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# Internet-based cattle health monitoring system using raspberry Pi

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**Abstract**--Cattle farming is one of the major branches of agriculture. People who grew and monitor cattle often don't have just a few of them. Instead, they have many numbers of cows, horses, oxen, etc. When the number of cattle increases, it becomes tougher for the one who maintains the cattle to check up on their health individually. To resolve this issue, this study aims the development of an IoT system that is capable of monitoring the temperature and heartbeat rate of the sensor periodically. This is achieved using sensors like temperature sensors, heartbeat rate sensors, etc. It also uses software like ThingSpeak, Rasbian OS, etc. The temperature of the cattle is measured with a temperature sensor and transmitted to the raspberry pi. The heart rate sensor also sends data about the cattle's heartbeat rate to the pi. The GPS sends the cattle's latitude and longitude to the

module. The information is then sent to the ThingSpeak software. The data collected by the sensors is displayed by ThingSpeak software. The data includes the temperature of the cow, the heartbeat rate of the cattle, and the latitude and longitude details of the cow. A hyperlink that leads to another tab that displays the location of the cow on a map is also displayed in the ThingSpeak software. The data collected from the sensors is also sent to the cloud and is checked whether the parameters are normal. If there are any discrepancies found, an alert message is sent to the user.

**Keywords**--Internet of Things, sensors, raspberry pi, temperature measurement, alert message, etc.

## **Introduction**

Agriculture has constantly been one of the maximum critical occupations in India, and it's going to stay so withinside the future. Agriculture will in no way be out of favor because the call for meals and different meals merchandise maintains to rise. Agriculture is greater than simply developing plants and plants; it is usually a fundamental occupation inclusive of farm animals farming, rooster farming, and so on. Animal husbandry is some other period for farm animals farming. Animal breeding and elevating for diverse functions inclusive of meat, wool, eggs, and so on. Working animals like cows, donkeys, horses, and oxen. For loads of years, dogs were used to assist in farming, harvesting, rattling, different animals, and the environment transporting agricultural merchandise to customers. The people who manage the cows often have more than ten to twenty cows to grow. It becomes tougher for the people to continuously monitor the health condition of the cattle. Sometimes meager issues like temperature changes can be fatal.

This study aims at the construction of a circuit that consists of both hardware and software components. A hardware circuit is designed using sensors like temperature sensor, heartbeat rate sensor, etc. The software requirements include the ThingSpeak software and the Rasbian OS. This circuit monitors the temperature and the heartbeat rate of the sensor. The construction and working of the circuit are explained clearly in the upcoming chapters.

## **Literature Survey**

Several types of research and studies have been done in the field of agriculture and cattle farming. One such research is done by a group of researchers from the Tokyo Institute of Technology, Japan. They stated that Cattle behavior tracking is vital for knowledge of the welfare and fitness fame of livestock. A neural network-primarily based tracking device that analyses time collection information from inertial sensors connected to cows is one of the maximum effective and cost-powerful tracking strategies. Their studies indicate numerous inertial sensor information augmentation strategies which are tailor-made to the traits of livestock behavioral information. The proposed methods are used to categorize livestock behavior through the usage of convolutional neural networks, that's a

tough challenge given the restrained information. Finally, they concluded that the information augmentation methods supplied right here can assist to enhance deep mastering of overall performance in livestock behavior type whilst reducing universal device charges because of information acquisition and labeling [1]. The Internet of Things or the IoT is the major technology used in this study. IoT is also used in the development of many circuits and even in smart houses. Research by a team of researchers from the Rashtreeya Vidhyalaya Institute of Technology, India has reviewed the usage of IoT in various aspects. According to them, the Internet of Things aims to offer seamless offerings to anything, at any time and in any location. IoT technology is everywhere, ushering within the fourth disruptive era revolution after the net and facts and verbal exchange era. Their paper gives the cutting-edge country of the artwork of IoT practical pillars and rising packages to encourage academicians and researchers to expand real-time, energy-efficient, scalable, reliable, and steady IoT packages. Their paper affords an in-depth evaluation of the cutting-edge country of verbal exchange requirements and alertness layer protocols utilized in IoT. They additionally pointed out the problems that arose during the duration of the improvement of IoT systems [2]. As mentioned earlier, IoT is also used in the development of smart houses. One such research is done by the researchers from the University of Malaysia Pahang, who constructed a smart home using IoT. They stated that, with the development of communications technology, domestic automation structures have received quite a little attention. A clever domestic (SH) is an Internet of Things (IoT) utility that makes use of a domestic automation gadget to display and manage home equipment thru the Internet. The proposed IoT-primarily based domestic automation gadget can manage home equipment over the Internet without difficulty and efficiently, in addition, to aiding domestic protection via independent operation. The gadget designed for this have a look at is a low-price and reliable automation gadget that reduces strength intake at the same time as additionally offering SH citizens convenience, protection, and security [3].

