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Global Positioning System (GPS) for Animal tracking using Wireless Sensor Network (WSN).

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ABSTRACT: The importance of Wireless Sensor Network (WSN) and Global Positioning System (GPS) in today's technologically driven life cannot be over emphasized, given it rapid enhancement in data transferring technique as well as having a wide range of application in environmental monitoring , intelligent traffic system geometrics. This work developed an animal tracking system using GPS and WSN to proffer solution to the challenge of cattle rustling that has bedeviled the country. The 'heartbeat' of this work is the sensors attached to the animals (nodes) in the herd, it monitors the distance between the nodes. The master node, relays information (GPS coordinates of the animals) of the nodes on the field to the user node which is somewhere farther from the field using GSM (Global System for Mobile Communication). The master node transmit this information 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. In this manner, the herd is protected. A modular approach was used in this work. Each module was individually developed and later coupled together to realize a functional prototype.

KEYWORDS: Global Positioning System, Wireless Sensor Network, Animal tracking, sensor nodes, Dry cell, Photovoltaic system.

I. INTRODUCTION

A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes. The wireless protocol selected depends on application requirements. Some of the available standards include 2.4 GHz radios based on either IEEE 802.15.4 or IEEE 802.11 (Wi-Fi) standards or proprietary radios, which are usually 900 MHz (Puccinelli and Haenggi, 2005).The importance of using satellite to track a system is because of very low power that is needed of small transmitter that is attached to the animal (Yasuda and Arai, 2005). Nonetheless because the distance accuracy of Global Positioning System (GPS) receivers made it possible for researchers to carry out research in animal behavior to achieve huge success (Rempel et al .,1995). The GPS receiver needs a very large power, therefore it is better to study how to carry out research with bigger and larger animals that can withstand the battery weight (Cain et al. 2005; Loarie et al. 2009; Wark et al. 2009; Hebblewhite and Haydon 2010)

1.1 History of Global Positioning System

A Global Positioning System (GPS) is found in computers, cars and even mobile phones in todays world. It would have been difficult to locate someone or even get direction, if not for the help of a GPS. The application of GPS has gone beyond Military and research use but its application is broad and starts with space exploration.Sputnik 1 was launched into orbit by the soviet union in 1957, hoping that its exact location will not be known. However, Sputnik's radio transmission was investigated by William Guier and George Weiffenbach in United State.

Surprisingly it was realized that Sputniks location was tracked using Doppler effect of radio waves.This prompted the US navy's interest and, Guier and Weiffenbach were employed to produce the first satellite system known as TRANSIT which function is to provide location information once every one hour.The technology of the GPS was for the military alone until 1983, when Rnald Reanan directed that the technology be made available world wide to everyone even the civilian. In 1989 the first GPS was launched into orbit which contains 24 satellites that rotate in every 12 hours. The civilian GPS units started flooding the market one year later (Hulbert and French 2001).

1.2 History of Animal Global Positioning System (GPS) Tracking

Early animal tracking used VHF radio devices to monitor the movement and habitat use of wild animals (Cochran and Lord1963). In the late 1980s and early 1990s, the availability of satellite-based tracking provided researchers with animal location and movement data that had better spatial accuracy and temporal frequency than radio-tracking systems (Fancy et al. 1988; Harrington and Veitch 1992; Foster 1993; Rempel et al. 1995). Satellite tracking systemsnorporated data loggers, enabling a larger number of location points to be collected automatically, without the need for researchers to spend long periods of time physically tracking animals (Hulbert and French 2001).

1.3 Problem Statement.

Animal theft 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) and Global Positioning System in combating the menace is timely.

1.4 Aim and Objectives

The aim of this work is to develop an animal tracking system against theft using wireless sensor networks (WSN) and Global Positioning System (GPS) To achieve this aim, the following specific objectives are set.

i. To design an animal tracking system using wireless sensor node capable of detecting location
ii. To design an adaptive communication link between the herd and the base station
iii. Using the extracted coordinates from the GPS to develop a map using Google Earth Application installed on a personal Computer.

