on the production of cattle farms.

A herd of cattle infected with a contagious disease can significantly reduce the farm's productivity. As a result, identifying ill cattle is highly advised.

In this regard, IoT can make a significant contribution to the development of an autonomous system for cow health monitoring. In this world, a system is being built.

Contents

Chapter 1

1Introduction:

1.1 Project Background/Overview:

Agriculture is the country's principal source of income. Livestock families such as cows, buffalo, sheep, and goats play an important role in rural life because it is not only a large portion of the GDP of Pakistan [1] but also it is the source of income for villagers. Many types of diseases affect these animals on the farm thus suffering the farmers[2].

As we know Pakistan is an under developing country[3] and we need to develop such a system that will not only increase the milk productivity but also ensure the health of dairy farm animals with sustainable expenditures that's why we take this project for the betterment of Pakistan[4]. We should produce a movement in dairy farming towards automating processes to reduce (physical) energy and labor costs [5], [6] with effective and good results [7]. Now a day's livestock industry is facing many challenges about monitoring of animal and health care. Traditional farming and agricultural industry should use smart technology for better result. The traditional methods should use different gadgets, sensors, robots, drones etc. Internet of things seems to be one of the solutions for high efficiency and productivity in livestock industry.

1.2 Problem Description:

We propose **sustainable health monitoring of livestock** which will not only monitor the cows but will help predicting the occurrence of diseases as well. Through this, we will get all the information about the cattle's health. Our goal is better care of livestock animals which provide many benefits for farmer and in other way around in agricultural. A smart device which will not only reduce the labor cost but provide better monitoring of cows and is available at cheap rate. The farmer will be able to see the sensor's data on his mobile and desktop and if he has no time to see the whole sensors data.

1.3 Project Objectives:

. Then our system monitors the cow and give a notification alert if situation goes alarming.

- ✓ Our project aims to achieve more productive, efficient, and sustainable farm operations based on the effective use of digital technologies.
- ✓ Better animal health, welfare, and living conditions.
- ✓ The largest potential lies in individual animal monitoring and analysis, here tools and sensors are used to continuously and automatically

monitor key performance indicators of livestock in the areas of animal health.

- ✓ Consumers have become more aware of animal welfare. Brand owners increasingly focus on supply chain monitoring and quality assurance to guarantee animal welfare.

- ✓ To satisfy the demands of a customer by providing a product that meets the customer's requirements at a price that enables the producer to make a profit.

1.4 Project Scope:

We cut down our project into different small tasks. Tasks include identifying the sensors which perform best in monitoring as well as are cheaper, then buying these sensors, sensors interfacing with microcontroller unit after that uploading the data on server and analyze the data, generate notification if the value goes beyond threshold value.

1.4.1 Cost of Hardware Tools:

NAMES	MODELS	PRICE
Microcontroller	ESP32s microcontroller	850
Skin temperature sensor	DS18B20	350
Environment's temperature Sensor	DHT-11	200
Heartbeat sensor	XD58C	400
Accelerometer	3-axis(ADX L345)	300

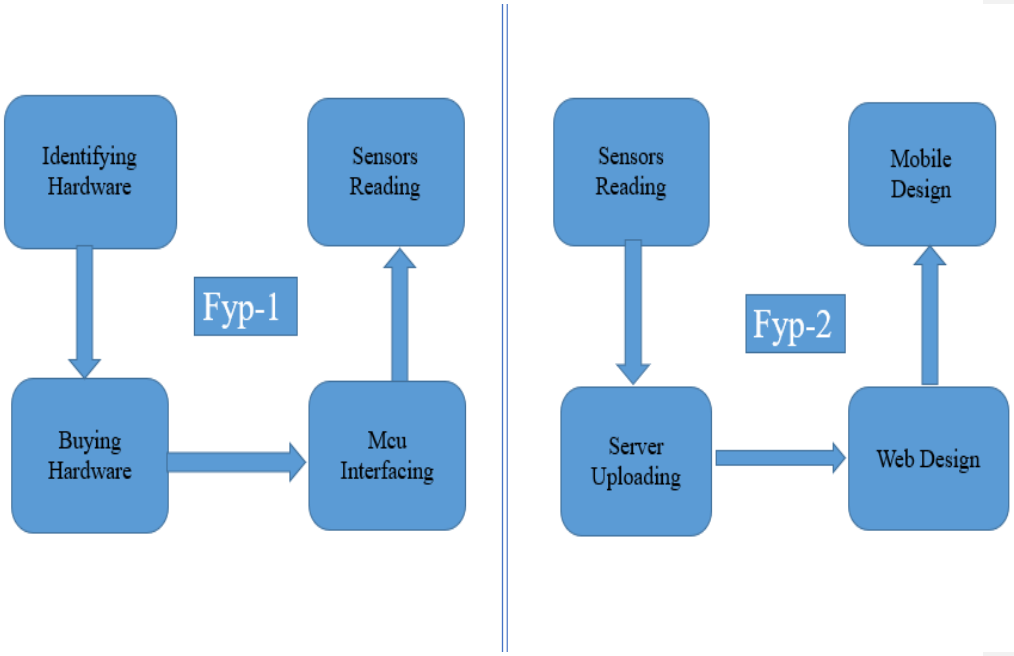
Device price = 2100 PKR

1.5 The Degree Project Report:

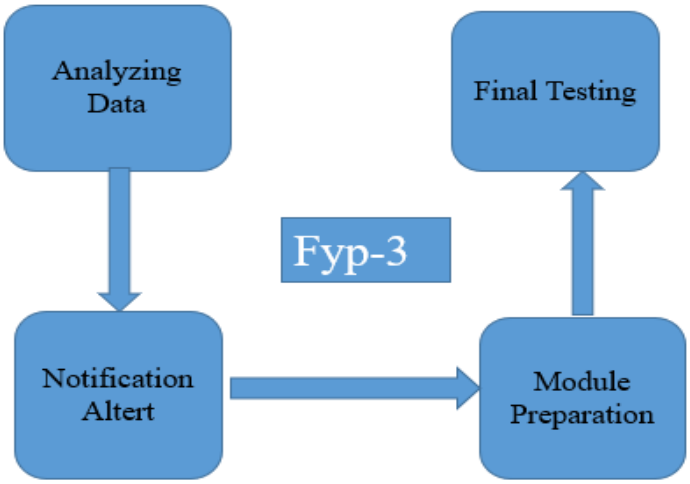
We divide our project into three different phase.in final year project phase-1, we identify the problem and drive its solution by studying different research papers. As we identify the problem for monitoring the health of animals in dairy forms especially cow. We decide to make a IoT smart device which predict the health of cows.

In phase-1 identify hardware and buy it. Esp32s is interface for first time with Arduino software connection build through Wi-Fi. Different sensors also attached with Esp32 to take readings.

In phase-2 different sensor were make sured working properly. These sensors get the value from environment and upload it on server which is further connected with web page and mobile app.



In final phase of final year project, we analyze the data to notify the user. Prepare a module in proper device shape and after that final testing is performed and run the system by supposing different scenarios.


Analyzing Data
Final Testing
Fyp-3
Notification Altert
Module Preparation

Chapter 2

2 Literature Review:

literature review is result of study different research paper.
in paper[6],they build open source system in which they use raspberry-pi in the specific environment and another wearable device which is also a raspberry-pi. They used accelerometer for measurement and body temperature sensor, environment temperature and LEDs for system information like low battery. TCP connection is built and uploads data to work station. A Wearable raspberry-pi just expects acknowledgments, whereas the Environment raspberry-pi can receive instructions for its actuators.

