Wireless Sensor Network Based Health Monitoring System for Cattle

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***Abstract*— With the exponentially increasing demand in dairy productivity farm automation is of major concern these days. There is a need of technology which would result in reduced cost and labour inputs with increased farm productivity, and to meet the above said requirement cattle health monitoring should be given a priority. The aim of this study is to prioritize the routine monitoring of health of dairy cattle using non invasive, low cost sensor technology which would monitor various health parameters of the farm cattle. As it is a complete wireless and portable health monitoring system, it can be a valuable remote monitoring tool for cattle health care service providers by reducing the cost of their services. The proposed monitoring system includes the infrastructure, hardware, software and representative physiological measurements. We will be able to continuously assess the health of individual cattle by aggregating their health monitoring data, and reporting the results to owners and local health service providers.**

Keywords—Wireless Sensor Networks: Cattle Health Monitoring: Non Invasive Technology: Physiological Parameters

I. INTRODUCTION

In the past few years farm automation has increased at a very fast pace right from the traditional health monitoring system where human labour in close contact with the cattle used to judge their health to today's industrialized farm where modern health care techniques are being implemented to wirelessly transfer the data to a remote health care centre and the cattle can be monitored hence in minimum time investment and labour. The proposed cattle health care monitoring system will monitor the health conditions of each animal (cows), with the sensors being mounted on the cattle. Sensor networks consist of many small low coat devices coordinating with each other in an organized ad hoc systems. The role of the sensor network is monitoring the health parameters of animals, gather and transfer the data to other sink nodes. The sensed data from the node is transmitted to the sink in a multi-hop manner. The use of energy in the network can be reduced if the amount of data to be transfer is reduced. The ultimate goal of this study is to build a monitoring system capable of monitoring one or more cattle during their daily activities at farm. The proposed system consists of a main node and a group of distributed nodes and in this respect its nodes form a wireless sensor network[1-6].

II. PROPOSED MODEL

The aim of the proposed model is to monitor the health condition of the animal using a wireless sensor node [fig1]. The sensor node contains in-network processing algorithm for improved health monitoring and routing of health data [1]. This type of system is very useful to check epidemiological disease to which cattle are more prone to. It maybe food and mouth disease. Once the difference between the normal and abnormal condition of the cattle is detected it is stored and transmitted to regional and national collection centres that monitor the health of herd of cattle and provide essential services for their treatment.

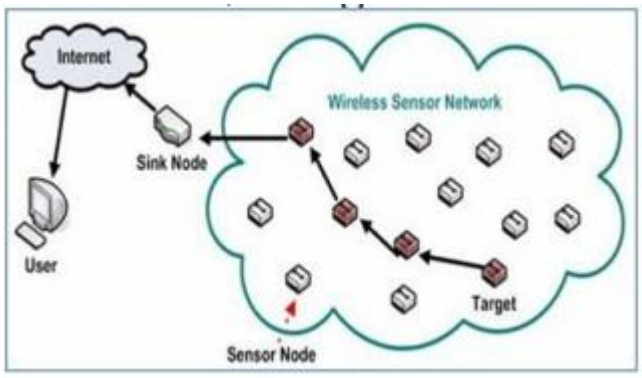

Fig.1 A typical ad hoc network for Wireless Sensor Node

A. Wireless Sensor Network For Cattle Health Monitoring

- *Hardware Description*

This proposed network for health monitoring system comprises of a multi hop data transfer sequence. It reads different health conditions of the cattle trough various sensors and sends the stored data wirelessly to a remote terminal. One terminal is the interface between the sensor nodes and the personal computer where the received data is stored, processed and transmitted. The block diagram of this health monitoring system is shown below in Figure 2.This specific monitoring system is designed based on the Arduino Uno [12-14].This single-board processor is a low cost and strong solution to monitor the required data for the research.

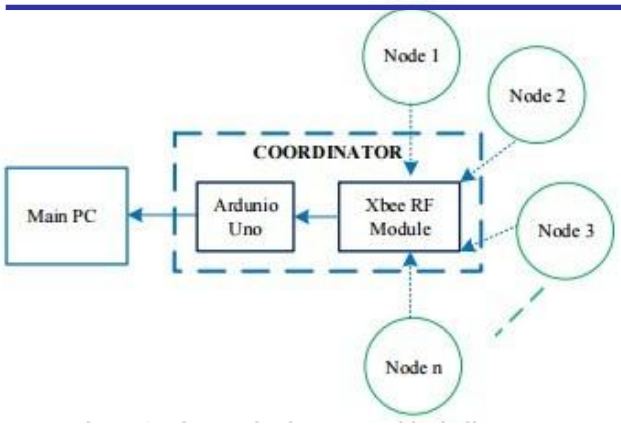

Fig.2.Complete health monitoring system block diagram

The Arduino microcontroller is an easily available and strong tool used as a single board computer and is very popular among researchers and students for project point of view.It is an open source hardware and program development tool.It is easy to write programs and develop interface to many sensors and hence we have focused on using arduino board shown in fig.3[23] for the same.

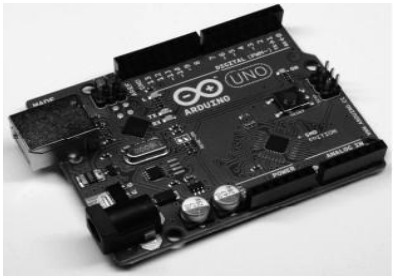

Fig.3 Arduino Uno board

With the Arduino board, you can write programs and create interface circuits to read switches and other sensors. The Duemilanove board consists of an Atmel ATmega328 microcontroller operating at 5 V having 2 Kb of RAM, 32 Kb of flash memory for the purpose of procuring program data, and 1 Kb of EEPROM for retaining program parameters. The clock speed is 16 MHz, which translates to about executing about 300,000 lines of C source code per second. The board has 14 digital I/O pins and 6 analog input pins. There is a USB connector for communicating with host computer and a DC power jack for external 6-20 V power source

III. DESCRIPTION OF THE SENSOR TO BE USED

On the basis of sensing technology there are two types of sensors which can be used to sense various parameters.