II. MATERIALS AND METHODS

The system is made up of a master node or relay node, four slave nodes and User node.

2.1 Master or Relay Node

The relay or master node is one of the components of the wireless sensor network, it is made up of power supply unit, programmable microcontroller chip, GPS communication module, four GSM modules and RF transceiver module.

2.2 Power Supply Unit

The power supply is made up of a solar PV for charging the 3.7V,500mAh LIPO battery used as backup, a LIPO charging system, voltage regulator system of 5V DC at 2.0A.This power source was used due to it portability and efficiency in providing the needed energy for the system. In the course of implementing this research work, many energy saving strategies (such as sending information in batches not continuously, idle mode activation for none working GSM module) were considered in order to increase the life span of the nodes.

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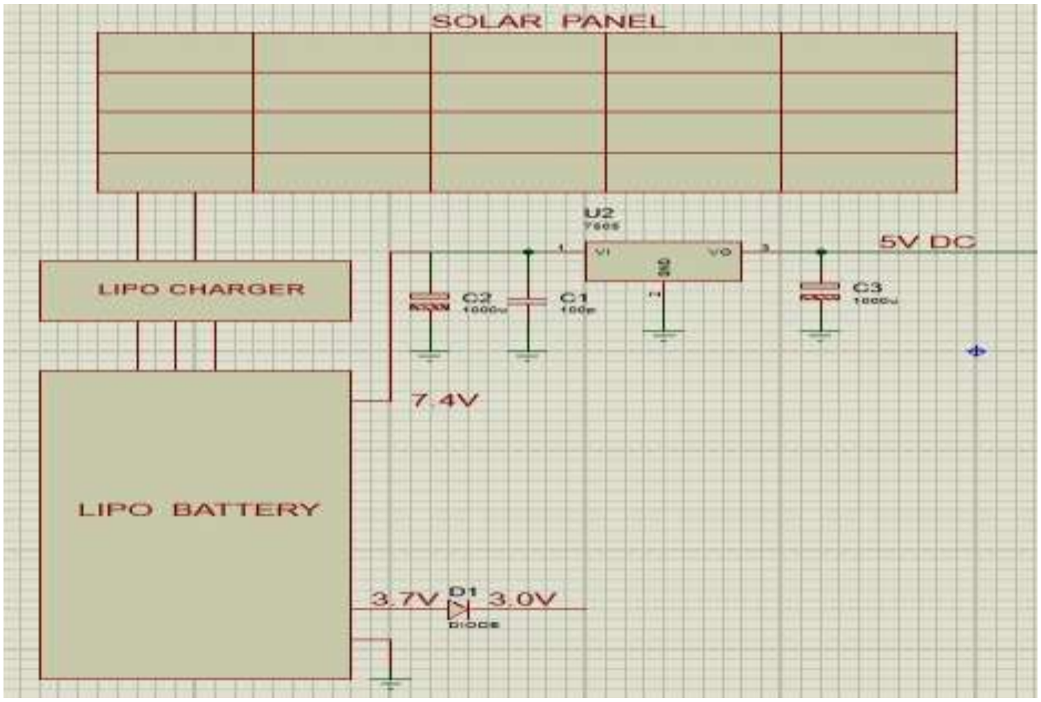

Figure 1: Proteus Implementation of the Power Supply Unit

2.3 Microcontroller Unit

The microcontroller used in this research work was ATmega328p programmable controller chip with a Power-ON reset configuration of resistor and capacitor in case of power instability. The chip is programmed in C++ programming language and when it received signals from the modules (RF, GSM, and GPS) for monitoring process and executes command based on the processed information.