In paper[7],an advanced cost-effective method to monitor and deliver rapid notification for sustainable healthcare systems as a solution to the existing challenge of monitoring the health of cattle and humans. ESP32 is a Wi-Fi Bluetooth gadget that collects data from several sensors and transfers it to a cloud storage service. Mainly it consists of (Temperature Sensor, ECG Sensor, Blood Pressure Sensors) which are connected to the ESP32microcontroller chip with 5v battery. These entire devices are placed in a particular belt where every human can wear it. This device checks the temperature, blood pressure and heart beat rate of humans and stores this data in the cloud using things speakapp.so the user can access the data from any place.

In paper[8],farming industry gives significant income for farmer. But livestock in the farms are mostly affected by a number of diseases. The regular temperature of cow is 38-42 ◦C. When the temperature is below 38.5-39.5◦C the diseases arise are indigestion, milk infection and when the temperature is above 42◦C the diseases arise are influenza and anthrax. When the temperature of the animal is very high on that time it may die. When the humidity is between 1-72%(No stress), 72-79% (Mild stress), 80-90% (Moderate stress), 91-99% (severe stress)[8]. Humidity can reduce heat exchange and have enervating impact on the cattle. The adult cow has a heart rate of between 48 and 84 beats per minute[11]. An elevated heart rate may be a sign of pain, and is seen in conjunction with several diseases.
Different sensors are attached to an Arduino Uno, and they use a GSM module and a SIM to track their location. Data is sent to the GSM module first, then to the sim module, which sends the information to the server and displays the values on the monitoring system.

In paper[9],The sensors are used to measure a variety of health variables automatically. Such sensors would be mounted on the cattle's body and would continuously monitor the cattle's body issues, such as heartbeat rate, body temperature, [12]and deliver output in the form of electrical indications[13]. After that, the indications are compared to a standard range of normal values. In the sophisticated cattle health monitoring system, sensors such as a respiration sensor, humidity sensor, and rumination sensor are used. The Arduino uno is connected to these sensors[14].

In paper[10],They built a cow monitoring system in their research article, which contains a device to measure parameters, a router, hubs, and a Wi-Fi access point. Cloud is a database and application hosting platform. The gadget is built around the nRF 52832 system on chip, which includes an ARM Cortex 4F processor and a Bluetooth Low Energy (BLE) v.5 radio transceiver. Raw data was initially saved on an SD card[15]. They were downloaded every week, analyzed offline, and used to design preliminary algorithms.

2.1 Suggestion on the bases of literature review:

By studying the different research papers, we conclude different recommendation that is

1) System should be work properly and give almost 95% efficient results.
2) There is problem for real time data tracking so this problem should be counted while making project.
3) Message notification is not available which is necessary for emergency.

Chapter 3

3 Specific Requirements:

3.1 Functionality requirements:

- Health monitoring of livestock animal**:**
  This system will ensure bio security while monitoring the livestock and will notify the farmer or customer if situation gets worse.
- Display health status on Web App or Android App:
  Health values like heartbeat, temperature will be displayed on screen either on PC or android phone
- Notification in worse case:
  Whenever system will see the values gone beyond the threshold values it will immediately send notification to customer about health of animal.
- Dynamic monitoring:
  System is real time based will do dynamic monitoring without even human involvement.
- Input:
  Health parameters of animal through sensors.
- Output:
  Graphical views of heath parameters displayed on screens and error or emergency messages.

3.2 Non-Functional Requirements:

- Sustainable device:
  System will be embedded in small IOT device. Sustainable here means affordable system and our priority is to make the battery-less device that are much benefited for the livestock.

- Battery-less device:
  It will be battery less so that energy can be harvested and will be reliable.
- Energy harvesting:
  Energy will be harvested through various techniques in order to make a reliable system.
- It should be both Wi-Fi based and Bluetooth:

  It has 2 modes either Wi-Fi if reasonable or Bluetooth. Sometimes as in village area there is no Wi-Fi so Bluetooth there is a perfect option for connectivity.

- Reliable system:

  It is a reliable system as it's cheap and eco-friendly, too handy and even a lay man can understand this system.

3.3 Use Case:


Sign up
<<exclude>>
Authorized User
<<include>>
Login
Admin
farmer
View status
Notification Alert
sensors
management

3.3.1 Use Case Description:

Use Case ID:	UC-01
Use Case Name:	Authorized user
Actors:	admin
Description:	When the user try to login on website it trigger on every time and enters their email and password if he is login if he entered the wrong password then an error message is displayed.
Trigger:	When user try to login on website.
Preconditions:	User must have device id
Post conditions:	Verify the user already have account or not
Normal Flow:	User login to website
Exceptions:	Wrong password is entering or may be not have registered account
Includes:	Verified email and password and device id
Assumptions:	User bought device and have id
Notes and Issues:	May enter wrong device id

Use Case ID:	UC-02
Use Case Name:	Sign up
Actors:	User[former]
Description:	When the user come to website for first time than first, he registered his account and in registration he enter the device id.

Trigger:	When user first time come to website
Preconditions:	Have a correct device id.
Post conditions:	Verify it from it email that he entered
Normal Flow:	First sign up and verify email and then login into website
Alternative Flows:	If verify email is not receive then try again with correct device id
Exceptions:	Incorrect device id and or wrong email
Includes:	Device id and email address
Assumptions:	User buy our device
Notes and Issues:	Note that device id must be unique and only can accept with one email and multiple device id can have one email
Use Case ID:	UC-03
Use Case Name:	login
Actors:	User[former]
Description:	This use case describes how a user logs into system. Users will be prompted to login with their account information before they can use the system.
Trigger:	User request to login. The user has an account. The user is trying to log in with their specific id.
Preconditions:	System must be fully configured; appropriate user IDs and passwords must be obtained.
Post conditions:	If this operation is successfully occurred next screen will be containing graphical display of data
Normal Flow:	Correct credentials then go to data screen
Alternative Flows:	Incorrect password give option to re-enter or reset

Exceptions:	Incorrect credentials
Includes:	User email and password
Assumptions:	User have verified email account and already registered it on website
Notes and Issues:	With one login paged multiple device data can be displayed if the owner has multiple devices

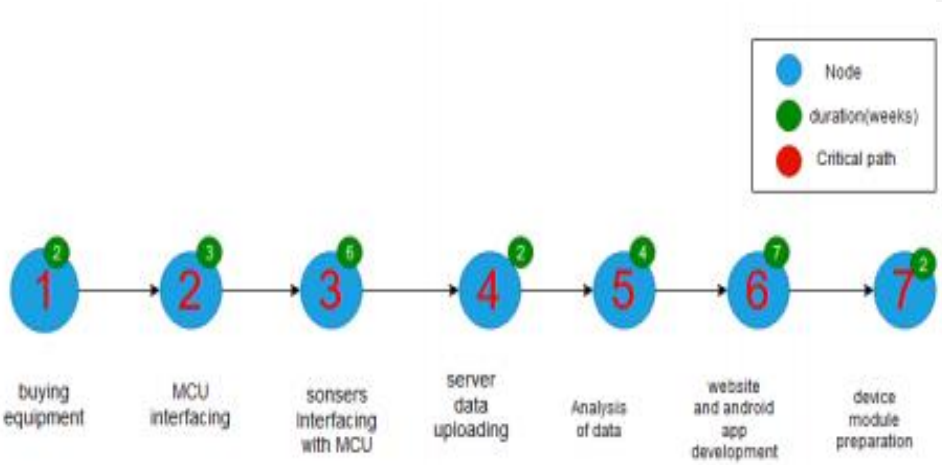
Use Case ID:	UC-04
Use Case Name:	View status
Actors:	Admin and user [former]
Description:	User accesses the system either through web app or android app. User press view status button. System displays the health parameters of livestock. User see the display either through phone or computer
Trigger:	User want to have a health check from even outside the farm.
Preconditions:	System must be fully configured; appropriate user IDs and passwords must be obtained.
Post conditions:	Check the data is updated refresh the page.
Normal Flow:	Refresh the page and see the data.
Exceptions:	Notification alert in value go above the thresh hold.
Includes:	All sensor data must be visualized through graphic and digits value.
Assumptions:	User have device and register account on website and login into the website.
Notes and Issues:	Data may not be refresh and device may not work properly.