The raspberry pi is one of the most effective microcontrollers. With its operating system, the raspberry pi is always a better option for designing IoT systems. A study that recognizes facial recognition also uses raspberry pi as the microcontroller. This study was done by a team of researchers from the University of Sains. The challenge of figuring out a person's cutting-edge emotion is referred to as facial features recognition (FER). It is important in healthcare, marketing, and counseling. This paper describes a hybrid CNN-KNN version for FER at the Raspberry Pi 4, with CNN used for function extraction. Following that, the KNN recognizes expressions. They constructed our device with an EfficientNet-Lite version of the usage of the switch studying technique. The KNN replaces the Softmax layer within the EfficientNet within the hybrid version they propose. They educated our version on the FER-2013 dataset after which as compared its overall performance to that of different architectures educated in the equal dataset. Their version can generate an accuracy of 76% [4]. The raspberry pi module is so precise that it can be used in applications that require the analysis of minute details. Research by a team of researchers from the University of Chile is proof of the above statement. They used raspberry pi in the field of astronomy, i.e., in tracking the stars. In the Lost-In-Space scenario, they added the SPE Lab Open Star Tracker (SOST), an ultra-low-price answer that presently offers sub-

arcminute precision at a frequency of one to three estimations according to minute. They created a brand-new set of rules to clear up the Lost-In-Space problem, which fits through obtaining a picture and evaluating it to diverse stellar catalog segments. They positioned our set of rules to take a look at the usage of snapshots from operational satellites. The capability of our platform changed to assessing the usage of night-sky snapshots taken from the ground. They extensively utilized a thermal-vacuum chamber to carry out environmental checks on our platform. By the usage of  $5^\circ$  as section separation, their achievement fee will increase to 99 percent, however processing time doubles [5]. Temperature measurement is mandatory in almost every field. The requirement of a temperature sensor is also inevitable just like the usage of the temperature sensor. Research that develops a resonator for isopropanol is done by the researchers of the Beihang University of China. The entire study of them is based on a temperature sensor. Because each entry points of the resonator are fiber handles, the micro bottle resonator (MBR) is selected for its ease of fabrication and extraordinary bundle properties. The modes in MBR had been widely recognized to be characterized via way of means of azimuthal mode quantity  $m$ , radial mode quantity  $p$ , and axial mode quantity  $q$ , which represented the sphere distributions across the resonator circumference, withinside the radial direction, and alongside the bottle axis, respectively [6].

The heartbeat sensor is also used in various medical applications and wearable devices. Another group of researchers from the Beihang University of China has used the heartbeat sensor in bionics. According to them, to reap pulse-taking, a bendy piezoelectric movie becomes adhered to a timber cylinder to simulate the shape of the finger. ANSYS become used to simulate a piezoelectric movie beneath neath numerous pressure regions and bending degrees. The consequences verified that the sensor shape proposed in this paper cannot best simulate the residences of the finger to reap TCM pulse-taking, however additionally enhance the sensitivity of the piezoelectric movie. The sensor becomes used to degree the heartbeat sign of a human in numerous states of movement and fitness conditions. The test verified that this technique can keep away from the want for the identical pressure as conventional pulse-taking methods [7]. The GPS sensor can be named a turning point in the history of location tracking. In some research, a GPS sensor is also used in the construction of autonomous vehicles. Research by the Sreenidhi Institute of Technology, India developed an autonomous vehicle. A large number of sensors and algorithms are employed by autonomous vehicles to analyze data streams from sensors to accurately interpret their environment. It is the goal of the research in this work to develop a set of sensor fusion rules that can forecast the next country in which to deploy and orient a self-sustaining vehicle using IMU and GPS data fusion. If you want the finest protection and safety standards, you must have a high-performance overall performance that is accurate and reliable. Recordings from an Inertial Measurement Unit (IMU) are combined with GPS readings to overcome the limitations of a GPS-based navigation system. In recent times, many researchers and studies use ThingSpeak as a platform to analyze the results of the study and display them directly to the user. Researchers from the Amirtha School of Engineering of India have used ThingSpeak in residential energy management. Because of the depletion of fossil fuels, the emphasis has these days shifted to the usage of renewable electricity. Because wind and tidal electricity are most effective

