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REVIEW OF CATTLE MONITORING SYSTEM USING WIRELESS NETWORK

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Abstract: ***The cattle industry is an integral part of the world economy. The continued production of quality beef requires new and improved methods for long term monitoring of animal health. Additional benefits can be realized from this class of technology, such as the ability to identify the presence of disease early and thereby prevent its spread. An important element of health assessment is the ability to monitor vital data such as core body temperature. This paper reviews other cattle monitoring systems and the importance of employing wireless sensor networks for monitoring cattle core body temperature and location in the ranches along with their advantages and disadvantages.***

Keywords: Cattle, Core body temperature, Wireless sensor network, GPS.

1. Introduction

Diseases, whether they occur naturally or as a potential result of bioterrorism, pose a serious threat to the livestock industry (Hoskins, Sobering, Andresen, & Warren, 2009). Body temperature is an important parameter for assessing animal stress (Brown-Brandt et al., 2003).

Dairy pastoralists and veterinarians have used body temperatures, most commonly rectal temperatures, in detection and management of febrile disease and changes in the state of cows (estrus, heat stress, and onset of calving) for many years (Bewley & Schutz, 2010)

Attempts to measure body temperature of cattle have been made at various anatomical locations including rectum, ear (tympanic), vagina, reticulum-rumen, and udder (milk). Rumen temperatures have been demonstrated to be effective measures of core body temperature (Prendiville, Lowe, Earley, Spahr, & Kettlewell, 2007).

The normal core body temperature of a healthy, resting cow is stated on average to be 101.5 degrees Fahrenheit (38.6 degrees Celsius). A cow's body temperature must be maintained within narrow limits in order to sustain its physiological processes. According to the research, the range is found to be 100 to 104 °F [37.8 °C to 40.0 °C].(Pei Jun Chen – 1998).

Wireless sensors and sensor networks have become a great interest to research, scientific and technological community. Cattle monitoring system using wireless network will be of helpful to the pastoralists, farmers and ranchers to monitor their cattle.

This can done remotely using wireless connectivity through computer as well as the mobile phone for alerting them about any abnormalities, such as cattle leaving the specified grazing areas, early signs of illnesses and critical levels of body temperature of cattle.

2. literature review

(Brown-Brandt et al., 2003)**,** described the comparative performance of a new telemetry system for core–body temperature measurements in poultry, beef cattle, swine and dairy cattle.

The telemetry system was used in the studies based on the specified resolution of temperature transmitters, overall accuracy of the system, and flexibility of taking measurements on both free roaming and housed animals. Transmitters were specified based on battery life and size of transmitters, and transmitting distance.

Miniaturized ambulatory receiver/loggers were used in the trials with feedlot steers, swine, and dairy cattle. These loggers are small (12 × 6 × 2.5 cm), lightweight (< 200 g), powered by a 9–VDC battery, and record data from only one transmitter at a time. The loggers draw 5–mA current in standby mode and 20 mA in reading mode; therefore,

battery life depends on sampling frequency. At 1–min sampling intervals, a lithium battery will last approximately 10 days.
The transmitter transmits only a short distance (maximum of 0.5 m from the animal), and the logger needs to be setup for each individual transmitter. Therefore, each animal is required to either be in close proximity to the logger (for example in a tie stall or a small pen) or have the logger physically secured on the animal (e.g. in a pouch on a harness or a vest). This logger has a data storage capacity of 25,000 readings.(Brown-Brandt et al., 2003).

2.1 TRANSMITTERS

These transmitters (fig. 1) are considered single–time use because the batteries cannot be replaced. Battery life of the transmitter is approximately six months.

Figure 1. Cattle transmitters: a. improved transmitter, b. original Transmitter. (Brown-Brandt et al., 2003).