Use Case ID:	UC-05
Use Case Name:	Notification alert
Actors:	Admin and user
Description:	The system will match the health parameters to the threshold values. If values got raised or decreased it will get alert. System will immediately send alert message to user.
Trigger:	User wants to have a check on livestock's health.
Preconditions:	System must be fully active to take appropriate readings.
Post conditions:	Last scenario
Normal Flow:	If value goes above threshold then send notification alert
Exceptions:	Device may have wrong
Assumptions:	User bought device and have id
Notes and Issues:	May device not working properly
Use Case ID:	UC-06
Use Case Name:	Sensor management
Actors:	Admin
Description:	This system will see management of fields of sensors, sensors can be added removed or updated by admin.
Trigger:	Admin wants to have a check on Sensors.

Preconditions:	System must be fully active to take appropriate readings.
Exceptions:	If sensors not working or connection failed.
Notes and Issues:	May device not working properly.

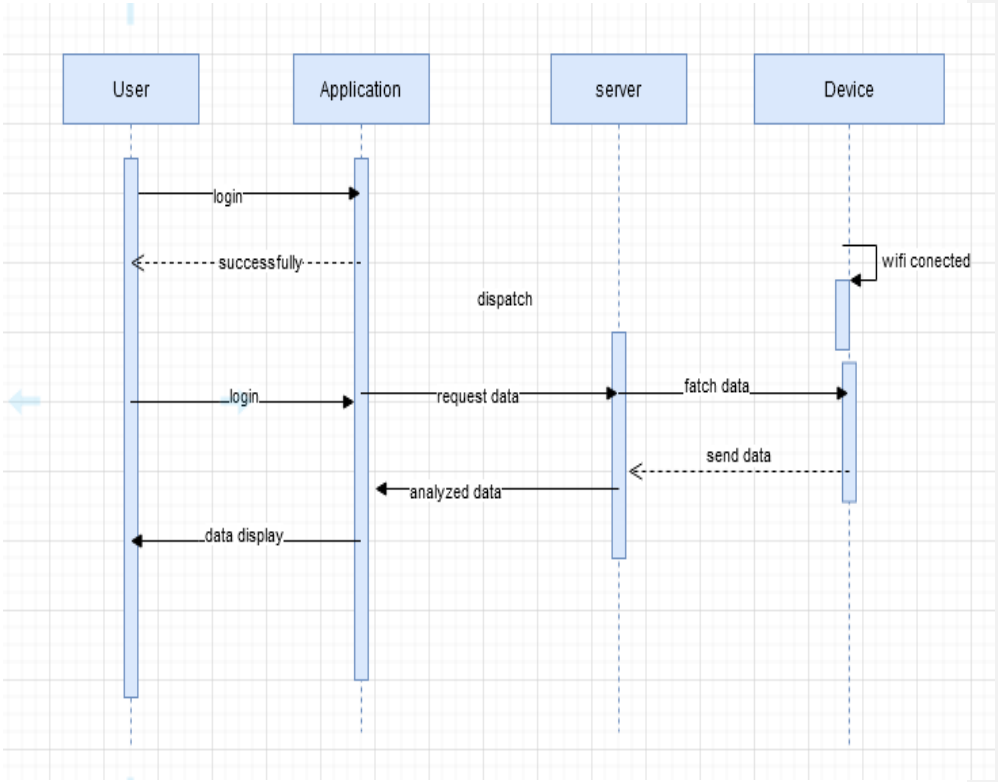
3.3.2 Pert chart:

There is seven total task that is must be included to complete the project. First task is identifying the hardware that is best for the project and identify its model no and buy it. this task is completed within two weeks. After identifying and buying the hardware install the Arduino software and program the MCU(microcontroller unit) To run the led on the MCU. Different sensors are attached with MCU and program as well to take the input. After that program with web server after that we analysis the data and send the notification to former(client) after that we design the website as well as android app which takes almost 7 weeks after that prepare module and test our device on cow.



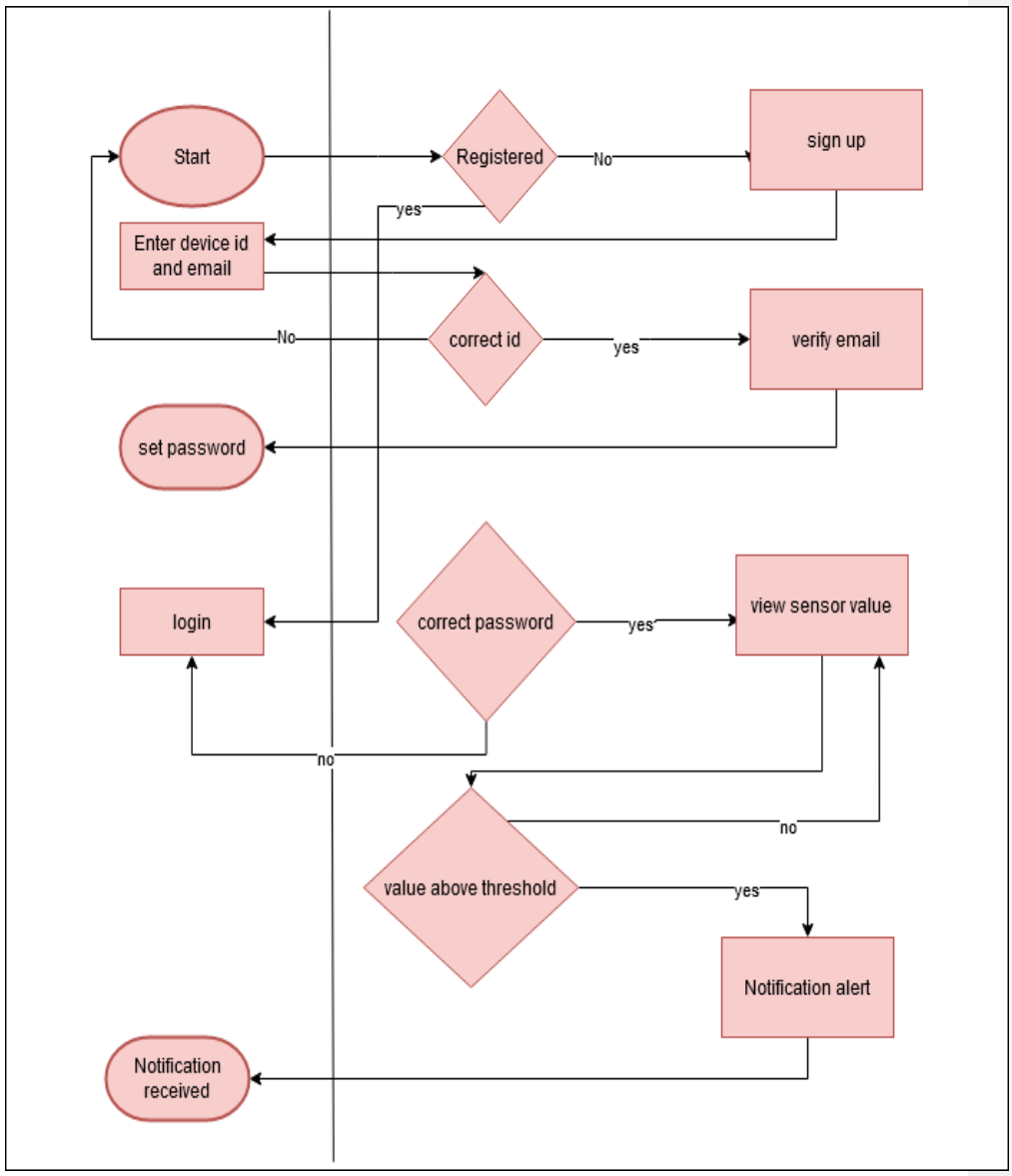
3.3.4 Sequence diagram:

In the beginning user will be login to the website if it is registered user then he can proceed farther otherwise it goes to sign up page to register himself/herself.
Data from the monitoring device goes to the cloud after analyzing the data.
Sensor readings display to the user. We use the threshold values if the values go beyond the threshold values thein a notification is sent to the user otherwise it is the normal condition.



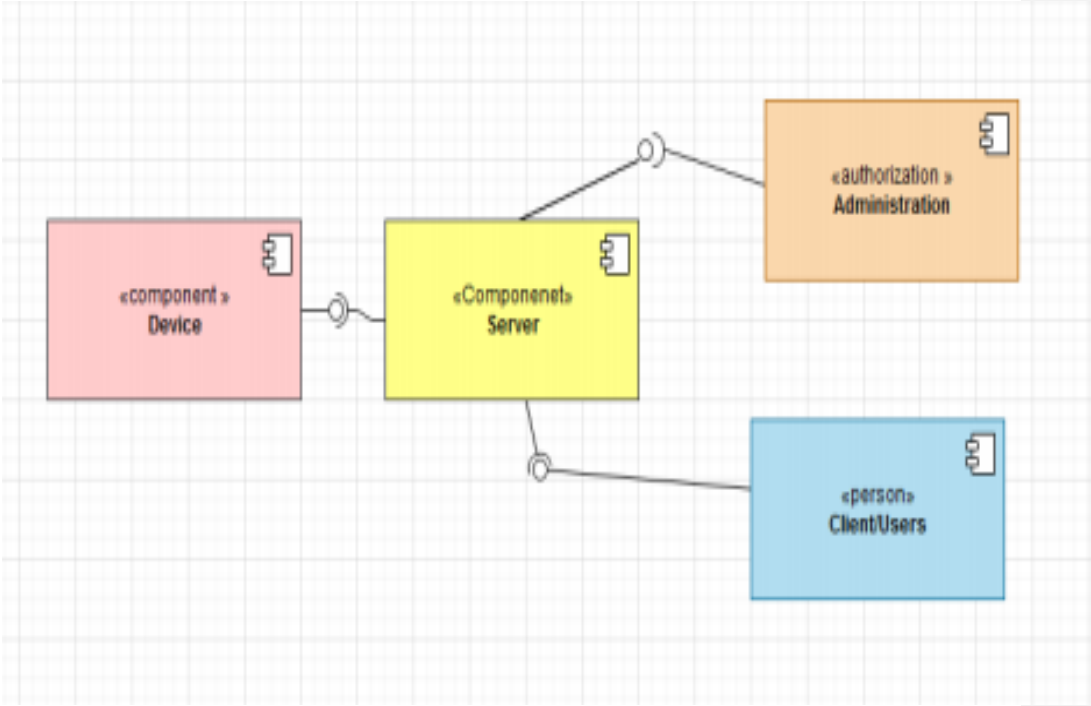
3.3.5 Activity Diagram:

In the beginning user will be login to the website if it is registered user then he can proceed farther otherwise it goes to sign up page to register himself/herself.
Data from the monitoring device goes to the cloud after analyzing the data.
Sensor readings display to the user. We use the threshold values if the values go beyond the threshold values thein a notification is sent to the user otherwise it is the normal condition.
Smart device is mounted on the neck of cow and sensors takes the reading and directly upload on the server which is further connected with web and mobile page. If the situation goes adverse then notify the former otherwise sensors reading is visible to the former.


Start
Registered
No
sign up
yes
Enter device id and email
correct id
No
yes
verify email
set password
login
correct password
yes
view sensor value
no
no
value above threshold
yes
Notification alert
Notification received

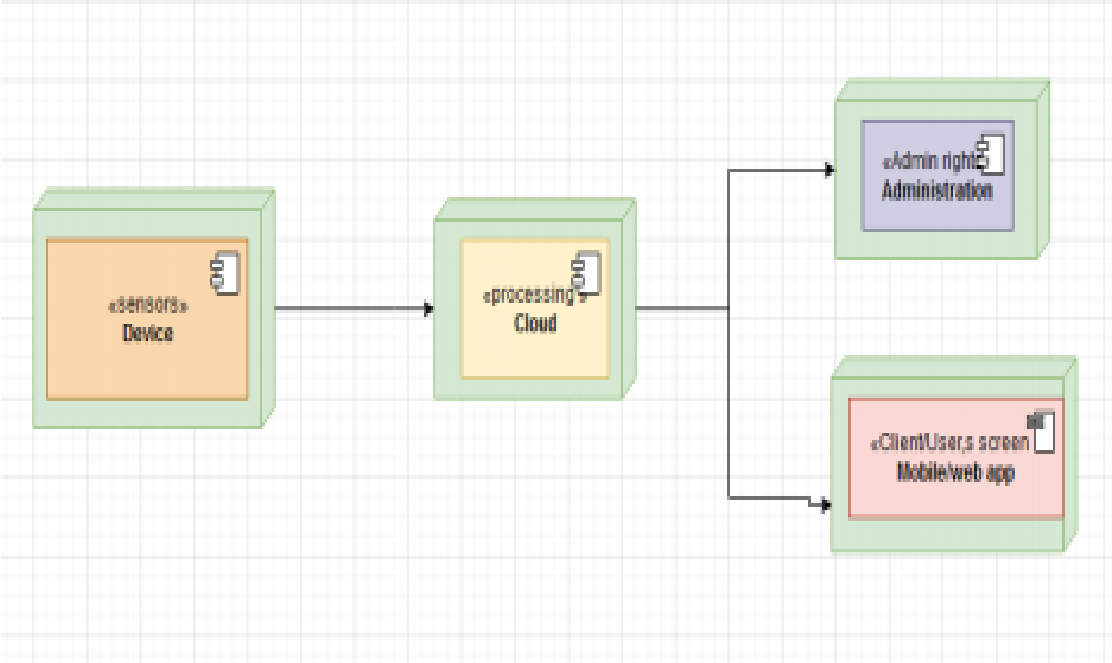
3.3.6 Component diagram:

There is four main component that is connected with each other. Component includes Device, Server, Administration and client. Device is on the neck of cow and make account on thingspeak. And administration control the admin rights and client can see the updates on web and mobile.



