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Distributed Data Storage Model for Cattle Health Monitoring Using WSN

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Abstract

Now a day, wireless sensor networks (WSN) are being deployed in various applications like industrial, environmental, health care, societal monitoring. The sensor networks have tendency to generate huge amount of data. Hence data storage techniques become a critical issue for the success of these applications. In this paper, we have proposed a distributed data storage model used for WSN based cattle health monitoring. We have also defined the structure for the same. We have divided this model into two levels namely a local level and a central level. The main aim of storing data locally is to get quick response for any query raised by the user. The second level where the data is centralized is used to make long term decision, planning and policy for the cattle health monitoring.

Key words: *Wireless Sensor Network, Mobile Network, Internet, Cattle, Health, Data Storage Model.*

1. Introduction

Wireless Sensor Networks (WSNs) are widely used for monitoring physical happenings of the environment. The data gathered using WSN is bulky, heterogeneous and distributed through the network. As the data would be massive, the data gathering process needs appropriate data storage.

In WSN, three data storage and retrieval methods namely External Storage (ES), Local Storage (LS) and Data-Centric Storage (DCS) [15] are generally used. The external storage is used when the data is to be stored on an external storage device. Here, the nodes send data to the base station without any query being generated by the user; also it does not perform any kind of aggregation. This results in high traffic that causes unbalanced energy consumption and delayed services. The local storage has an inbuilt database that keeps the data locally. The node is unaware of the target node to which the data is to be transmitted. This results in more energy and resource consumption. The data centric storage is used where the data of same type is stored in the same geographic location. Hence, the query with a particular type of data will go to a specific location always and thus avoid data flooding.

Our aim is to suggest a data storage model for animal health monitoring that uses WSN. In this model data storage and manipulation would be done at two levels, local and central. The local level data storage responds immediately for any query raised by the animal owner or health worker. This response is transmitted using mobile network. The data stored at central level is used for decision making and for long term policy making to improve the health monitoring infrastructure. .

The section 2 of the paper introduces wireless sensor network, section 3 shows the related work, section 4 identifies the basic parameters that are used to monitor the health of the cattle, section 5 show how to spot the disease/s in cattle and lists different types of disease, section 6 shows the proposed data storage model followed by conclusion in section 7.

2. Wireless Sensor Network

The Wireless Sensor Network technology enables design and implementation of novel and intriguing applications that can be used to address numerous industrial, environmental, health care, societal and economical challenges [13][20]. The node consists of sensor interface, microcontroller, memory and battery unit

together with a radio module. The wireless sensor node thus are able to carry out distributed sensing and data processing as well as share the collected data using radio communication channel [7][14][15].

The ideal wireless sensor is networked, scalable and consumes very little power [8][9]. It is smart, software programmable, capable of fast data acquisition, reliable and accurate data transmission for extensive time-period [11][16][17].

In the early era, the development of wireless sensors was limited to military applications but the introduction of civilian wireless sensor systems has greatly diversified application domain which has further boosted research efforts in the field of WSN [3][5][31]. WSN technology is now implemented in variety of fields, which are able to monitor a wide variety of conditional like animal tracking, temperature, humidity and rain fall, forest, health, vehicular movement, fire detection, etc [18],[19],[23][24],[28],[29].

3. Related Work

Wireless Sensor Network (WSN) and monitoring environment require some effective solution to present the data in simple and efficient manner to user [4][10]. With the ability of broadcasting capability of mobile device, it is now possible to use the mobile device with collaboration with Wireless Sensor Network and provide a user interface in order to view all the information gathered by the Wireless Sensor Network[25][1]. This section shows some of the applications where different data storage mechanisms are used. [32][33]

Abhishek Ghose et.al proposed a Resilient Data-Centric Storage (R – DCS), as the method to achieve scalability by replicating data at strategic locations in the sensor network [2]. They show that this scheme leads to significant energy savings in reasonably large sized networks and scale well with increasing node – density and query rate.

Bo Sheng et.al considered the storage node placement problem aiming to minimize the total energy cost for gathering data to the storage nodes and reply to queries [6]. They examine deterministic placement of storage nodes and presented optimal algorithms based on dynamic programming.

Norbert Siegmund et.al presented an approach to provide robust data storage for Wireless Sensor Network [26]. They achieved this goal by providing FAME-DBMS, a customizable database management system which can be tailored according to the varying requirement of a sensor network.