(Foulkes et al.), employed a low power wireless sensor network to relay health and location data from the herd of cattle back to the farmer's computer. Where a farmer may have difficulty managing the herd 24 hours a day, the developed system would be able to track and monitor the well-being of each cow continuously and report all data back to a central PC. Proposed sensors would monitor pulse rate, temperature, respiration, and location information, in order to alert the farmers of any abnormalities, such as cattle leaving the specified grazing areas, early signs of illnesses, critical levels of body temperature or heart rate, and many other concerns related to the well-being of cattle. Research was done to lay out a basic method for monitoring bovine vital signs and location, and then relaying that information back to the farmers.

2.2 Cattle Temperature

Multiple temperature sensors were considered for measuring a cow's core body temperature through the ear, anus, or within a bolus. Due to the fact that the nearest location from the ear tag to get a reading for the core body temperature is the ear canal, a probe inserted at least two inches into the ear was the most convenient and least invasive method. The sensor chosen was similar to that used in the previously mentioned FeverTag. It was imperative that this probe be inserted into the lower ear canal deep enough for consistent readings without creating a nuisance to the cow. To prevent the probe from dislodging from the ear due to the cow's movement, the rigidity was strengthened by wrapping wire around the probe's length. In addition, the probe was selected due to it having an adjustable resolution for obtaining a more accurate temperature and a waterproof housing to prevent contamination from the elements.

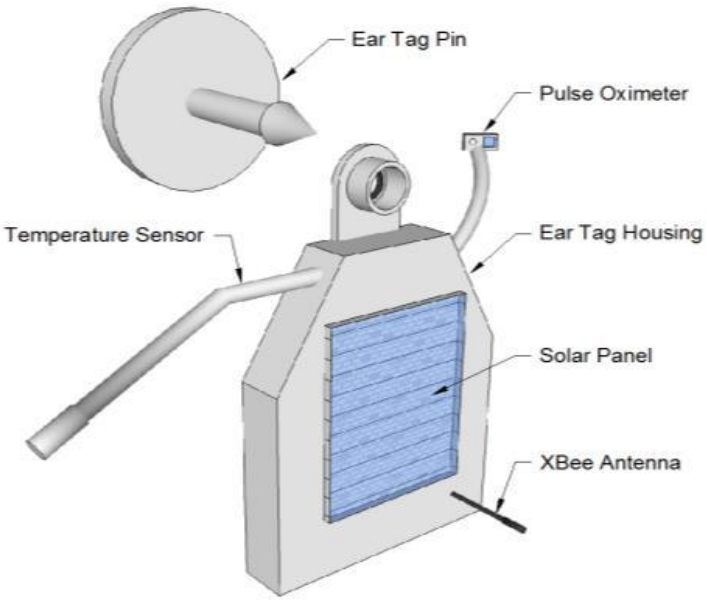

Figure 2 Ear Tag Diagram. (Foulkes et al.)

2.3 Tracking Unit Locations

The most common methods of guiding and tracking remote systems are based on the idea of triangulation. Triangulation is the process of determining the location of a point by measuring the time difference of arrival of a signal to three different receivers. Currently, the most common usage of a triangulation like technology is in GPS systems, which determine a position based on information from multiple satellites.

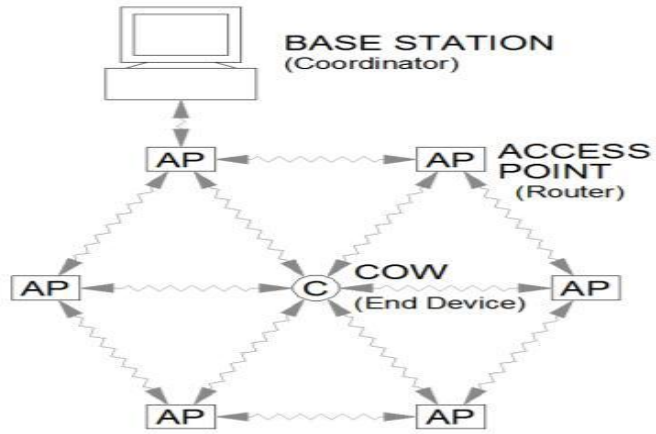

Figure 3. Network Layout. (Foulkes et al.)

