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ABSTRACT

In the Wireless Sensor Based Animal health Monitoring system, important parameters affecting cattle health such as rumination, body temperature along with surrounding temperature and humidity are continuously monitored. The system also includes analysis of stress level of animal in terms of thermal humidity index. Raspberry Pi Model B+ is used as a web server. In this system, PIC microcontroller senses the rumination activity, body temperature and humidity. Graphical display is possible for analyzing rumination process and stress level of animals. The Graphical User interface is implemented using PHP Hypertext Preprocessor (PHP).

Keywords- Raspberry Pi, Graphical display, sensors, Zigbee, rumination, temperature, thermal humidity index.

I. INTRODUCTION

Dairy farm business is one of the major occupations of India. In this business it is sometimes difficult to increase profitability and yield. Dairy farmers are in search of new ways to manage large dairy farms by improving cow's well being & producing high quality milk. In olden times experienced farmers used to watch their cows for many hours to learn about their health problems. However visual observation becomes limited in modern times. It is not fully accurate and analysis is not possible. Moreover there are emerging animal health issues and diseases that are difficult or impossible to prevent, for example Johne’s disease, Bluetongue, Salmonellosis[1].

Electronic means of monitoring cattle health or animal health were developed. Tools were used in large herds for an early detection of metabolic disorders. Tags or collars were placed on the neck which gave information to the user [2]. The microphone was incorporated in a plastic gadget, which is attached to the left side dorsally on the head collar. The sounds are analyzed through a complex algorithm inside the tag. Based
on validation trials from the developer the tag is claimed to detect rumen activity with 97% of accuracy. Wireless network based monitoring of animal health using RFID were also developed [3].

Rumination is one of the significant parameters which can be considered in monitoring cow’s health. It is an important constituent of the digestive function in ruminant animals and one of the main functions is physical breakdown of coarse material to facilitate its passage from the rumen. Rumination duration is mainly decided by the amount of feed ingested together with the ration composition mainly fibre content and particle size. Excessive starch and easily fermented carbohydrates results in a reduced chewing activity. As a consequence, the saliva productions is decreased and create metabolic disturbances that affects cow health and production negatively. Prolonged daily rumination resulted in higher milk yield [4].

A drop in rumination is a clear indication of health problems which can affect milk production. Many sensors have been developed to monitor rumination [5].

One of the common diseases seen in cattle is Bovine respiratory disease whose signs are fever, nasal discharge and rapid breathing. Another disease is Leptospirosis whose signs are fever, bloody urine, and anemia. Also pregnant cows may be aborted. In such cases monitoring body temperature becomes important. Many new technologies have been introduced to measure body temperature of cattle at various locations including ear, rectum, reticulum-rumen, skin and milk [6].

Body temperature is an important parameter for assessing animal stress for instant a cow's body temperature should be set within slender limits to maintain its physiological processes [7]. Based on several research findings the range is found to be 100 to 104 °F [37.8 °C to 40.0 °C]. Body temperature rises in cattle infected with a disease-causing organism as the immune system begins to fight the infection.

II. METHODOLOGY

This project consists of four sections: module containing Raspberry Pi, Accelerometer module, Temperature and humidity sensor modules.

![Block diagram of Animal Health Monitoring System.](image)

The AHMS detects the animal parameters such as rumination, body temperature along with surrounding temperature and humidity. Zigbee protocol is used for data transmission and reception. Raspberry Pi is used as web server and only authorized person can monitor the data. Two types of programming are done in
Raspberry Pi, PHP and C programming. The front end of web server includes Graphical User Interface design using PHP. The back-end development is done using specific database management. Front-end is what you see. Graphical display of rumination (accelerometer), body temperature and stress level of animal is possible.

### III. RASPBERRY PI MODEL B+

Raspberry Pi is a basic embedded system which is a low cost computer on a single-board and is popular recently. The Raspberry Pi includes an ARM1176JZFS processor with 700 MHz speed, with VideoCore IV with 256 megabytes of RAM and later enhanced to 512 MB in Model B & Model B+ [8]. The ARM11 chip at the heart of the Pi is based on version 6 of the ARM. The system has Secured sockets like Digital (SD) or MicroSD (Model A+ and B+) for boot media and persistent storage. Raspberry Pi uses Linux-kernel-based operating systems.

