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WIRELESS SENSOR NETWORKS: A POSSIBLE SOLUTION FOR ANIMAL HEALTH ISSUES IN RURAL AREA OF GUJARAT

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1.0 Abstract

The rural area in India has 68.84% population as compared to the 31.16% urban population [R1]. Agriculture is the main source of income in rural areas of India. Animals like cow, buffalo, sheep, goat etc play a significant role in lives of rural India. They are used as a source of income. Hence animal husbandry becomes a major concern.

This paper discusses the issues and concerns related to the health of animals with respect to the rural areas of Gujarat based on the survey done by us. After discovering the concern we have proposed possible solution for the said issues. The solution uses the upcoming technology of Wireless Sensor Network (WSN). It shows how the upcoming technology can be integrated seamlessly in the rural environment to improve and uplift the life style of people staying in rural area of Gujarat.

2.0 Keywords



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Agriculture, Network, Sensor, Wireless, WSN

3.0 Introduction

A Wireless Sensor Network (WSN) is an infrastructure comprised of sensing, computing and communication elements that gives us the ability to observe and react to events in a specified environment. Basically Wireless Sensor Network (WSN) has four components: an assembly of distributed sensors, an interconnecting wireless network, a central point of information gathering, and a set of computing resources at the central point. It gives administrator ability to instrument, observe and react to events in a specified environment. Usage and deployment of wireless sensor technology has increased in several areas within industry as well as day to day life. WSN are used in application like health care, monitoring, tracking and sensing.

The animal husbandry sector plays an important and vital role in Gross Domestic Product (GDP) of Gujarat State, which is to the tune of nearly about 5.0%. This sector also contributes to product nutritive food, rich in animal protein, to the general public and good supplementary income to the economically weaker section of society. In addition, it offers a good employment generation opportunity, if adopted on a large commercial basis [R3].

Livestock sector is another sector that has been making rapid stride and spectacular growth in recent time, with positive impact on the lives of rural people mainly small farmers, marginal farmers and agricultural landless laborers by raising their living standards considerably [R3].

4.0 Animal Husbandry In Gujarat

State of Gujarat is situated in the western India, surrounded by Arabian Sea in West and South where as by the States of Rajasthan, Madhya Pradesh and Maharashtra in North, East and South respectively. The geographic area of state of Gujarat is 1,96,024 Sq. Km, which is 5.96% of the India's geographic area. It comprises of 26 districts, 225 Talukas and 18,225 Villages. Agriculture scenario in the state of Gujarat has been largely dependent on South West

Monsoon. Its soil type is sandy to deep black. The main crops of the state are sugarcane, paddy, cotton, juwar, bajra, wheat, ground nut, pulses and legumes.

According to the last Livestock Census done in 2007, the total livestock population (excluding dogs and stray animals) in the state was 235.25 lakhs, registering an increase of 8.55 percent over the year 2003. As per the census there were 79.76 lakhs cattle, 87.74 lakhs buffalo, 20.02 lakhs sheep, 46.40 lakhs goats and 1.34 lakhs other animals. The percentages graph of total population is shown in Figure 1. Table1 shows the comparison of different category of live stocks after the census in year 2003 and 2007.

Percentage Cattle Category Of Live Stocks In Census 2007

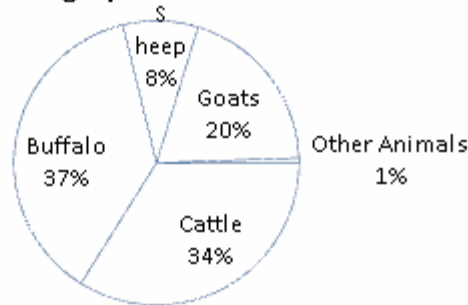


Figure 1: Percentage cattle category of live stocks after 2007 census

Category	Live-Stock (In Lakhs) after Year 2003 Census	Live-Stock (In Lakhs) after Year 2007 Census	% Changes (In Lakhs)
Inmilk Indigenous Cow	14.06	13.35	-05.08
Milch Indigenous Cow	21.20	20.03	-05.47
Inmilk Crossbred Cow	02.50	03.98	58.37



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Milch Crossbred Cow	03.18	05.25	65.14
Inmilk Buffalo	27.94	30.40	08.84
Milch Buffalo	39.38	43.90	11.50
Inmilk Goat	17.58	15.61	-11.19
Milch Goat	26.69	24.53	-08.03
Camel	00.54	00.38	-27.78

Table 1: Comparison of Livestock Census Figures in State of Gujarat

As per the year 2007 Census State of Gujarat ranks tenth in veterinary infrastructure among all the states and union territory of India. India is one of the largest milk producing country in the world. 8844 M.T which contributes to about 8.28% of total milk production in India comes from State of Gujarat. In year 2009 state of Gujarat contributed to 1.34% of milk production in the whole world.