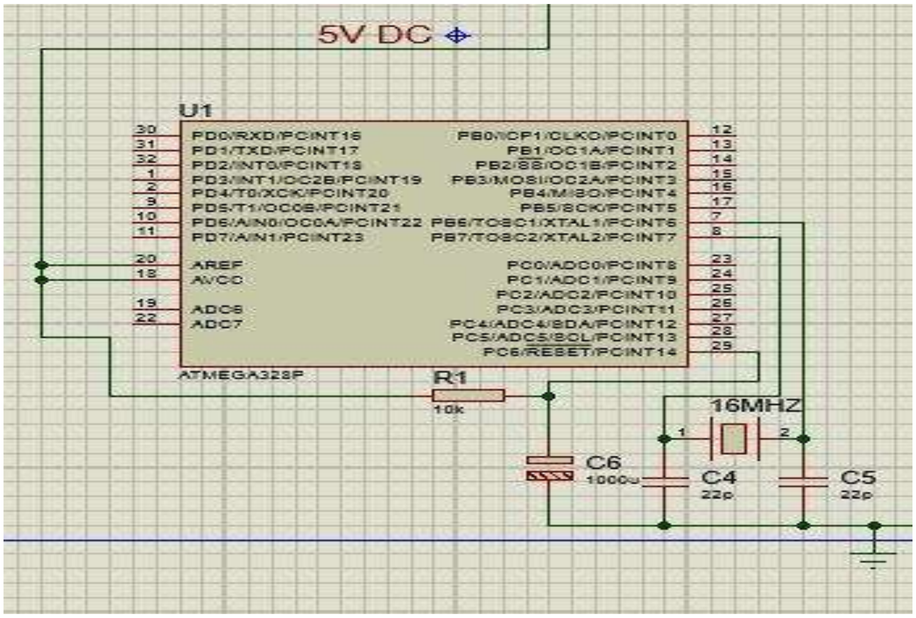

Figure 2: Proteus Implementation of MCU Configuration

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2.4 GPS Module

GPS module was interfaced with the microcontroller in order to get the geographical information (position coordinates) of the system at every instance of time. The GPS modem have the capability of communicating with the satellite system positioned in the sky using line of sight communication principle to extracts information after every second of time.

