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IoT Based Animal Health Monitoring System using Raspberry Pi

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Abstract: *IoT has bought many changes in the existing technologies, where its applications are numerous in the field of industry automation, bio-medical, agriculture, transport, smart cities etc. The key benefits of IoT enabled livestock management in real time is enabling farmers to quickly treat animals and prevent the spread of illness or disease, track gazing animals to prevent loss and to identify grazing patterns, gather and analyze historical data to identify trends in cattle health or to track the spread of illness, monitor readiness to give birth , preventing the loss of new calves and optimizing breeding practices. In this paper a smart animal health monitoring system is developed for monitoring the parameters such as body temperature, heart rate and rumination pattern has been monitored. Different kind of sensors are mounted on the body of animals and related information is gathered which can be accessed by the authorized person through internet. Raspberry Pi is used in this work, where different information is gathered from the sensors and placed on to the cloud so that the information can be accessed from the mobile using internet.*

Keywords: IoT, Animal health, Raspberry Pi, Wi-Fi

I. INTRODUCTION

The productivity of the animals depends on the environment and weather conditions which impacts the cattle farming. There is a rapid increase in the demand for the products given by the cattle where there is a need to improve the productivity and also quality. Every year there will be the loss of productivity because of animal illness. IoT based livestock management solutions helps the farmers to improve the farming principles, livestock conditions and dairy products . Just like crop monitoring sensors, different livestock monitoring sensors are also attached to the animals to monitor their performance. Livestock monitoring factors varies on the categories of animals under consideration such as conductivity of milk, pest attack, humidity, and water quality. By tagging RFID to individual animal allow farmers to track their location, thereby preventing animal from theft. Connected sensors and wearables in the livestock allow the farmer to monitor overall animals' activities and data streamed to the cloud directly helps the farmers to identify the issues. Cowlar and SCR by All_ex are using smart agriculture sensors to monitor animals health, activity, temperature, nutrition and collect information on each individual as well as about the herd. In the field of livestock several studies have been realized. In the field different IoT sensing devices have been deployed to monitor the weather conditions via weather station and sense other activities in the field by all other data sources which have been implemented in the whole farm. Sensed data is stored on the cloud server, which user can use for decision making. User can interact remotely by using multiple smart devices (Laptops, Tablets, and Mobile etc.).

II. PROPOSED SYSTEM

In this paper we have proposed an "IoT based Animal Health Monitoring System". In this paper the parameters like body temperature, heart rate, rumination pattern are monitored continuously. The controller can sense values of sensors and process it. The controller Raspberry Pi with inbuilt Wi-Fi module can create the database on to the cloud using IoT and that information can be seen on internet using mobile phone.

An email can also be sent to the authorized person so that they can get the data easily and can monitor the health of his cattle [23]- [25]. The regular monitoring of animal health helps the farmer to monitor the sickness of cattle in the earlier stage and proper treatment can be given to reduce the loss of animals and economic loss also[35]. Thus this system can be quite helpful and crucial for the welfare of farmers who practice mixed agriculture. These data can help the

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government in making animal healthcare policies and can help the government in better targeting to specifically affected areas[31]. It will also help in research and development in veterinary science