The total milk production of the state during 2010-2011 is 9320.84 thousand tones, which shows an increase of 5.41% over the previous year. To maintain the increases of milk production we need good breeds of animals.

Having good breed of cattle does not guarantee increase in milk production. We need to make sure that proper infrastructure is in place to tack care of the animals. Veterinary hospital /vaccine institute/dispensaries/veterinary centers/ mobile veterinary dispensaries play a significant role in maintaining the health of animals. Table 2 shows the veterinary infrastructure in State of Gujarat as per year 2010-2011 [R4].

Infrastructure	Nos.
College of Veterinary Science	004
Animal Vaccine Institute	001



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Veterinary Polyclinics/Hospital	023
Veterinary Dispensaries	595
Branch Veterinary Dispensaries	027
First Aid Veterinary Centers	552
Mobile Veterinary Dispensaries	035
Mobile Disease Diagnostics Laboratory Ambulance	063
Rural Primary Veterinary Health Care Centers	178
Epidemiology units	002
Animal Disease Investigation Units	017

Table 2: Veterinary Infrastructure in Gujarat as of year 2010 – 2011

The above statistics though shows a feel good scenario of the veterinary infrastructure, we still feel that the current infrastructure needs further improvement.

5.0 Survey On Issues And Concerns Of Animal Health

To find the actual scenario of the problem related to animals and animal health issues, we did a survey in rural areas of the State of Gujarat. The survey was spread across 3 districts, 6 talukas and 19 villages. A total of forty questions related to animals and there well being were framed for the survey.

The partial outcome of the survey is given in this section. The results mentioned are mainly related to milk producing capacity or health of the animal. After conducting the survey we found that 98% of the surveyors agree to the fact that milk production decreases when the animal falls ill. Thus it was observed that majority of the villagers believe that illness of the animal also affects its milk producing capacity. As the milk production was getting affected due to illness, we tried to find out the season during which the livestock falls ill majority of the time; Figure 2 shows the outcome of this question.

Season in which the animals fall ill majority of times

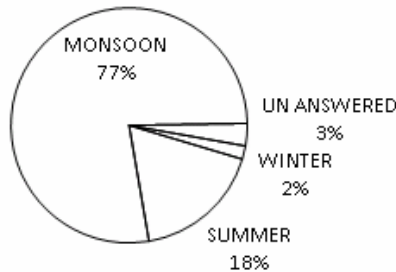


Figure 2: Season when animals fall ill majority of time

It was observed that 77% villagers believe that in monsoon season animals fall ill majority of times. Thus it becomes mandatory in this situation that the staying environment of the animal should be more hygienic and maintained properly in monsoon. This ensures that the animal does not get affected by the weather and its environment.

The next thing we needed to identify was the remedial action that the owners took in case of illness of livestock. Figure 3 shows that out of 140 persons surveyed 124 took advice of doctor.

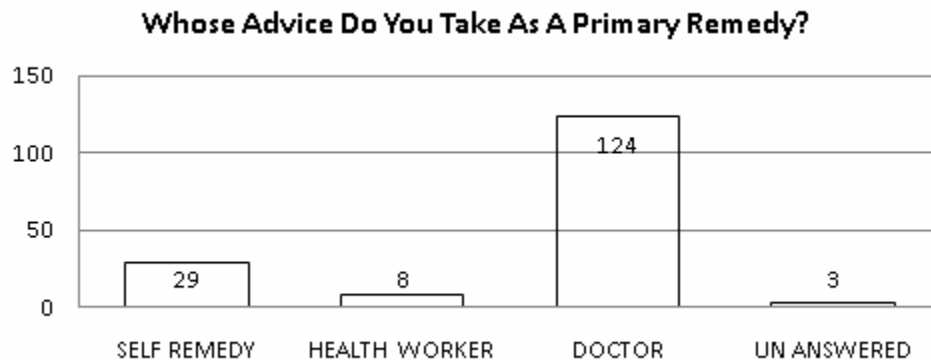


Figure 3: Whose advice is preferred incase of illness

As the people prefer to take advice of doctors it is necessary to take the animal to the doctor or a doctor's should visit the animal. In both cases the distance between hospital/ dispensary and the ill animals is of significance. Figure 4 show that 31% of the people surveyed take the animal to the doctor by walk. This may result in deterioration of health condition of the animal.