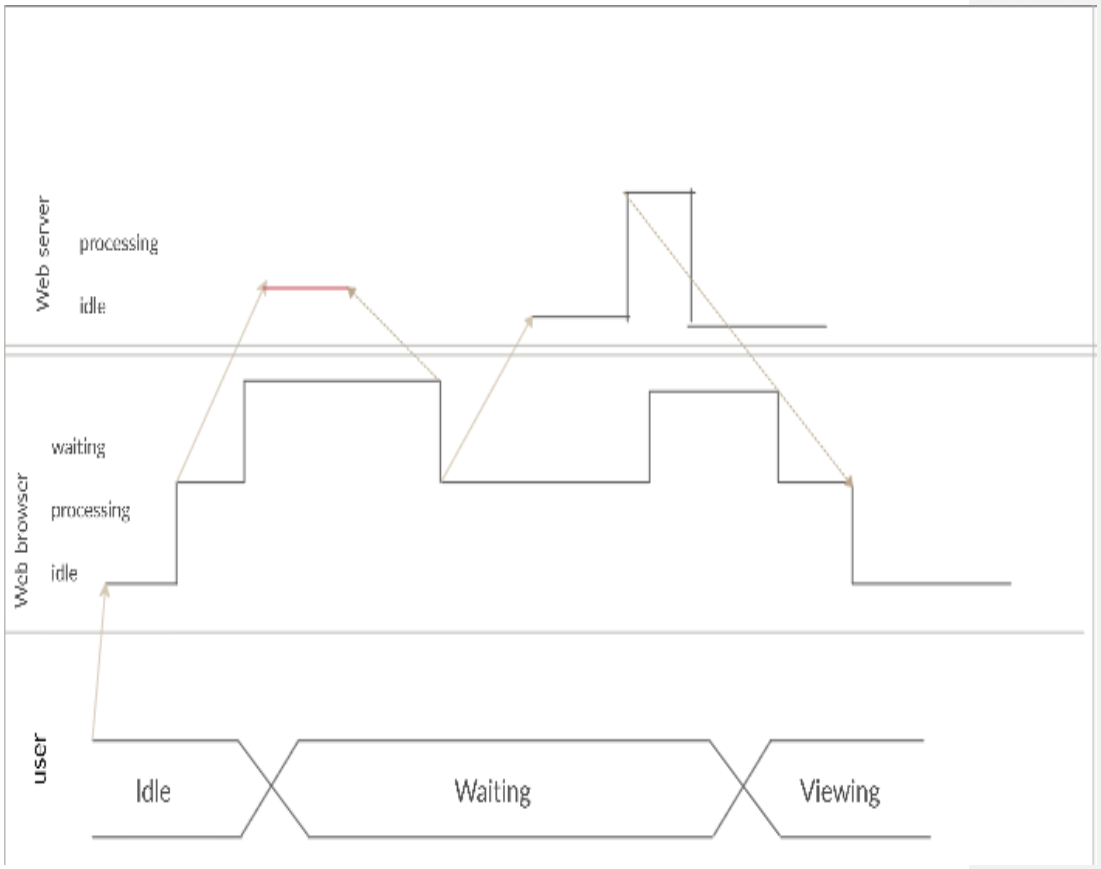
3.3.7 Deployment Diagram:

There is four main component that is connected with one another. Component includes Device, Server, Administration and client. Device is on the neck of cow and make account on thingspeak. And administration control the admin rights and client can see the updates on web and mobile.



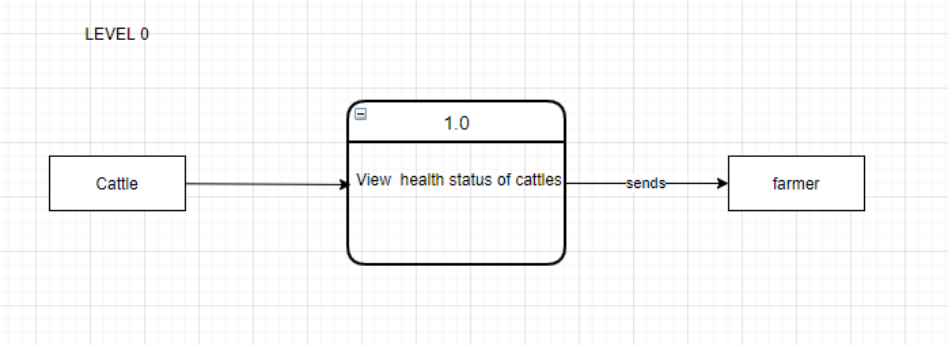
3.3.8 Time Diagram:

First user request to login into website and after that browse process it and send the request to web server after the query to process successfully the user can login and view the sensors values.

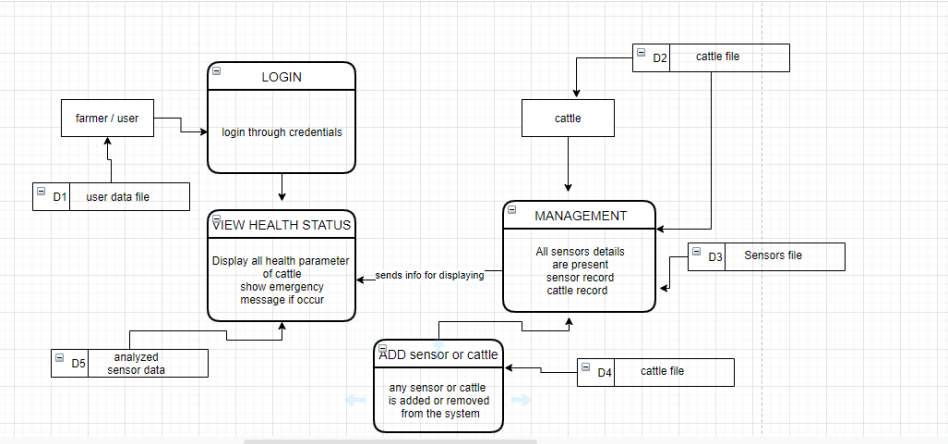


3.3.9 DFD Diagram:

LEVEL: 0 (DFD)



LEVEL: 1 (DFD)



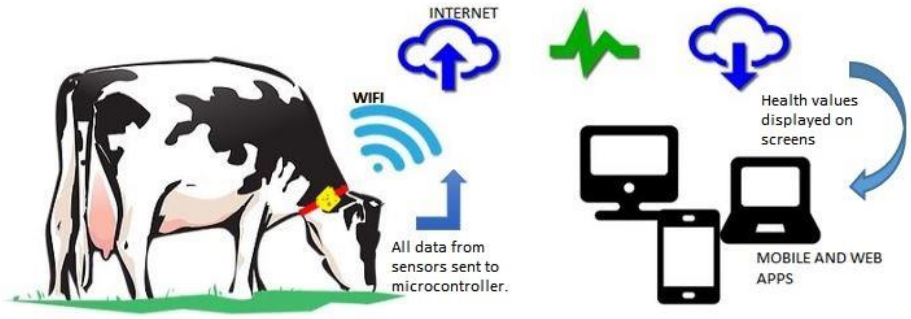
Here is our DFD of level 1. In this we have 4 data stores for storing user file, cattle file, sensor file, analyzed sensor file after analyzing. There are 4 processes as well for login, management of system, health status display and adding or removing sensor or cattle.

Chapter 4

4 Design:

4.1 System Architecture:

The three sensors (temperature sensor, heartbeat sensor and accelerometer will be attached to cow. All the values from these sensors will be sent to ESP 32s microcontroller which will post it on Thingspeak through server. ESP32s will be connected to your WIFI. Thingspeak shows the data through Web page as well in mobile app. When these collected values will go beyond the threshold value then the farmer will be notified through Mobile App notification or in message.