to be had in coastal areas, solar electricity is desired in metropolitan areas. During the day, the electricity generated with the aid of using a roof-hooked-up sun panel is both saved in a battery or used to energy the linked load of that capacity. Data is gathered as uncooked enter withinside the shape of voltage and current, that's then processed the usage of a Node microcontroller unit (NODEMCU) to decide the value of diverse energy consumptions thru statistics mining. This statistic is then dispatched to the cloud-primarily based statistics analytics platform ThingSpeak. It aids in the plotting of daily and annual load curves through the use of data analytics techniques [9].

The combination of raspberry pi and the ThingSpeak software is also not new in the field of the Internet of Things. Researchers from the University of Technology, Mara, Malaysia have developed a portable health monitoring system using both raspberry pi and the ThingSpeak software. They designed a device that can degree and showsan affected person's fitness status, which is crucial for higher healthcare. The Raspberry Pi serves because of the tracking system's vital controller. ThingSpeak shows real-time sensor information on a website and may be monitored. If necessary, an alarm is likewise dispatched through ThingTweet. The sensor information is stored on a database net web page for offline clever sample evaluation for the affected person withinside the future. They said that the hospital's present-day tracking structures are typically stressed out to bulk gadgets for tracking. There also are domestic tracking gadgets available. They also are limited from transferring toward the affected person due to the fact the gadgets can simplest be used by the affected person [10].The Raspbian OS is also said to be one of the most secure and safest operating systems to work with. The security of the Raspbian OS is analyzed and compared to that of Ubuntu by a group of researchers from the University of defense in BRNO, Czech Republic. The Internet, which started as an educational community for the speedy alternative of information, has developed right into a business media, business, and, eventually, commercial communications surroundings. It became these days introduced to the listing of fight domain names in cyberspace. Any tool linked to an unprotected Internet is as a consequence prone to assaults with the aid of using a whole lot of organizations and people pursuing numerous criminal, security, and political goals. As a result, every such tool needs to be configured to be as proof against those assaults as possible. People regularly use the small computing device Raspberry PI, that's generally ready with the running device Raspbian Linux, to enforce small home, academic, or commercial systems. Such a tool is regularly linked to an unprotected Internet surrounding and, if efficiently attacked, can function as a gateway for an attacker to go into an organization's or a home's inner network [11].

### **Proposed Method**

The study aims in monitoring the health of the cattle and intimates the user in case of discrepancy. This process is done using the help of the Raspberry Pi. The flow of the study is represented graphically in figure 1. From the image, it can be seen that the temperature and the heartbeat rate of the cattle are constantly monitored. The data obtained is then processed. The processes of the study are shown as a flowchart in figure 2.