Way To Transfer Animals To Hoispital



Figure 4: Way of Transfer Animal to Hospital

It was observed that around 597 veterinary dispensary, 587 veterinary aid centers and mobile dispensaries are available in the State of Gujarat. The health worker from these facilities does seldom visit villages for regular checkup of animals.

To implement our proposed solution we needed to know the comfort level of villagers in use of technology. It was found that 77% villagers (animal owners) have mobile phone and use it for voice call as well as sending and receiving SMS.

After analyzing the data we conclude that majority of the villagers have their own cattle. Production of milk and work efficiency of animals is affected if the animal falls ill; which in turn affect the animal owner's income. The animal mostly falls ill in monsoon season. Due to absence of veterinary hospitals in the village, the animal owner has to go extra miles in taking care of its ill animal. Insufficient staff of health worker or irregularity in the work of health worker



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leads to more problem related to animals health. Table 3 summarizes the outcomes of the survey.

Issue	Answer	Percentage
Average number of animal with each family	1 to 5	72%
Milk production is reduced during illness of animal.	Yes	92%
Season in which animal falls ill maximum time	Monsoon	77%
Primary advice taken from whom at time of illness	Doctor	75%
Veterinary setup (hospital) available in village	No	63%
Way of transportation of animal at the time of illness	By walking	31%

Table 3: Summarizes the outcome of our survey

Weak health and improper treatment of animal directly affects the trade of animal husbandry and agriculture which is back bone of village life. Due to problems faced by animal owner special attention needs to be given on animal health monitoring. Thus it becomes necessary to look out for solution that provides smart health care for animals.

6.0 Related Applications Using WSN

WSN has been used in various applications related to monitoring and tracking of animal, human etc [1], [2], [3], [4], [5], [6], [7], [8], [9], [11], [12], [13], [14]. Some of the applications are as mentioned below:



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Kevin Mayer et. al has described how wireless technologies can be used to create a platform for cattle health and behavior monitoring[10]. They used both internal and external body sensor for monitoring cattle. The sensors communicate wirelessly with each other, and are continuously connected over the mobile telephone network to provide a real time view of to data using standard web services.

Tsung Ta Wu et. al propose use of WSN for Cattle Monitoring System[16]. In this paper author describes a cost effective WSN technology for monitoring the health of dairy cow. By understanding cow behavior, farmers can identify the onset of illness.

Dr. Prabhat Ranjan et. al. has created a wireless sensor network for wildlife monitoring [15]. In their system a specially designed collars with sensor node attached would be put on wild animals. These collars collect data about the desired parameters from the vicinity of the animal and transmit it to the base station. This information is used by the scientists/wildlife officials for habitat monitoring and behavioral habit of these animals.

Prabhat K. Saraswat et. al. have created a WSN architecture for monitoring of turtle [R2] In this paper an attempt has been made to track the migratory path of turtles. The purpose is to help wildlife researchers understand rather unusual migratory behavior of sea turtles and to propose measures to protect the nesting grounds and habitats of these creatures. A two tier sensor nodes based solution is proposed to track the turtles.

7.0 Proposed Solution & Architecture

In this paper we propose a health monitoring and reporting system that uses WSN architecture. Using this architecture we intend to monitor the health and environmental scenario of animals located in rural area of the State of Gujarat. To make sure that we get accurate and regular details of the animal, we need to monitor various physical aspects like heart rates, heart rhythm, body temperature, animal identification and animal location along with the animal we also intend to monitor the place where the animals are kept. This monitoring will make sure that the animal always stays in a healthy environment.



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The monitoring has to be done on continuous basis and will not interfere with the movement of the animals. It will also make it convenient for the owner as well as health worker to keep track of physical as well as environmental concerns. In case of any eventualities like increase in body temperature, heart beats etc, a message informing the change can be generated instantly and sent to either the owner, health worker or doctor and thus timely action can be taken to improve the health of animal.

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 healthcare provider (Veterinary Doctor) can be informed about the health status of the animals if required. The proposed architecture is as shown in Figure 5.