4.2 Design Constraints:

The Architecture of livestock health monitoring system using IOT consists of three significant units that are namely:

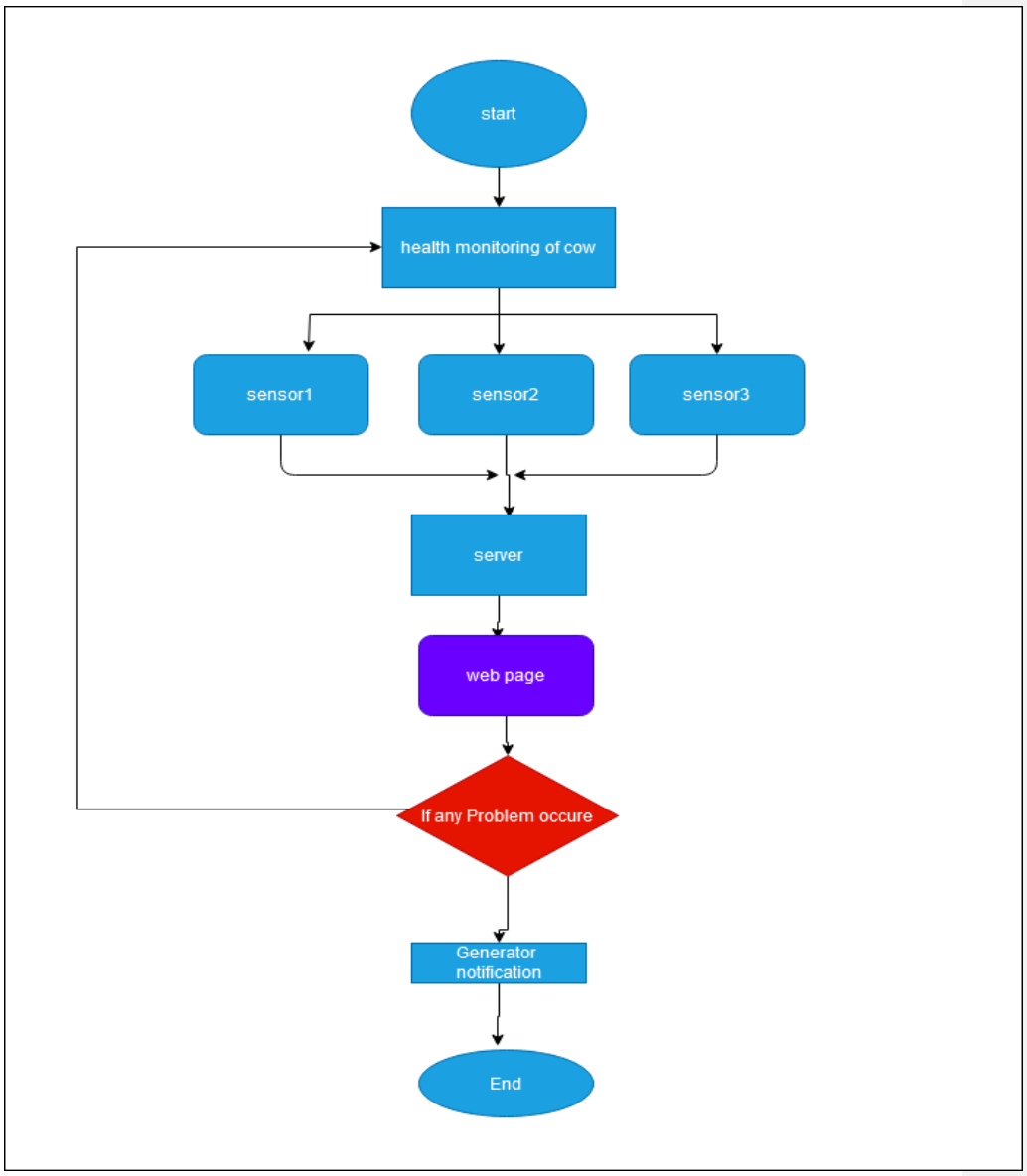
1) Data Gaining Unit.
2) Data Interact Unit
3) Administering Unit

Data gaining unit consist of different types of biomedical sensors like body temperature sensor, blood pressure sensor, humidity sensor, heart beat rate detection sensor. The data gaining units

obtain data and makes it accessible for the data administering and data interact unit (cloud, server and web page). if administering unit are observed major changes or abnormal changes in cow then notify the former at real time.

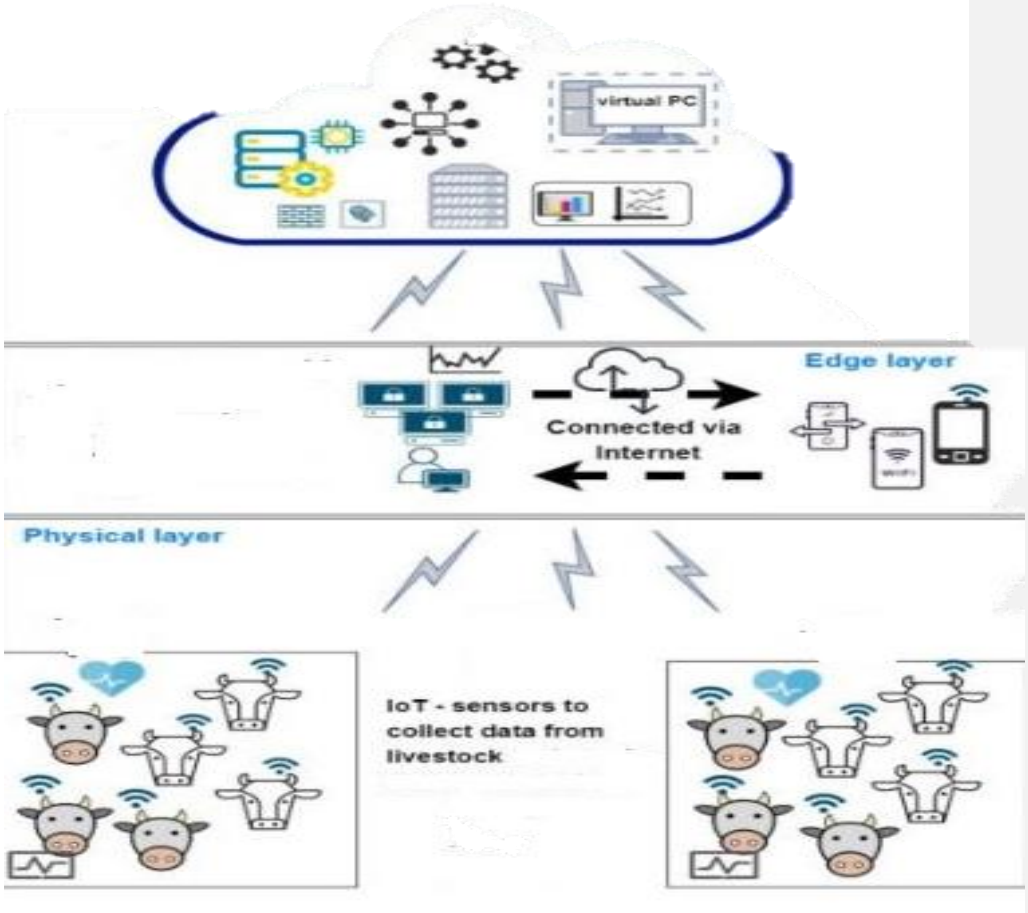
4.3 Design Methodology:

Smart device is mounted on the neck of cow and sensors takes the reading and directly upload on the server which is further connected with web and mobile page. If the situation goes adverse then notify the former otherwise sensors reading is visible to the former.


start
health monitoring of cow
sensor1
sensor2
sensor3
server
web page
If any Problem occure
Generator notification
End