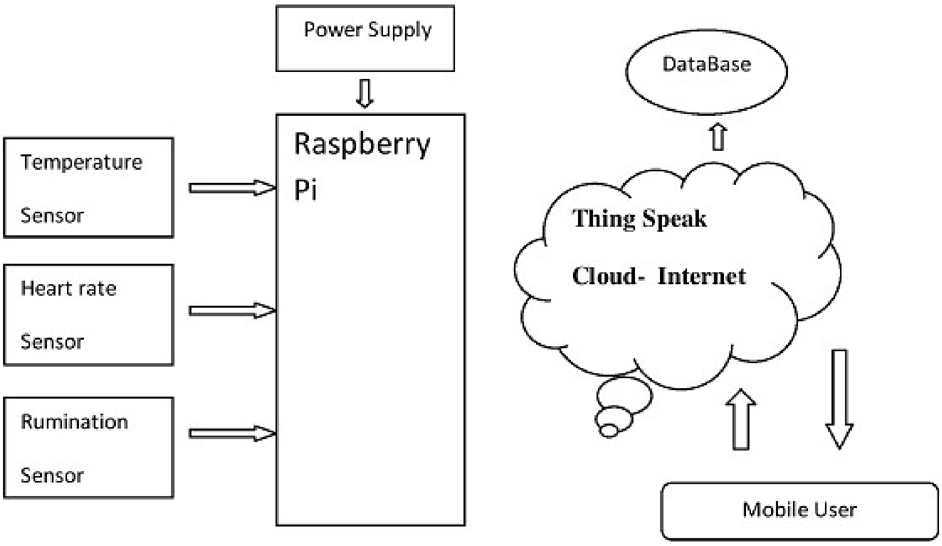

Fig. 1: Block Diagram for Animal Health Monitoring System

III. HARDWARE USED

The hardware is composed of the Sensor module: temperature sensor, heart rate sensor, rumination sensor and Raspberry Pi module.

- **Sensor module**: Sensors have many functions, like detection, collection, calculation and routing of surrounding data. Sensors are used in monitoring the real time parameters. The sensors like temperature sensor, heat sensor, rumination sensor are mounted on the body of the animals and continuously monitor those parameters and sends output in the type of electric signals. These signs are compared to the standard limiting normal values.These sensors are connected to the ADC (analog to digital converter) and raspberry pi. So sensor module will be mounted at the body of cattle so that critical parameters affecting cattle health like body temperature, heart beat and rumination will be continuously monitored with the help of sensors discussed below.
- **DS18B20 Body Temperature Sensor Cable:** The core temperature of animal is necessary to monitor. There are many diseases related to temperature, any illness may give rise to body temperature. The diseases related with body temperature lower than normal are milk fever, poisoning, indigestion etc. and when the temperature is more than 41oC, diseases occurs are anthrax, influenza and foot and mouth disease. DS18B20 sensor is utilized to measure the body temperature of the cattle. There are a numbers of infections which can occur in cattle when the core temperature of the animals changes. So it is necessary to monitor body temperature. The usual cattle temperature is **38.50C-39.500C**. DS18B20 has unique 1-wire interface which enables it to communicate with devices easily. It can measure temperatures from -55°C to +125°C.
- **Heartbeat Sensor:** The rate of heart beats per minute (BPM) is the critical factor in evaluation of health. Normally in a fit cow the heart beats in the range of 48 to 84 times in a minute. Multiple diseases and uneasiness causes fluctuation in BPM. "Heartbeat Sensor is a well designed plug-and-play heart-rate sensor"[15]. It is an analog sensor but raspberry pi does not support analog sensors so an "analog to digital converter (ADC: MCP3008)" is used. The sensor is interfaced with ADC then to Raspberry Pi.
- **Rumination Sensor Module:** Rumination is directly linked to the health status of animals. They stop ruminating normally as soon as they start feeling uneasy due to physical problem or some disease. So it indicates that animal is normal and health. Its also a part of the digestion in animals**.** Normally an animal ruminate almost "one third of a day (9-10 hours). [4] The variationin rumination signifies the disease like food digestion, mastitis, metabolic calving disease etc. Moreover the coming back to normal rumination is fantastic

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signal of successfulness of treatment. The monitoring of rumination of the cattle is required because it can give quite precise status of the health of animals. We have used Accelerometer ADXL335 for developing "rumination sensor". [14]ADXL335 is a energy efficient, small, and inexpensive, affordable device which can be used to measures the 3-axis acceleration with a range of ±3g. [5] The ADXL335 output signals are analog voltage that is proportional to the acceleration. The advantages, drawbacks, and specification are discussed in. It can also work in the static and dynamic measurement of the acceleration. "By measuring the amount of acceleration due to gravity, an accelerometer can figure out the angle it is tilted at with respect to the earth". The accelerometer can figure out the speed and direction of movement of animal jaw by detecting the "amount of dynamic acceleration" and thus by observing the sensed data we can get to know whether its normal or not . The accelerometer is very easy to interface with MCP3008 ADC using 3 analog input pins, and MCP3008 is connected to Raspberry Pi3 which gives the digital value of analog output ofADC. "The operating voltage range of the ADXL335 module is 1.8V-3.6V and it is operated at a fixed voltage of 3.3V. At the 3.3V, the maximum output voltage of the accelerometer are - 560mV for the Xaxis, +560V for the Y-axis, and +960mV forthe Zaxis".