Model B+ was developed in July 2014 which was upgraded version of Model B. The number of USB ports is 4 and GPIO of pins are increased from 26 to 40. The model includes an improved power circuitry for attaching high powered USB devices. The functionality is replaced by 3.5mm audio/video jack in place of composite video connector. Switching regulators can be used to reduce power consumption.

![Fig. 2. Raspberry Pi B+](image)

### IV. ZIGBEE MODULE

The autonomous devices distributed spatially using sensors form a Wireless Sensor Network (WSN) which cooperatively monitors physical or environmental conditions like temperature, wetness, sound, vibration, pressure etc. at different locations. WSN reduces installation and maintenance [9]. Here Zigbee protocol is used for data transmission. Zigbee has many advantages compared to Bluetooth [10]. Number of cell nodes connected together in Bluetooth is less than in Zigbee. Cost of Zigbee can be compared with Bluetooth [11]. Transmission range of Zigbee is 10 to 100 metres [12].
In AHMS system XBee 2mW Wire Antenna - Series 2 is used.

V. SENSOR MODULES

A. Rumination Sensor Module

For monitoring rumination, accelerometer is used. In the development of rumination sensor ADXL335 accelerometer is used. Basically ADXL335 is an energy efficient, compact, and inexpensive device and can be used to measure the 3-axis acceleration with a range of ±3g. ADXL335 output signals are analog voltage that is proportional to the acceleration. The operating voltage range of the ADXL335 module is 1.8V-3.6V and it is operated at a fixed voltage of 3.3V.

The ADC on a microcontroller will be used to read the output value from accelerometer. Accelerometers are low-power devices which are less expensive than digital accelerometers.

![Fig.3 Circuit of Rumination sensor](image1)

![Fig.4 Rumination sensor module board](image2)
B. Temperature Sensor Module
LM 35 is used as temperature sensor. Body temperature of the animal can be sensed by PIC microcontroller and values are sending using Zigbee. Environmental temperature can also be monitored.

C. Humidity Sensor Module
DHT11 sensor is used for monitoring humidity. DHT11 is a low cost Composite Sensor Module with calibrated digital signal output of temperature and humidity. DHT11 module includes thermistors (NTC) as temperature measurement device. The resolution utilizes 1 wire digital communication protocol.

VI. SOFTWARE SECTION

PIC Programming
The programming software for PIC microcontroller is MPLAB IDE (Integrated Development Environment). It is a simulator for PIC microcontroller. It contains MPLAB editor, MPASM assembler, MPLINK object linker and Hi-tech C compiler. The program is written in Embedded C.

PHP Programming
PHP is an established server-side, embedded HTML scripting language for creating dynamic and interactive Web pages [13]. The PHP provides many features that are looked by commercial entities. The major platforms (UNIX, Windows and even mainframes) are supported by PHP. PHP features native support for most popular databases

PHP is used presently like regular HTML pages and you can create and edit them in similar way as normal HTML pages. In addition to the speed and features of each individual tool, PHP and MySQL collectively work very well together, PHP is open-source, and offers tremendous connectivity to most of today's common databases including Oracle, MySQL, Sybase, ODBC, etc. The integration with various external libraries is offered by PHP. The developer by using this feature can able to do anything from generating PDF document to parsing XML.

VII. RESULTS AND FUTURE WORK
A part of the present work has been completed. Circuit for Accelerometer and Zigbee section is drawn. Web server programming is completed and activated. Graphical display for accelerometer output, body temperature and stress level are obtained as shown in figure 5. X-axis, Y-axis and Z-axis output are displayed. As the present work is in progress the hardware part will be implemented and completed soon. PCB design is being done in ORCAD software. Simulation of the program has been completed in Proteus software.
VIII. CONCLUSION

In the animal health monitoring system, real time monitoring of animal parameters such as rumination, body temperature along with contiguous temperature and humidity has been developed. Raspberry Pi is used as web server. Graphical display of various parameters is obtained. After implementation, this system will be able to continuously provide information about health of the animal to concerned persons.

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Fig. 5 Graphical Display of various parameters
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