4. Basic Parameters of Cattle Body

"Prevention is better than cure" is a true saying and worthy of being remembered by every animal owner. The first step to identify any disease/s in cattle is to measures the TPR (Temperature, Pulse, and Respiratory Rate) [W1][W2]. Cattle's basic body parameters help animal owner or health worker to check the symptoms of any disease/s in cattle. Each category of animals has some standard parameters values which represent normal and healthy behaviors of animals. If some or all of the above parameters change it indicates a sign of disease in the cattle [W3][W4]. Table 1 shows the standard parameters of Cow and Buffalo that should be considered as threshold values in any health monitoring system.

Table 1: Normal Body Parameters for Cow and Buffalo

Cattle Type	***Body Temperature (in Fahrenheit)***	***Heart Beats/ Minute***	***Respiratory/Minute***
Cow	101.5 °F	50-60	20-25
Buffalo	98.3 °F	40-50	15-20

5. Diseases in Cattle

Animal owner should develop keen eye to spot the ill animal/s. Any changes in its behavior or in its appearance should be identified by the animal owner. Some common signs of ill animals are like loss of appetite and stopping rumination, change in quality and quantity of milk yield, sunken eye with the fixed staring, change in consistency in dung, change in color or mixture of blood in urine, change in pulse rate and a coarse and dry skin have been identified in [W2][W5] which would be indicative of disease. Using the parameters mentioned in the above section the diseases can be identified as contagious or non contagious.

5.1 Contagious diseases in cattle

The contagious diseases are generally caused by bacteria and viruses among the cattle. In India and particularly in Gujarat, the crossbred cows have increased in number. And these crossbred animals are highly subject to tropical diseases and variations in climate. Contagious

diseases usually take a heavier toll on crossbred cattle than native cattle.

The animal gets these diseases through any one or combination of things like other ill animals, unhygienic food, polluted grass, water, air, soil infected with bacteria, insanitary conditions of the cattle shed, infected dung, or even by the hand of the cattleman. Table 2 shows few commonly occurring bacterial and viral diseases in cattle.

Table 2: Commonly occurring Contagious Diseases in Cattle

Bacterial Diseases	***Viral Disease***
Anthrax	Cow Pox
Black Quarter	Foot and Mouth Disease
Haemorrhagic	Rinderpest
Septicaemia	
Mastitis	
Tuberculosis	

5.2 Non-contagious diseases in cattle

In cattle, non-contagious diseases occur due to improper care, dietetic issues or sometimes even due to toxic substances. The most common non-contagious diseases of cattle are listed in Table 3.

Table 3: Most Common Non- contagious Diseases in Cattle

Non Contagious Diseases	
Milk fever	Metritis
Tympanities	Mammits
Diarrhoea	Constipation

6. Proposed Data Storage Model

In [4], we have proposed a health monitoring and reporting system that uses WSN architecture. Using this architecture we intended to monitor the health and environmental scenario of animals located in rural area of the State of Gujarat. The system consists of heterogeneous wireless sensor devices capable of sensing and transferring data. The devices when combined will form a network. This network would be capable of collecting, aggregating, processing the data collected on occurrence of various events. Once the data is available, proper analysis of the data can be done and the stakeholders can be informed about the health status of the animals if required.

In the scenario of animal health monitoring using WSN, the data storage model should be capable enough to store large amount of data and speedy execution of query or problems send by health worker or animal owner. The main goal of designing a data storage model is that it should be scalable, able to balance load, consume less power and robust.

For cattle health monitoring, we will require different types of sensor nodes connected with database server using WSN. Some of the sensors will be fitted on the body of the cattle and some of the sensors will be fitted in surrounding environment where cattle will roam around. Body sensors will send the data like body temperature, plus rate and respiratory rate of the cattle at a specific pre configured time interval. The occurrence of data transmission of body sensors data will be very high. The second type of sensory data will be the environmental data; it will send the data like water pollution level, soil infection level, dust level in air, humidity in air. This data transmission will be comparatively low.

For this type of data transmission, we propose two level distributed data storage model. In the first level, data accumulated at a local database server that maybe kept in nearest Gram Panchayat's office. To transfer this data to the required stakeholder locally as well as globally this database server should be connected with internet. Figure 1 shows the architecture of the proposed local data storage and response model.