- **Raspberry Pi Module:** The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. [33]

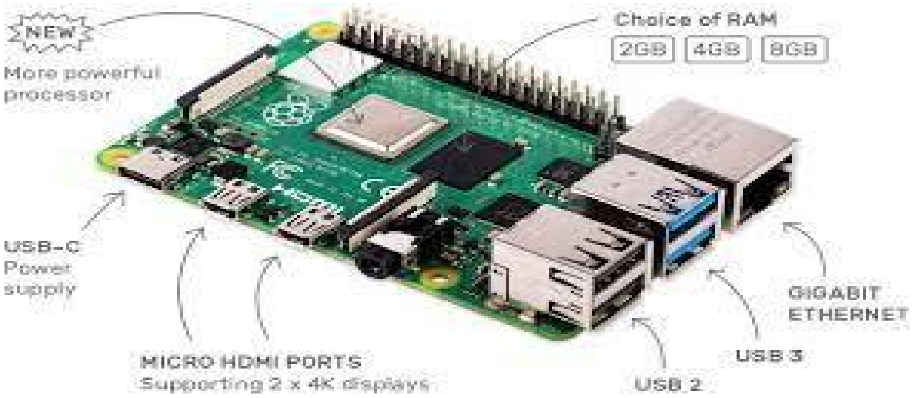

Fig. 2: Raspberry Pi.

IV. SOFTWARE USED

The practical realization of hardware usage for all necessities are supported with the capability of the supporting software. The main theme of 'IoT' is beingemployed in the enforcement of this solution, makes the need for software a primary attribute. A common programming platform has been used to build for interfacing of the discussed hardware with one another and web server, and for accessing of data by the end user. TheRaspberry Pi module, ADC and the sensors communicate by means of the python script run onthe Raspberry Pi.

- **Thing Speak Cloud***:* The Thing Speak API (Application Programming Interface) is "an open source Internet of Things (IoT) which collects incoming data, timestamps it, and give outputs to it for both human users (through visual graphs) and machines (through easily parse-able code)".It acts as a data base to store all the data related to animal health and displays the information received from the Rpi in graphical form. Moreover, Thing Speak enables us to create "applications around data collected" by different sensors. It provides " real-time data collection, data processing, and also simple visualizations for its users. Data is stored in channels, which provides the user with a list of features". [1],[26].
- **Mobile User/Android Module:** This module is installed as an Android app in the users phones and display the health status by connecting to the Thing Speak Cloud.

V. HARDWARE IMPLEMENTATION

Interfacing Diagram:

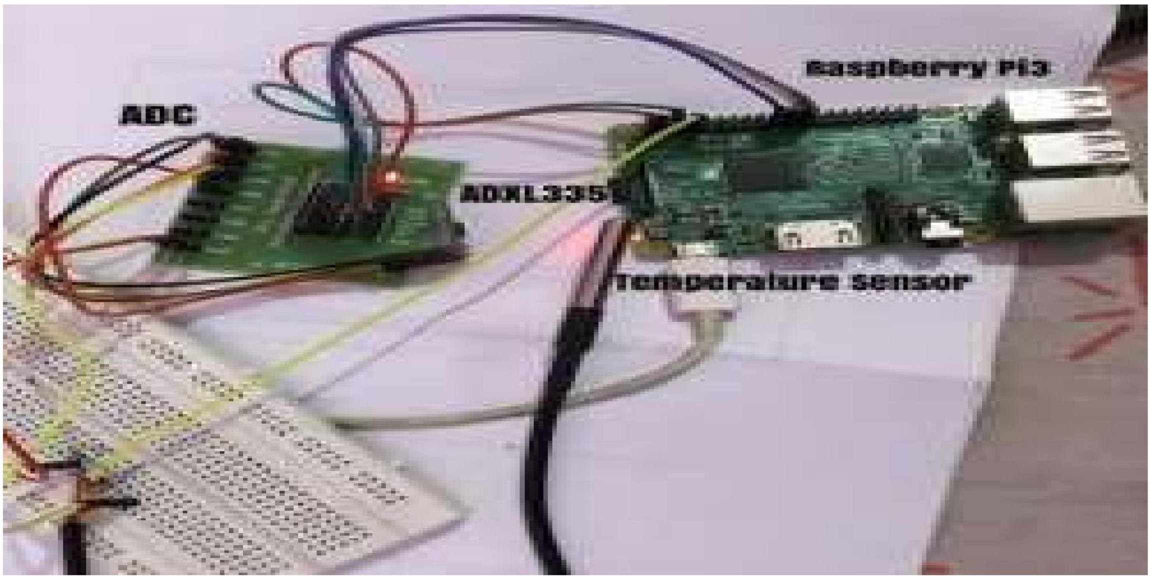

Fig. 3: Interfacing diagram of Temperature sensor and ADC with RPi.

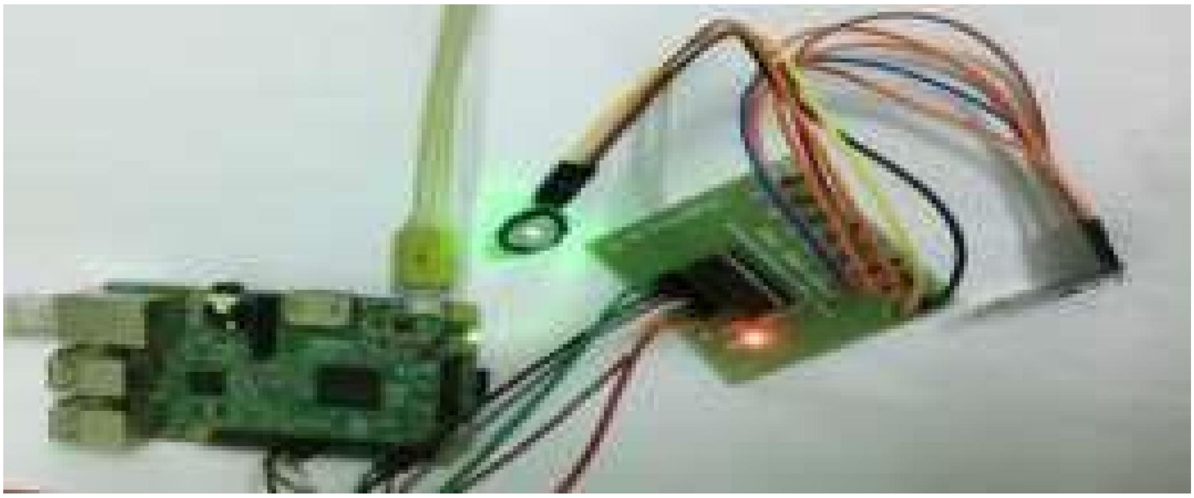

Fig. 4: Interfacing diagram of Heartbeat Sensor and ADXL335 with ADC and RPi.

VI. PROCEDURE FOLLOWED

The health parameters of animals are measured by sensors (Temperature Sensor, Heartbeat Sensor and Rumination Sensor) interfaced with MCP3008 and Raspberry Pi. After measuring data, i.e. in the normal range/ out of normal range, the data is sent to"Thing Speak" using internal Wi-Fi of RPi.

Registration is done on the Thing Speak Cloud and channel is being created for collection ofthe data. The Data from the sensors is sent to the Cloud where it is displayed graphically.