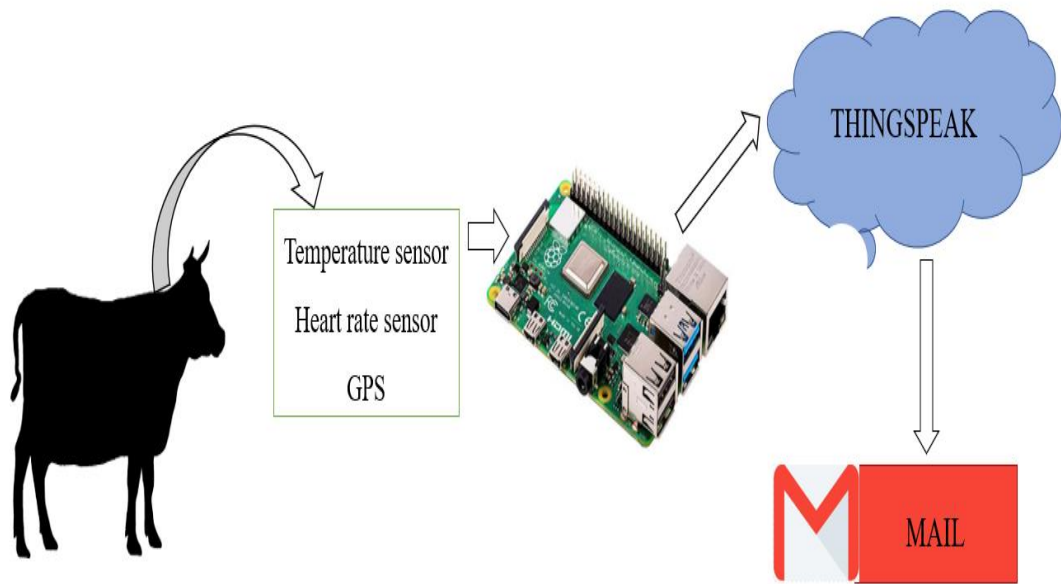


Figure 1. Workflow of the proposed methodology

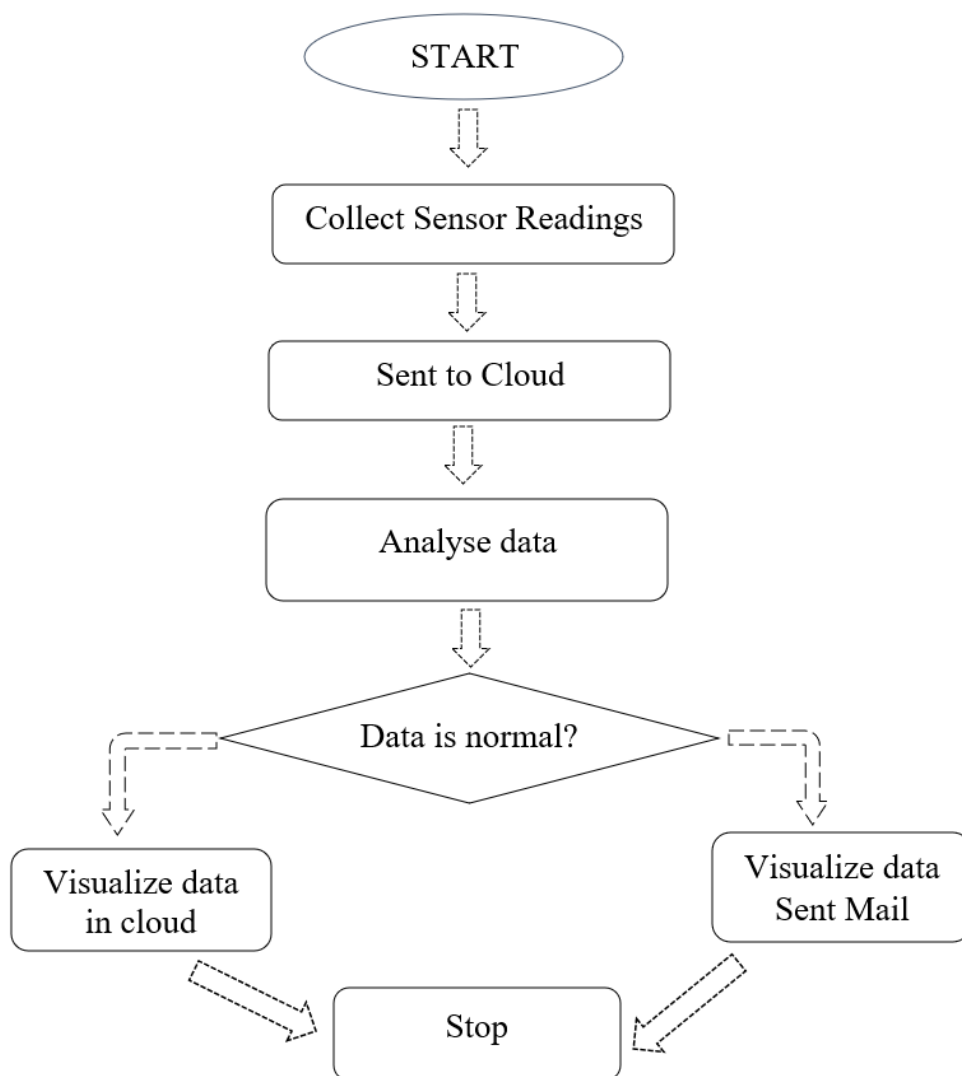


Figure 2. Flowchart of the process

The temperature sensor and the heartbeat rate sensor are directly connected to the cow. They constantly monitor the temperature and the heartbeat of the cows and they send the data collected to the cloud. The data collected is then compared with the optimum values of the parameters. This analysis of data is done using the code which was dumped into the raspberry pi module. If the values collected stay within the range of the optimum values, the values are then just sent to the cloud and visualized. This data can be viewed in the ThingSpeak software along with the latitude and longitude details. A hyperlink that leads to an external page where the location of the particular cow is displayed on a map is also displayed in the ThingSpeak software. If the values do not stay within the range of the optimum values, an alert message is sent to the user via email stating that immediate attention is needed for a certain cow.

## **Hardware and Software Requirements**

The IoT system which was constructed in this study is a combination of both hardware and software components. Along with the hardware and software components, the study also requires data about the optimum health conditions of the cattle. This chapter explains all the required hardware and software components. It also explains the data requirements of the study.

### ***Hardware Requirements***

As mentioned earlier, sensors play a major role in monitoring the health conditions of cattle. The sensors used in this study and other such hardware components are discussed below.

**Temperature Sensor:** The terminology "thermostat" relates to a temperature measuring device. This could be the temperature of the air, a liquid, or the temperature of powerful threshold limits. Temperature sensors employ electric indicators to provide data. Sensors produce an electrical voltage or resistance by sensing the voltage between the diode ends and utilizing this to estimate temperature. Temperature increases in lockstep with voltage increase.

**Heartbeat rate Sensor:** A heartbeat sensor is a digital tool that measures the coronary heart charge or the charge of the heartbeat. Heart charge video display units come across electric alerts out of your coronary heart. They are despatched to a wristwatch or a records center. Many fashions assist you to examine records of the usage of a computer and having those records permit you to interpret your exercise and higher recognize its benefits. They additionally consist of photodiodes and infrared transmitters and receivers.