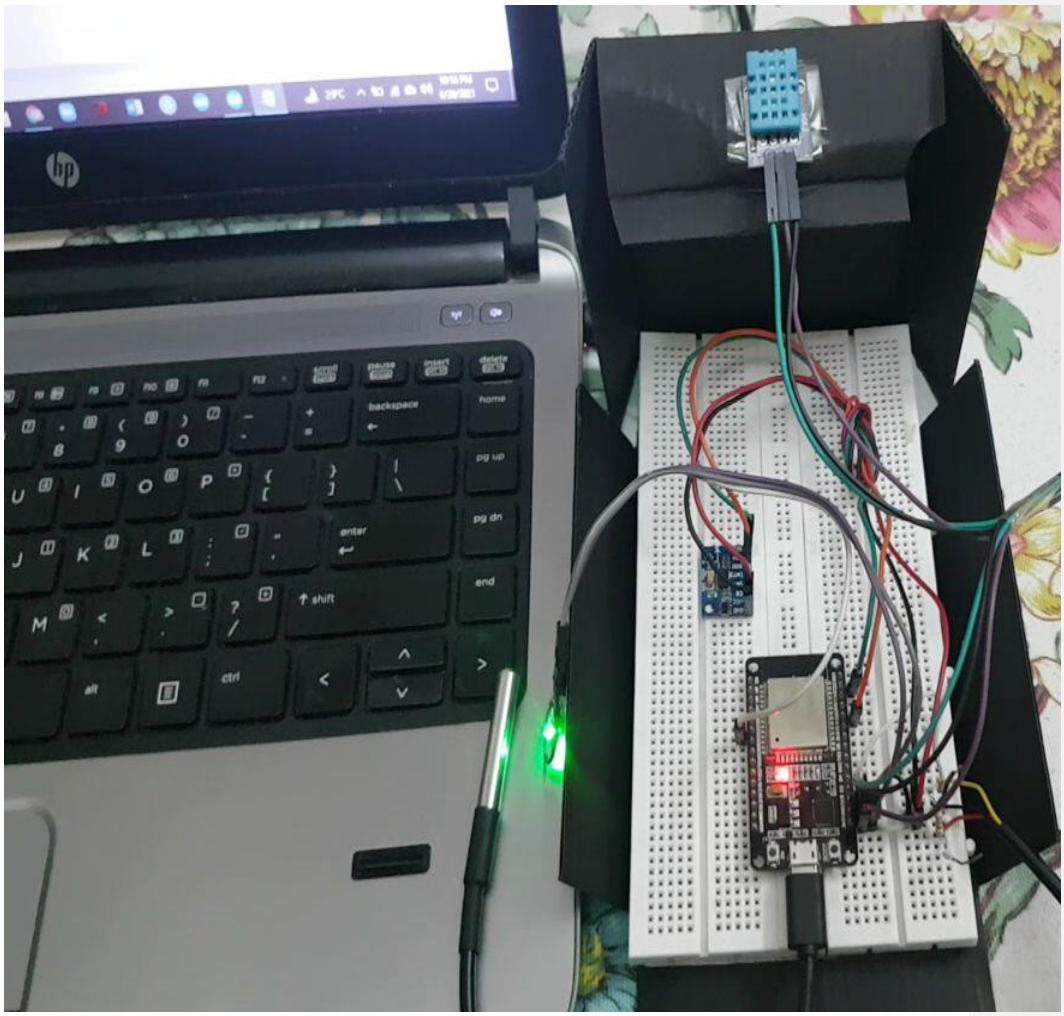
4.4 High Level Design:

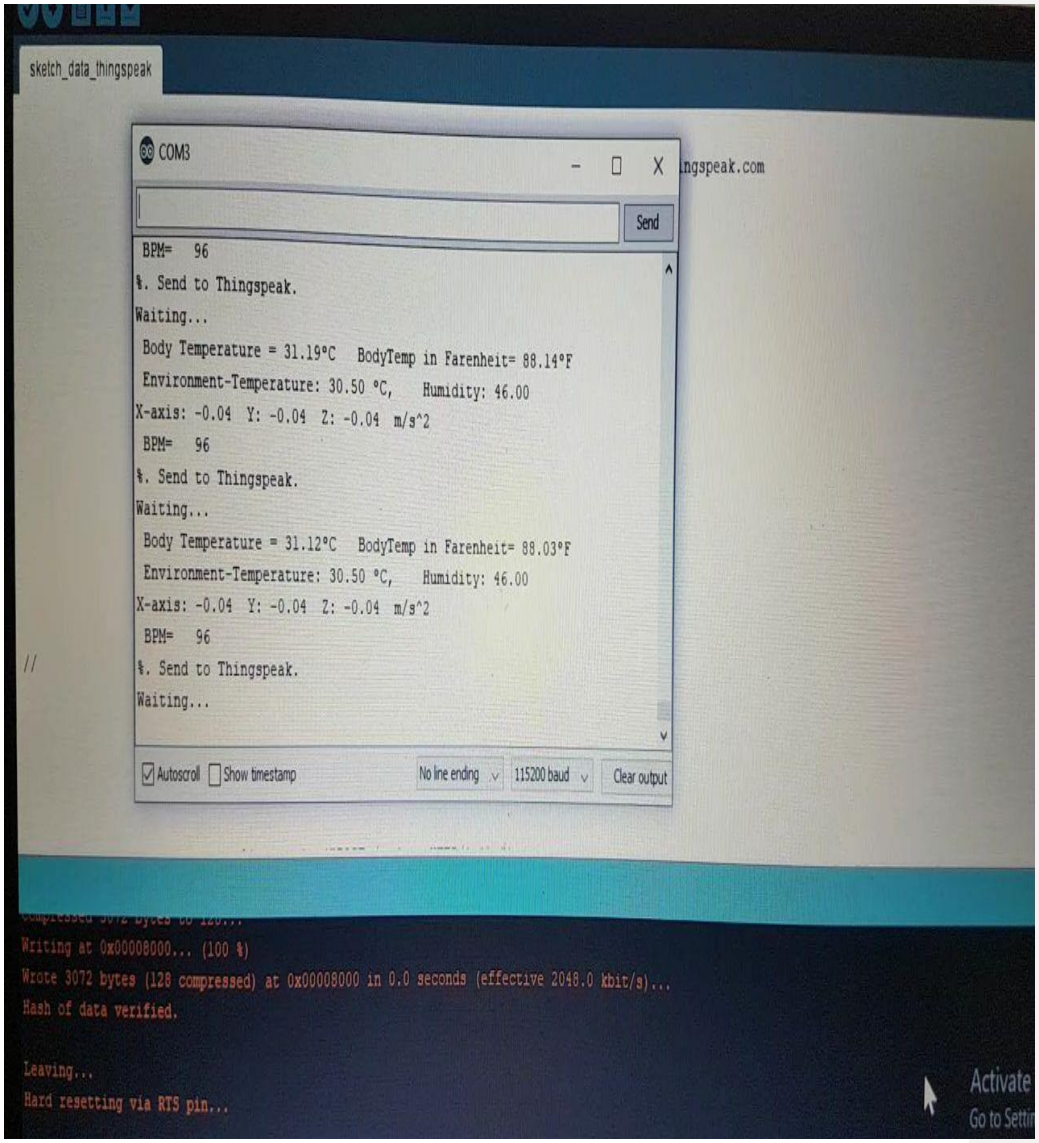
In high level system architecture, three layers cloud layer include the server.in edge layer server is connected with user interface like web page and mobile app. In physical layer device is mounted on the cow.



4.5 Low Level Design:

In low level system design hardware and Arduino program run in MCU.