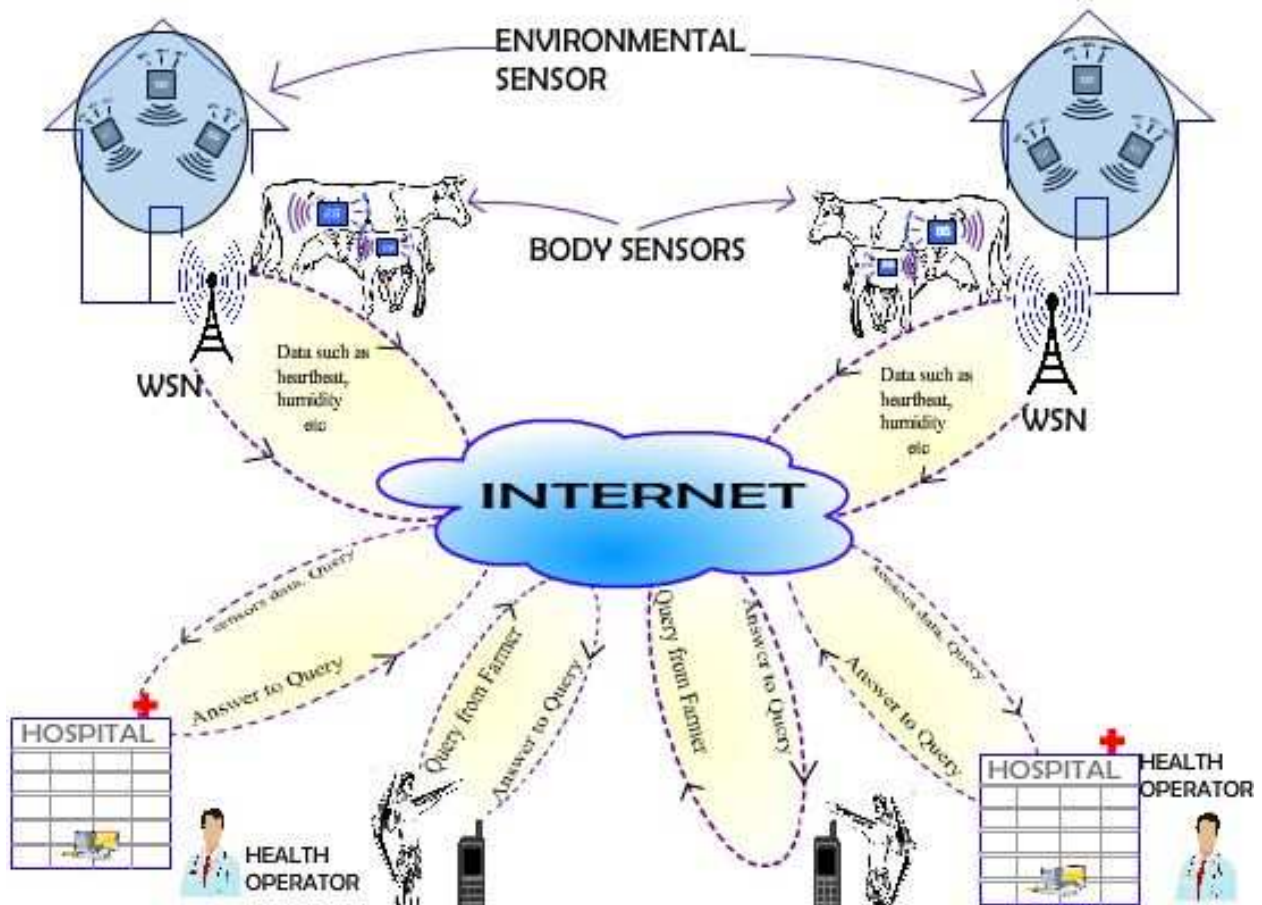


Figure 5: Animal Health Monitoring Architecture

As can be seen in the figure, the monitoring will be done by two types of sensors i.e. body sensors which will monitor the heart beat, body temperature, blood pressure etc; while the second type of sensors known as environmental sensors will monitor humidity, dust level, air pollution and other parameters. All these data are collected by sensors and transmitted to veterinary hospital using WSN. These data can be filtered using a graphical interface for generating required information regarding animal health. Animal owner can also send a query related to animal health via mobile interface to health worker or veterinary hospital, using same interface health worker will be able to send a reply. The animal health is being monitored on



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continuous basis, hence in case of problems, solution can be provided faster as compared to traditional methods.

8.0 Conclusion

The proposed architecture will try to extend health care from traditional veterinary hospital setting to Wireless Sensor Network based remotely health monitoring and diagnosis system for animal. By using this system, we would get information and symptoms of the possible illness and disease of the animal on runtime. As the size of the seasons is tiny there is minimal patient (animal) interaction. Since monitoring is done in the live space the animals travel less often, which is safer and more convenient. The system will allow farmers in remote place to consult doctors. It will also allows doctors in remote and rural areas to consult with specialists in urban area if need be. 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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