**GPS:** The Global Positioning System (GPS) is a United States-owned software that offers positioning, navigation, and timing (PNT) offerings to users. The area section, the manipulate section, and the person section contain this system. GPS is a community of greater than 25 navigation satellites that orbit the Earth. We realize in they're due to the fact they ship out indicators all of the time. These indicators are detected with the aid of using a GPS receiver for your phone. Once the receiver has calculated its distance from 4 or greater GPS satellites, it could decide the region of the spot.

**Raspberry Pi:** The Raspberry Pi is a low-cost, credit-card-sized pc that connects to a pc screen or TV and operates with a popular keyboard and mouse. It is a successful little tool that permits humans of every age to test with computing and learn how to program in languages which include Scratch and Python. Everything is quality in phrases of programming. It can run nearly any programming language and framework, from Python to Fortran. Because of its low cost, modularity, and open design, it's miles extensively used in lots of fields, together with climate monitoring.

## **Software Requirements**

Just like the hardware components, the software components also play a major role in the development of this IoT system. The software components used in the study are discussed below.

**ThingSpeak software:** ThingSpeak is a cloud-primarily based IoT analytics platform that lets you aggregate, visualize, and examine stay statistics streams. ThingSpeak affords real-time visualizations of statistics published to ThingSpeak via way of means of your devices. ThingSpeak is constructed around a time-collection database. It gives unfastened time-collection statistics garage in channels to users. Each channel has most of 8 statistics fields. The code that powers this software program is written in Ruby.

**Raspbian OS:** Raspbian (previously Raspberry Pi OS) is a Debian-primarily based running machine for the Raspberry Pi. Raspbian Pi OS consists of a laptop environment, PIXEL, that's primarily based totally on LXDE and appears just like many famous computer systems including macOS and Microsoft Windows. It is the right general-motive running machine for Raspberry Pi users. Using the Rasbian buster software, it may be immediately downloaded into the Raspberry Pi module. Other running systems, which include Ubuntu, may be utilized in the area of the Raspbian OS. However, they slow down the raspberry pi module's process.

## **Data Requirements**

The main objective of the study and the code written in the raspberry pi is to check and monitor certain parameters of the cattle. For the pi to check whether the cattle are safe, the optimum values must be already entered into the system [12]. The optimum temperature values and the heartbeat of the cows are tabulated in table 1.