A mobile app in the end user's mobile device then talks to the cloud by connecting to it andthe information regarding the health and well being of animal is known to the user.

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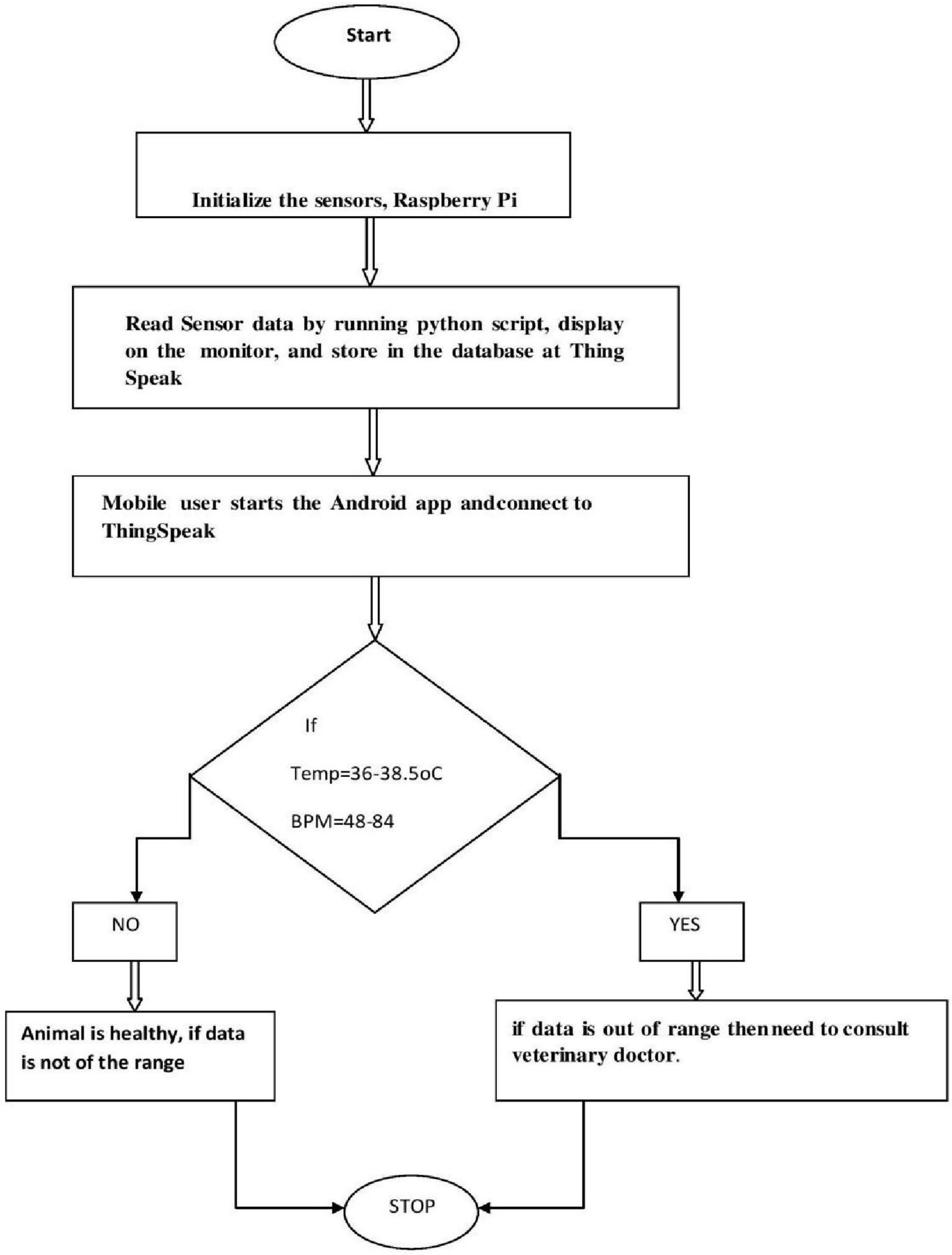

