



Abstract: The importance of Wireless Sensor Network (WSN) in today's technologically driven-life cannot be over emphasized, given its rapid enhancement in data transferring technique as well as having a wide range of application in environmental monitoring, intelligent traffic system geometrics. This research developed a multi-network cattle monitoring system using wireless sensor network to proffer solution to the challenge of cattle rustling that has bedeviled the country. The 'heartbeat' of this research is the distance sensors and the Global Positioning System (GPS) module attached to the cattles (nodes) in the herd. The master node, which bears the Global System for Mobile Communication (GSM) module of all the available networks. The distance sensors monitor the distance between the other nodes and the Global Positioning System (GPS) of the nodes as well and transmit same to the base station when queried or when a preset- conditions are violated. The nodes require power to transmit data to the base station. Dry cell and a mini photovoltaic system (PV) supply the power making it possible to access available information about the herd location from the base station at all-time using the network that has the highest signal strength. It was discovered that within a preset distance of 50 meters the communication within the herd was achieved which led to a decrease in the voltages of the nodes respectively and when a particular node goes out of the preset distance the voltage of that node did not decrease, hence a message was sent to the base station notifying it of the status of the herd. In this manner, the herd was protected, making it difficult to be rustled. A modular approach was used in this research. Each module was individually developed and everything coupled together to realize a functional prototype.

Keywords: WSN, GSM, cattle rustling, sensor nodes, Dry cell, PV system.

1. INTRODUCTION

Cattle rustling pose a serious security threat to the life and property of the people living in the Northwestern and middle belt region of Nigeria, and the use of Wireless Sensor Network (WSN) in combating the menace is faced with the challenges of battery lifetime and availability of constant mobile connectivity in transferring information about the location of cattle to the base station where analysis could be made and decision taken on when and where to deploy security personnel to recover the missing herd. The aim of the research study is to develop a multi-network cattle monitoring system against rustling using wireless sensor network.

The origin of the Wireless Sensor Network (WSN) concept is related to military applications and its appearance was motivated by the recent advances in Micro-Electro-Mechanical Systems (MEMS) area that has led to the production of low cost, low power and multifunction sensor nodes (Akyildiz *et al.*, 2012). In general, WSN concept concerns to a large number of inexpensive small sensing self-powered and communicate in a wireless way, with the final goal of delivering their data to a sink node.(i.e base station) which may be connected to other networks(e.g internet) (Puccinelli and Haenggi, 2005).

Kwong *et al.* (2011), made use of two analysis metrics in data communication requirement for agricultural livestock monitoring application using wireless sensor networks (WSNs), the two analysis metric are ; connection availability and duration which are used to quantify the impact of cattle movement on network connectivity.

Gutierrez *et al.* (2013), work on heterogeneous network mainly based on nodes that uses harvested energy to self energize the network, mostly kinetically powered, and is used for the localization of herds in grazing areas under extreme climatic condition. The network consists of secondary and primary node, the secondary node is powered by kinetic generator, take advantage of animal movements to broadcast unique identifiers, while the primary nodes are powered by battery.

Radio Frequency Identification (RFID) and Wireless Sensor Network (WSN) are both widely used technology in the present world, given their rapid enhancement in data transferring techniques as well as in size and range gives freedom for wide range of application.

Wireless sensor nodes have been used to optimize pasture utilization, monitor temperature changes and track an animal location (Guo *et al.*, 2007). The utilization of mobile wireless sensor nodes allows data collection for animal behavioral studies and will help prevent livestock theft as well as unnecessary loss due to environmental stresses.

Nkwari *et al.* (2015), combines Wi-Fi and ZigBee technologies in an application to monitor cattle, this combination has the potential to increase the range of the network when the animal herd is roaming out of range of the sink.

Cattle rustling has recently become a major internal security concern in Nigeria, with the country's northern region as the epicenter. Reports of bandits with automatic weapons storming herders' settlements and farms with the mission of