Table 1. Optimum values

<b>Parameter</b>	<b>Optimum value</b>
<b>Temperature</b>	38.5 °C
<b>Heartbeat rate</b>	48 to 84 beats per minute

## **Results and Discussion**

The temperature of the cattle is collected using the temperature sensor and is sent to the raspberry pi. The data about the heartbeat rate of the cattle is also sent to the pi using the heart rate sensor. The GPS sends the latitude and longitude details of the cattle to the module. The details are then sent to ThingSpeak software. This software displays the data collected using the sensors. The sample image of the results displayed in the ThingSpeak software is shown in figure 3.

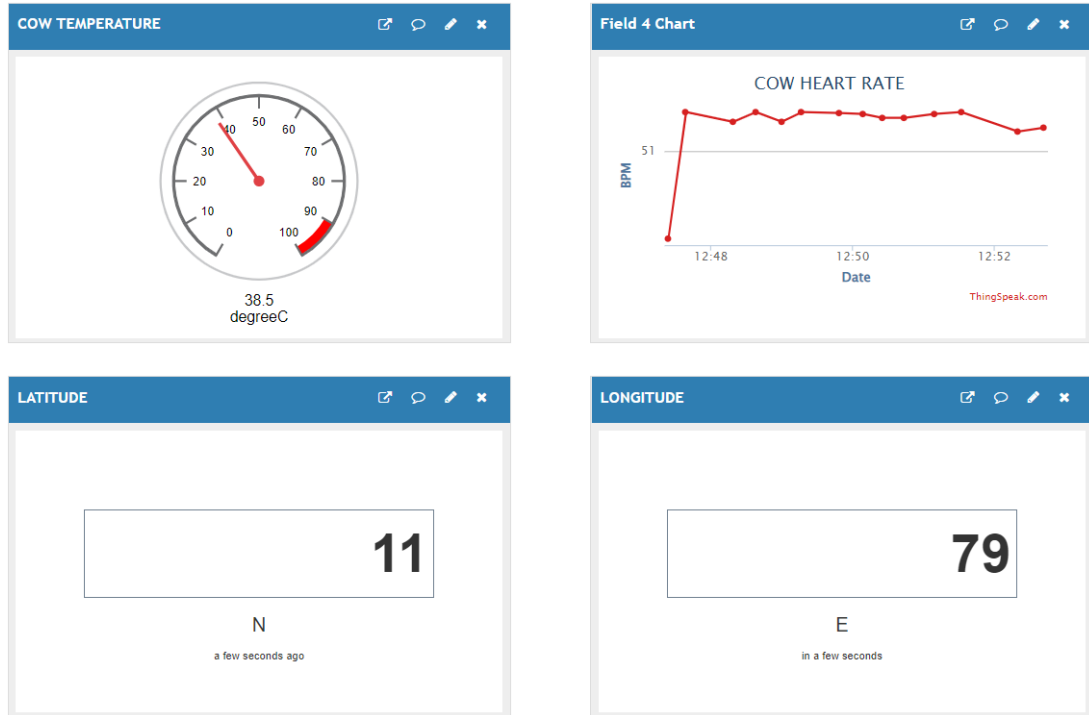


Figure 3. Results in the ThingSpeak software

The resulting image of the ThingSpeak software can be divided into four parts. The first part of the result displays the temperature of the cattle. The second part displays the heartbeat rate of the same. The third and the fourth part of the result displays the latitude and the longitude details of the cow.

The results of the ThingSpeak software also include a hyperlink that leads the user to another tab. In this tab, the user can view the location of the cow on a map making it easier to locate. The sample of the map is shown in figure 4.