2.4 Sensor networks

(Nagl et al., 2003), were designed a remote health monitoring system for cattle that hosts a suite of sensors and communicates wirelessly with a base station via Bluetooth telemetry.
The Bovine Mobile Observation Operation (BMOO) unit is designed to communicate with a variety of commercial and custom sensors and to use Bluetooth links to relay the data back to a farmer, a rancher, a veterinarian, or even an automated analysis system.
BMOO is a MicroChip PIC microcontroller. It is responsible for controlling the various sensors, translating their communication protocols into a common protocol, storing the data until the animal is within range of a base receiving station, and then transmitting the data to the base station. Multiple base stations can exist, ideally located near feed bunks or watering troughs. With a ten-meter wireless range, the animal only has to get reasonably close to a base station for a

connection to take place. With the data obtained by the BMOO unit, a farmer, rancher, or veterinarian can make detailed state-of-health analyses, enabling rapid treatment or early disease detection to prevent spread within or between herds.

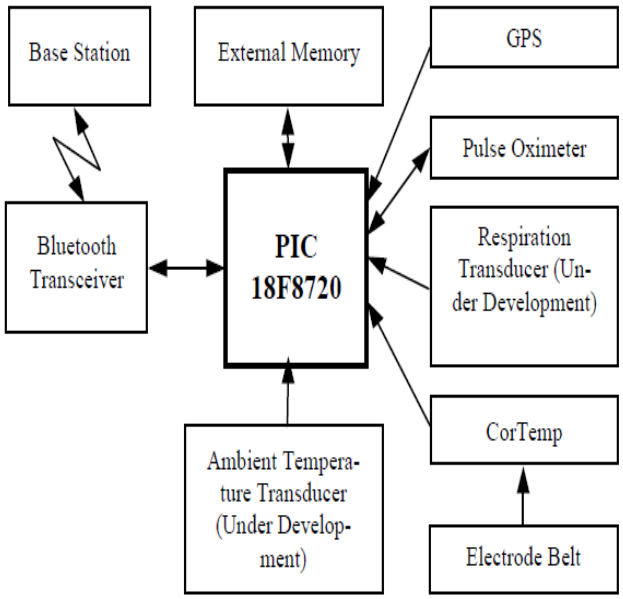

Figure 4. Block diagram of BMOO unit. (Nagl et al., 2003).

3 TEMPERATURE

Body temperature is an important parameter for assessing animal stress (Brown-Brandt et al., 2003),that is to say it warns for illness and diseases. However, obtaining data in the field is time and labor intensive, which speaks to the need for solutions that provide continuous and automatic acquisition of these parameters**.**

Attempts to measure body temperature of cattle have been made at various anatomical locations including rectum, ear (tympanic), vagina, reticulum-rumen, and udder (milk). Rumen temperatures have been demonstrated to be effective measures of core body (Prendiville et al., 2007).

The normal core body temperature of a healthy, resting cow is stated on average to be 101.5 degrees Fahrenheit (38.6 degrees Celsius). A cow's body temperature must be maintained within narrow limits in order to sustain its physiological processes. According tosome of the researcher findings the range is found to be 100 to 104 °F [37.8 °C to 40.0 °C]. (Pei Jun Chen – 1998).

Cattle body temperatures rise during the day rather than the animals spending energy to get rid of the heat. Minimum body temperature usually occurs early in the morning, then steadily increases during the day.

Body temperature rises in cattle infected with a disease-causing organism as the immune system begins to fight the infection. There are some untreated cattle which many overcome infection and recover, while others suffer elevated body temperatures and show other signs of illness.

4 COMMON DISEASES OF COWS

Perhaps the single most highly impacting condition affecting cow productivity is abortion, followed by performance-affecting or debilitating conditions such as internal parasites, lameness or footrot. In well-managed herds, clostridial or viral diseases causing systemic or respiratory distress are rare. However, conditions brought about by environmental stressors such as heat, drought, nitrate- or other toxin concentrating plants may be somewhat common.