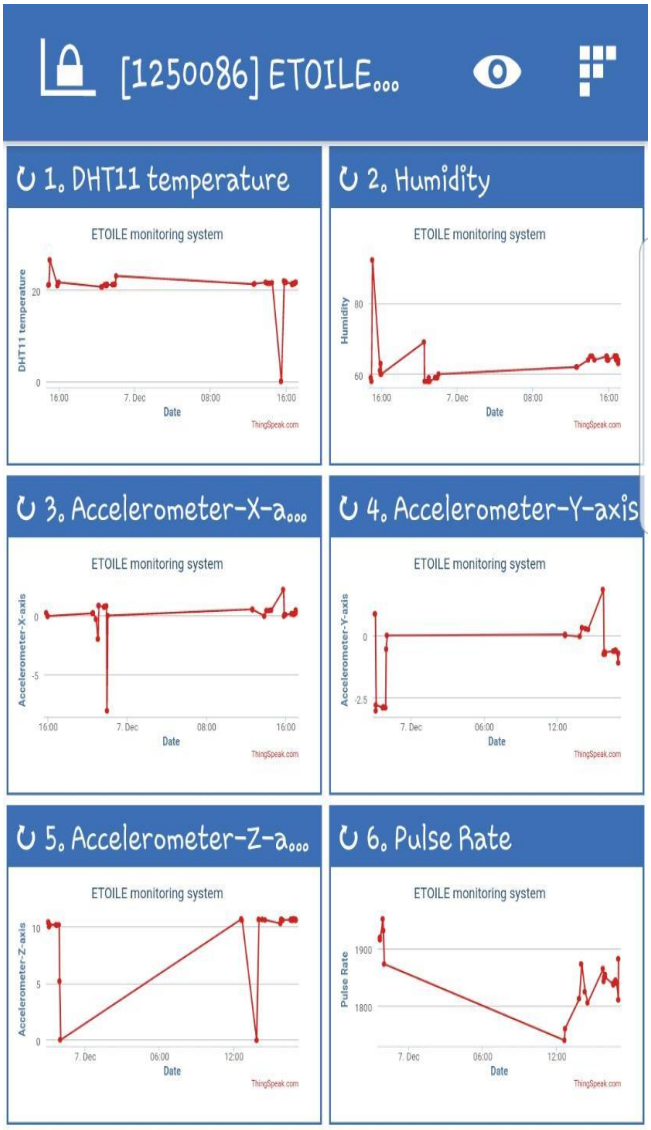



sketch_data_thingspeak
COM3
Send
BPM= 96
%. Send to Thingspeak.
Waiting...
Body Temperature = 31.19°C BodyTemp in Farenheit= 88.14°F
Environment-Temperature: 30.50 °C, Humidity: 46.00
X-axis: -0.04 Y: -0.04 Z: -0.04 m/s^2
BPM= 96
%. Send to Thingspeak.
Waiting...
Body Temperature = 31.12°C BodyTemp in Farenheit= 88.03°F
Environment-Temperature: 30.50 °C, Humidity: 46.00
X-axis: -0.04 Y: -0.04 Z: -0.04 m/s^2
BPM= 96
%. Send to Thingspeak.
Waiting...
Autoscroll
Show timestamp
No line ending
115200 baud
Clear output
Writing at 0x00008000... (100 %)
Wrote 3072 bytes (128 compressed) at 0x00008000 in 0.0 seconds (effective 2048.0 kbit/s)...
Hash of data verified.
Leaving...
Hard resetting via RTS pin...

4.6 GUI Design:

4.6.1 Website interface:

4.6.2 Mobile interface:



Chapter 5

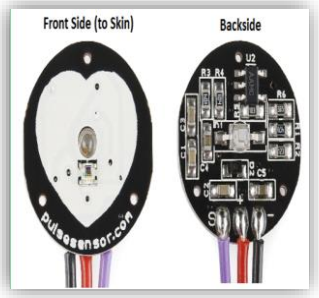
5 System Implementation:

The main functional units used in this proposed system are the following:

5.1 ESP32s microcontroller:

The ESP32s microcontroller is a series of low cost and low-power system-on-chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The microcontroller is cheap with low-power consumption and a great number of pins. Evidently, with its varied features, IoT becomes easier when it comes to ESP-32. The continuously sensed data from the temperature sensor and heart beat sensors are transferred by the ESP 32 module to the web server.

5.2 Heart beat sensor (Pulse sensor):

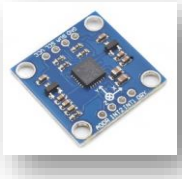


Heart beat sensor is designed to give a digital output of heat beat . When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This pluse sensor is connected to the microcontroller directly to measure the Beats Per Minute (BPM) rate.Cattle have heart beat in the range of 48-84 beats per minute. If the heart beat is beyond this value it indicates stress or animal anxiety.

5.3 Temperature sensor (DS18B20):

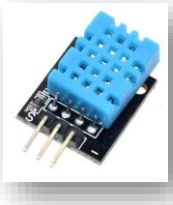
The DS18B20 is only one wire programmable Temperature sensor. It is used in hard environments. The constriction of the sensor is rugged and waterproof option making the mounting process easy. It can measure temperature from -55°C to +125°C. Each sensor has a unique address and requires only one pin of the MCU to transfer data so it a very good choice for measuring temperature at multiple points without compromising much of your digital pins on the microcontroller.

5.4 Accelerometer:



The Accelerometer is used to measure the momentum of the cattle. It measures the displacement of the accelerometer by cattle movement and measures the momentum numerical value in a time unit.

5.5 Temperature and Humidity of Environment:



A humidity sensor senses, measures and regularly reports the relative humidity in the air. It measures both moisture and air temperature. Here we are using DHT11

5.6 System Architecture:

The three sensors (temperature sensor, heartbeat sensor and accelerometer will be attached to cow. All the values from these sensors will be sent to ESP 32s microcontroller which will post it on Thingspeak through server. ESP32s will be connected to your WIFI. Thingspeak shows the data through Web page as well in mobile app. When these collected values will go beyond the threshold value then the farmer will be notified through Mobile App notification or in message.

Chapter 6

System Testing and Evaluation:

Evaluation is such type of work which is done almost in every step of final year project.
In evaluating we did test at every minor point. Like

1) When we bought hardware, we tested each sensor whether it is working or not.
2) Saw the result values matched with usual behavior.
3) MCU is interfaced with WI-FI.
4) DHT11 run on its own testing code. DHT11 sensor is interface with MCU. Get the values through Wi-Fi.
5) Repeat above step for every sensor.
6) After getting values on server one by one.
7) Shows separate graphical display of each data field with numeric display as well.
8) Used alternative sensors for temperature supposing the condition.
9) In notification alert, notify the farmer according to each sensor values.
10) Through sms notify is also tested.

Chapter 7

Conclusion:

This project aims to provide a substantial way for monitoring the health of livestock animals, specifically cows, by utilizing specific sensors. It not only aids in the improvement of animal health, but it also helps to keep up with the fast-changing state of animated forms.

With the growing population, there is a greater demand for dairy products, which is why it is more important than ever to look after cows and keep them healthy. Circuit complexity is reduced, as is power consumption. The use of solar panel reduces the system's overall power consumption. The modules employed are smaller in size and lighter in weight, making them easier to transport.

The proposed autonomous cattle health monitoring system will be extremely useful in detecting and monitoring livestock illnesses.

There is no need for continuous monitoring because an alarm message will be delivered to the owner if any of the parameters deviate from their normal value.

The data collection nodes' scalability is supported by the system architecture, which is an es sential requirement in terms of real world deployment

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