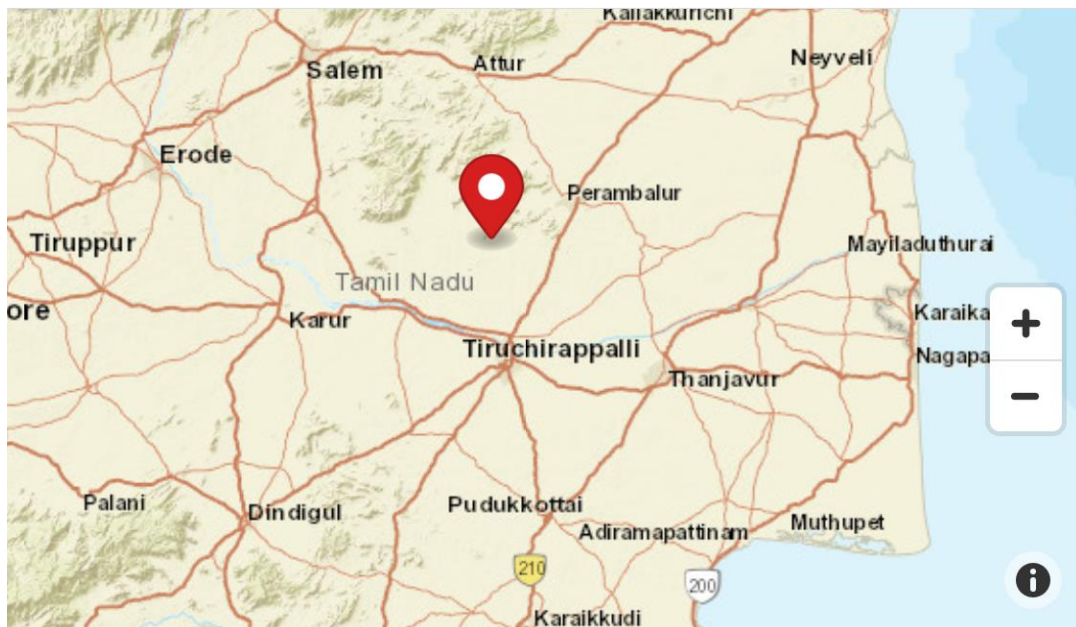


Figure 4. Location of the cattle on the map

From figure 4, it can be seen that locating the cow is easier when it is displayed on a map instead of just latitude and longitude details. The displayed details are then sent to the cloud and visualized if there are no discrepancies found. But when the temperature of the cow exceeds or gets too low, it may lead to hypothermia or hyperthermia. Thus, an alert message is sent to the owner of the cow via email to ensure the user knows about the current temperature of the cow. The alert message sent to the user is shown in figure 5. Another alert message which is similar to the one shown in figure 5 is sent when the heartbeat rate of the cow becomes abnormal.

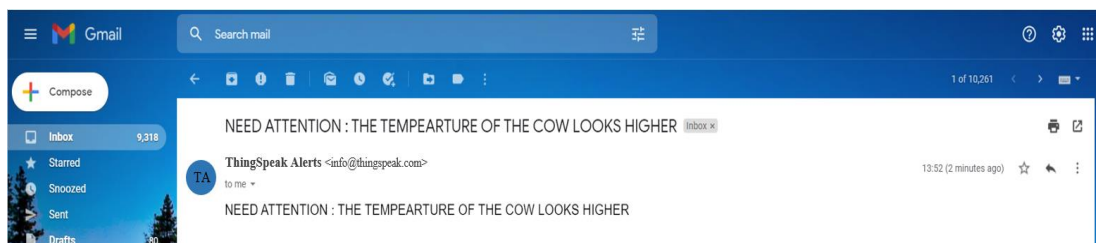


Figure 5. Alert message from ThingSpeak

## Conclusion

A circuit consisting of both hardware and software components is designed. It includes sensors like the temperature sensor, heartbeat rate sensor, etc., and software like ThingSpeak, Raspbian, etc. The temperature of the cattle is measured with a temperature sensor and transmitted to the raspberry pi. The heart rate sensor also sends data about the cattle's heartbeat rate to the pi. The

GPS sends the cattle's latitude and longitude to the module. The information is then sent to the ThingSpeak software. The data collected by the sensors is displayed by ThingSpeak software. The data includes the temperature of the cow, the heartbeat rate of the cattle, and the latitude and longitude details of the cow. Sometimes it becomes tough for the user to decipher the information about the location of the cattle just by using latitude and longitude details. Thus, a hyperlink that leads to another tab that displays the location of the cow on a map is also displayed in the ThingSpeak software. The data collected from the sensors is also sent to the cloud and is checked whether the parameters are normal. If there are any discrepancies found, an alert message is sent to the user. When this circuit is implemented as a real-time website or a software application, it will be incredibly effective for the users to monitor the health condition of the cow even when they're not around. It will also be very effective when the user has several cows to manage at different locations.

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