4.1 Abortion

Several factors and organisms cause abortion at any point during the gestation period. Of particular interest are the effects of the Bovine Viral Diarrhea(BVD) virus on the fetus. When cows are infected early after fertilization, they may have reduced conception. Then, infection during the first four months of gestation may lead to embryonic death, abortion, growth retardation and persistent infection (PI-infected calves). Congenital malformations occur when the fetus is infected during month four to six of gestation. Fetal mummification, premature births and weak calves are also seen in fetal infection with BVD virus. Other conditions such as heat stress, exposure to toxins from forbs, and listeriosis also lead to abortions at any time during gestation. https://www.Diseases and Parasites of Cattle.

4.2 Parasites

Two main types of parasites cause performance losses in cows and calves.

4.2.1 Internal parasites

Often lead to reduced milk production and light weaning weights. Well-managed herds rely on timely dewormer applications to reduce impact of parasite loads on cattle performance. Fasciola hepatica and Fascioloides magna disrupt liver function and lead to weight loss and reduced weaning weights. https://www.Principles of Animal Diseases.

4.2.2 External parasites

Such as flies or ticks are also known to affect cow and calf performance. Abuse or misuse of specific insecticides may lead to development of resistance in affected insects. https://www.Principles of Animal Diseases.

4.3 Footrot

This condition is caused by a pathogen present in the soil, which infects the hoof tissue when conditions are right (wet, muddy conditions).

4.3 Wasting diseases

Both tuberculosis and Johne's disease are caused by bacteria of the same species (*Mycobacterium*),and both lead to reduced performance, overall wasting, and, in the case of tuberculosis, impacts on inter-state and international trade. https://www.Diseases and Parasites of Cattle.

5. CONTROL SYSTEM

Proper and timely identification of sick stockers helps minimize unnecessary treatment expense and preventable production losses.

Dairy pastoralists and veterinarians have used body temperatures, most commonly rectal temperatures, in detection and management of febrile disease and changes in the state of cows (estrus, heat stress, and onset of calving) for many years (Bewley & Schutz).

Although valuable for monitoring animals, core body temperatures are inherently difficult to obtain, and rectal temperature only approximates core body temperature.

Because restraining animals to manually collecting of rectal temperatures may cause stress that alters those temperatures, a reliable method with no human intervention is likely to provide a more accurate measure.

A GPS unit yields both animal location and movement data; with this, it is possible to see which fields in the ranch an animal (and therefore, a herd) is grazing and whether the animal movement patterns are limited or erratic, each of which can indicate disease. Various researchers have used GPS-enabled collars to track animal activity and derive state of health, with varying degrees of success.(Smith et al., 2006).

6 ADVANTAGES AND DISADVANTAGE OF WIRELESS NETWORKS

6.1 Advantages

- Network setups can be done without fixed infrastructure.
- Ideal for the non-reachable places such as across the sea, mountains, rural areas or deep forests.
- Flexible if there is ad hoc situation when additional workstation is required.
- Implementation cost is cheap.

6.2 Disadvantages

- It is not affordable for small farmers.
- Less secured because network hackers can enter the access point and get all the information.
- Lower speed compared to a wired network.
- More complex to configure than a wired network.
- Easily affected by surroundings (walls, microwave, and large distances due to signal attenuation).

7. CONCLUSION

Although some systems are developed in livestock industry for cattle monitoring, are still a problem in most ranches especially Tanzania ranches. In Tanzania ranches the systems used to monitor cattle core body temperature are digital thermometer and manual inspection and for location monitoring techniques, there are no method(s) to date.
Although valuable for monitoring animals, core body temperatures are inherently difficult to obtain, and rectal temperature only approximates core body temperature. Because restraining animals to manually collect rectal temperatures may cause stress that may in turn raise those temperatures, a reliable method with no human intervention is likely to provide a more accurate measure.
Due to above situations, there is a need for employing wireless sensor network(WSN) for core body temperature and location in the ranches since it is easily to install the system so that to improve cattle health and production. Additional benefits can be realized from this class of technology, such as the ability to identify the presence of disease early and as a result to prevent its spread.

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