Fig. 5: Flow Diagram of the IoT based Smart Animal Health Monitoring System

VIII: RESULTS OBTAINED

The Codes when run on raspberry Pi have given the measured body temperature in degree Celsius and degree Fahrenheit, heartbeat in Beats Per Minutes(BPM) and rumination in terms of movement in X, Y, Z-directions. The displayed data at the console are forwarded to ThingSpeak cloud by Wi-Fi based on IEEE 802.11 standard .User can access those data from anywhere using internet and android app on their mobile. By careful observation of the available information at cloud of ThingSpeak user can easily diagnose the health status of animal.

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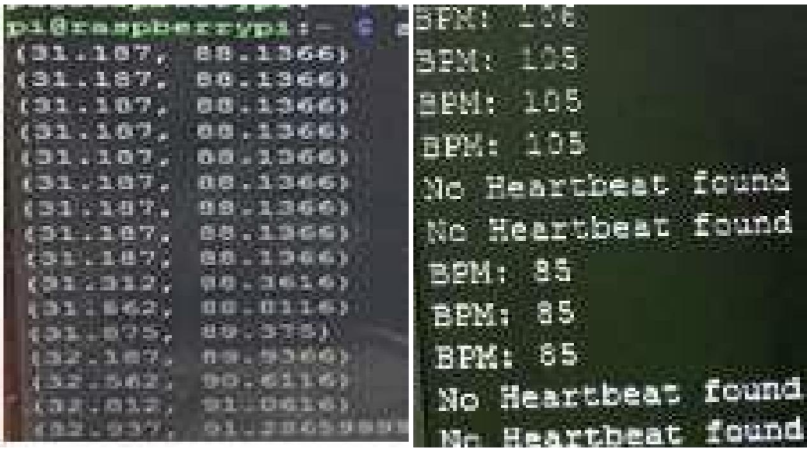

Fig .6: a) Console output of body temperature sensor b) Console output of Heartbeatsensor

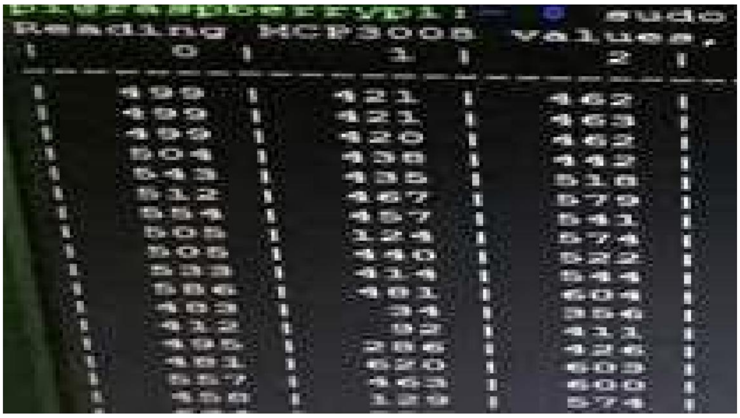

Fig. 7: Console output of Rumination sensor (Here 0: X-axis, 1:Y-axis, 2:Z-axis)

Fig. 8: Data of temperature sensors from RaspberryPi 3 to Thing Speak

IX. CONCLUSION AND FUTURE SCOPE

The goal of thispaper is to design and develop “a prototype of an IoT based animal healthcare monitoring system”**.** The developed system is capable of real-time monitoring the body temperature, heartbeat and rumination with the help of Raspberry Pi3 (with inbuilt Wi-Fi) . User can access those data from anywhere using internet and android app on their mobile. By careful observation of the available information at cloud of Thing Speak user can easily diagnose the health status of animal. If there is any abnormality he can consult veterinary staff and treatment can start at initial stage which can be cured easily reducing the treatment cost. The research work could further be enhanced by determining the QoS parameters of the obtained results. The practical implementation can be done on mass scale in different cow shelters. Moreover we will use GSM module also to send text to farmers and owners for real time monitoring of animal health

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