- Invasive sensors, and
- Non invasive sensors

A. Invasive Sensors

These types of sensors are used where accurate measurement of certain parameters is required without being affected by external environmental conditions. Though there are few disadvantages of using these sensors as sensors cannot be reused and the life cycle of those sensor are limited to the application time and required energy level.

There are some defined performance criteria for each sensor being implanted starting right from the technique being used, data collection, algorithm used and performances .The first three categories gives us the description of the technical of the sensor system (a) location of the sensor with respect to the cattle (b) measurement type (c) sensor alert and their comparison with the standard measurement. (d) frequency of occurrence of an event in the routine . The (e) comparative analysis of the measured and predefined data is carried out by an algorithm.

B. Non-Invasive Sensors

Immobile sensors located in a defined area

These types of sensors are located in the region where cattle are more likely to appear for a particular span of time. These places may be the grazing place near some pond or the place of stations for extracting milk or feeding. These sensors may be a temperature sensors or surveillance cameras.The result of temperature sensor being showed in fig4. And normal pulse rate in fig 5 [7-11].

External sensors attached to the cattle's neck collar or knees in order to monitor them throughout the day. Most commonly used external sensors are accelerometers, pedometers, vibration sensors, thermometers for temperature measurements (at hypodermal level), humidity sensors (at skin level), etc.

Pedometers are very cheap and easily available sensors which are used to find out the movement, lying time and temperature of the cattle under study. It comprises of a real-time monitoring and changeable measurement time. The purpose of the system was the identification of oestrus cycle times.
To identify different motion states of the cow the GPS system is been used which is infrastructure less system.

The GPS sensors are attached to the animals' neck collars. These sensors keep a tract of cattle activities eating, seeking, walking, lying and standing. Keeping a regular check on these activities almost 80% of the result has been achieved through these two sensors.. However, the success rate could be significantly increased by an integration of additional sensor signals (e.g. accelerometers). Another class of sensors, MEMS-based accelerometers, are these days prominently used to achieve real time accuracy based monitoring. Much better results can be obtained by using different position sensors to differentiate in between head and whole body movement. The advantage of this type of sensors is a continuous observation of the dairy cows. Especially the class of modern MEMS-based accelerometers is a promising candidate for successful commercial systems, presumably in combination with additional mobile sensors. The disadvantages are an increased effort for accessing the sensor data as well as an increased danger of damages to the sensor boxes (due to the movements of the cows in the farm). Both disadvantages are controllable by modern engineering.

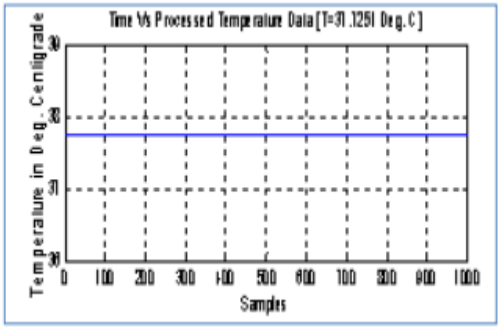

Fig.4.Normal body temperature plot for cattle

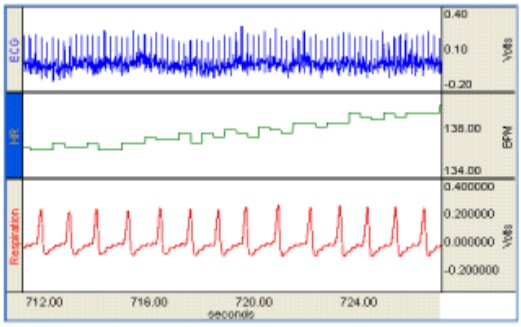

Fig.5. Normal heart rate pulse of normal cattle.

C. Diseases mapping with sensors are listed hereby in table-1[16-21].

Table-1.

	Milk Quality	Electrical Conductivity	Electrical Conductivity Sensor
Displaced Abomasum	Feeding		***Accelerometer***
Ketosis	Breathe Ketones	Grazing	***Accelerometer*** (Pedometer)
		Eating, Rumination	***Microphone***
		Breath smell	Gas Sensor
Milk Fever	Movement / Motion		***Accelerometer***
Retained Placenta		Excitement/ Stiffness	***Accelerometer*** (Pedometer)
Heifer Diarrhea	Fever	High Temperature	***Temp Sensor***
Heifer Pneumonia	Nasal Discharge	Running Nose	
	Cough	Coughing Sound	***Microphone***
	Increased Respirator y Rate	Sound Of Breathing	***Microphone***
	Decreased Appetite	Less Grazing/ Feeding	***Accelerometer*** (Pedometer)

CONCLUSION

Here we conclude that this proposed model has been investigated and a performance evaluation study to show the use of the proposed system has been carried out. In this paper, the proposed system's both hardware and software components have been presented. If connected to the Internet through a gateway, the proposed low-cost system enables health care providers to remotely monitor the cattle's main health parameters. It is also a valuable tool for the farmers and dairy farm people. The future work of this study consists of an evaluation study in a distributed scenario involving a herd of cattle.

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