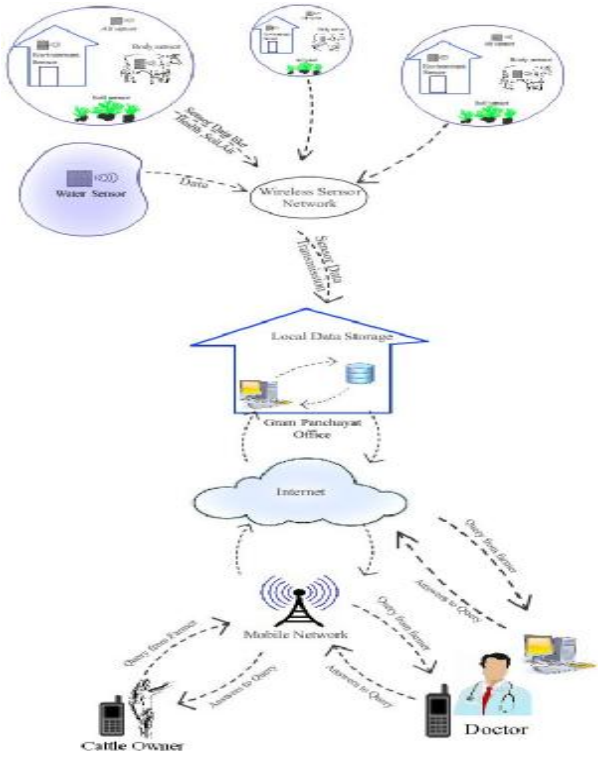

Fig. 1 Proposed Local Data Storage Model

In the proposed data storage model, data will be transmitted by different sensors in WSN and would be received by nearest database server. When any data that does not match the threshold is detected by sensors this database server will give intimation to the animal owner as well as the health worker. To send this intimation we will use mobile network. Animal owner can also send a query to local system; the local system will then process it and would give an immediate response. As the stakeholders will be more comfortable using regional language, at present the response will be based on regional language (Gujarati). Figure 2 shows the architecture of the proposed central data storage and response model.

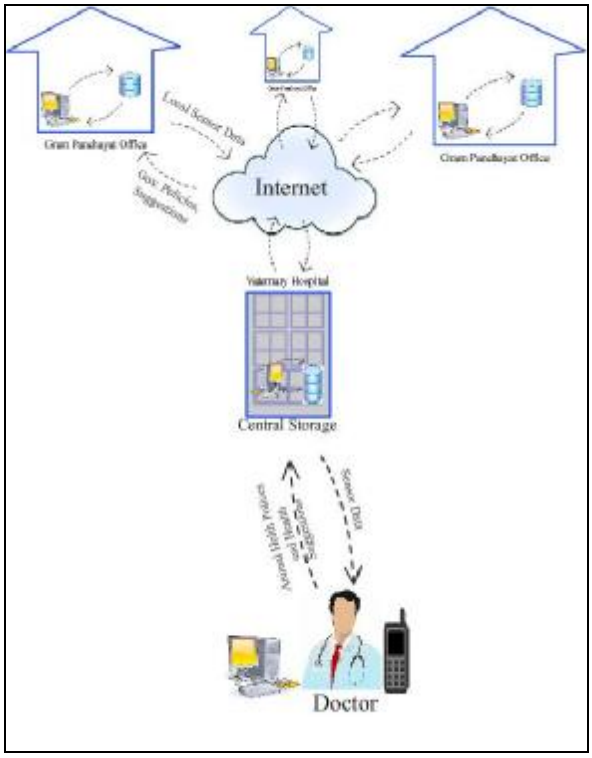

Fig. 2 Proposed Centralize Data Storage Model

In the second level of data storage model, data will be copied to central database server through Internet using batch processing. It is also important to keep track of the data pertaining to animal's health for future references. To achieve this, the data should be gathered at a common location. Therefore, the second level of data storage should be a centralized database server, which may be situated at a veterinary hospital or any other location as required. Here, the veterinary doctor may review the data using interface in the form of different types of reports. He can make appropriate decisions and policy for animal health care and can also get the annual statistics regarding the animal census, death ratio, illness ratio and other similar things.

7. Conclusion

This paper suggests a distributed data storage model for storing and analyzing the data used in animal health monitoring. The data storage model will be of help to many users like the animal owner, health worker in that village and even to nearby veterinary hospitals. Implementation of this data storage model will help the user to take appropriate and immediate action in case of any eventuality. By using this system, we would get information and symptoms of the possible illness and disease of the animal on runtime. Since monitoring is done in the live space the animals travel less often, which is safer and more convenient. Thus an overall improvement in the betterment of healthcare can be provided, which further will generate increase in annual yield of products and improve the quality of life of rural area of state of Gujarat.

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