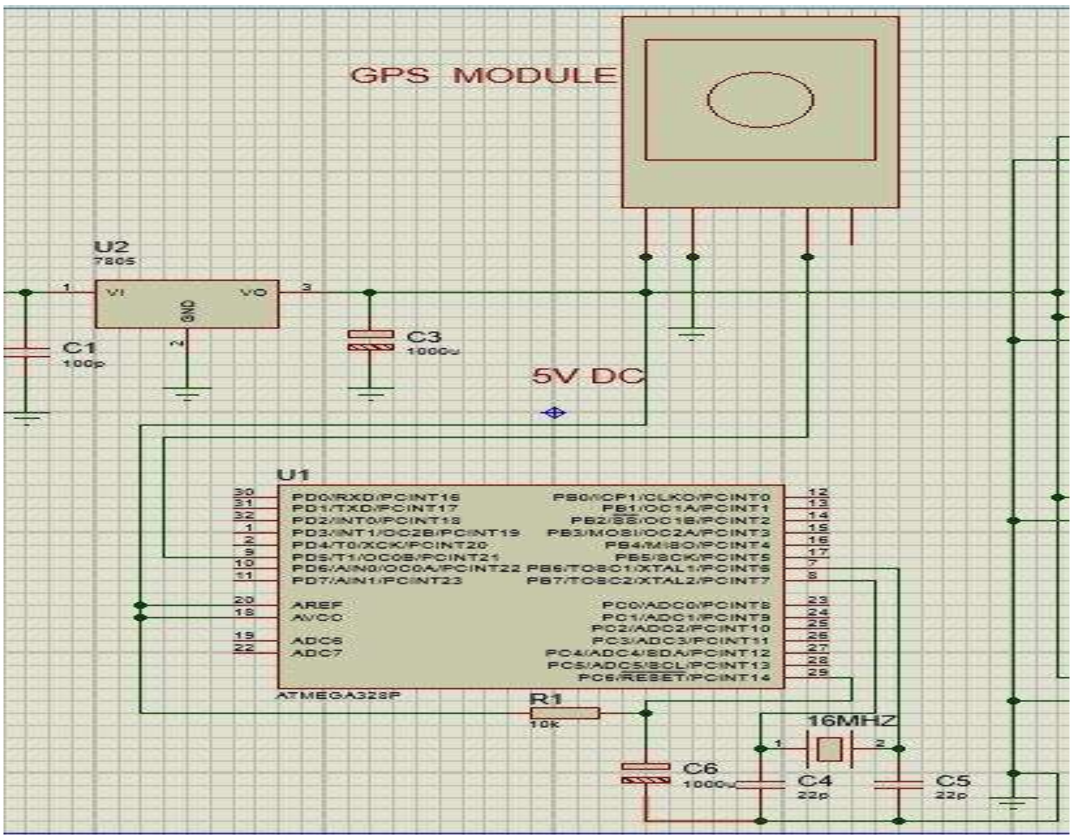

Figure 3: GPS Module Interfacing with MCU

2.5 RF Transceiver

The Radio Frequency (RF) transceiver is use to transmit and receive signal in form of radio signal over predefined distance between two devices. The RF module was chosen due to it portability in size, functionality as the case of high frequency band of up to 2400MHz and low energy consumption. RF communications help in short range data transfer between nodes in the WSN. Figure 2.4 showed the connection of the RF module to the MCU.

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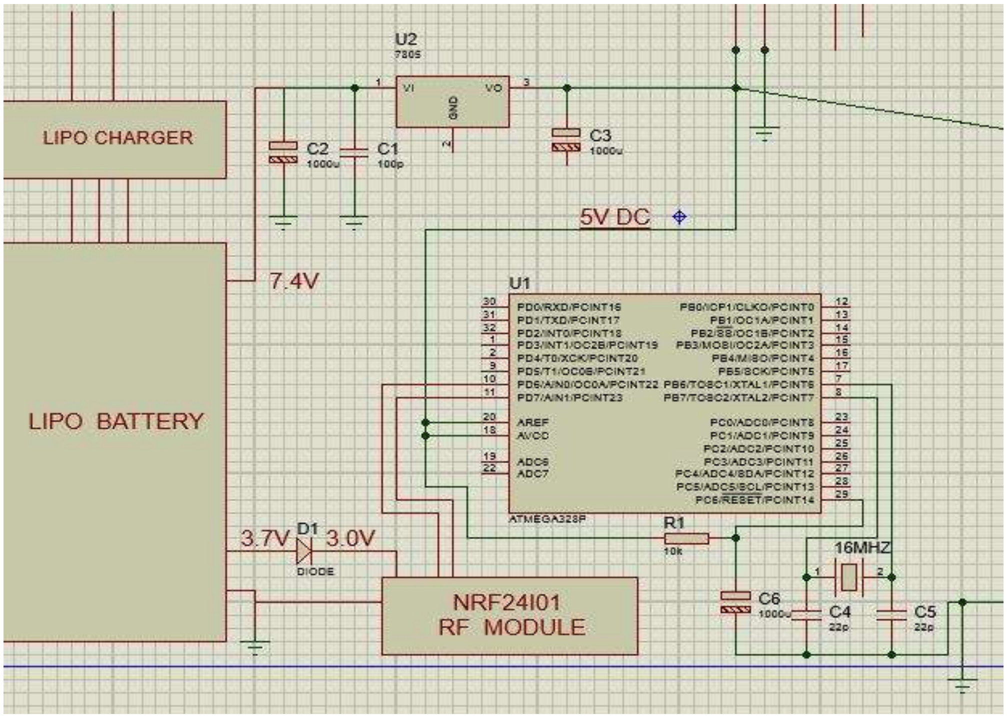

Figure 4: Interfacing of RF Module with MCU

The complete circuitry connection of the components that made up the master node is given in Figure 5

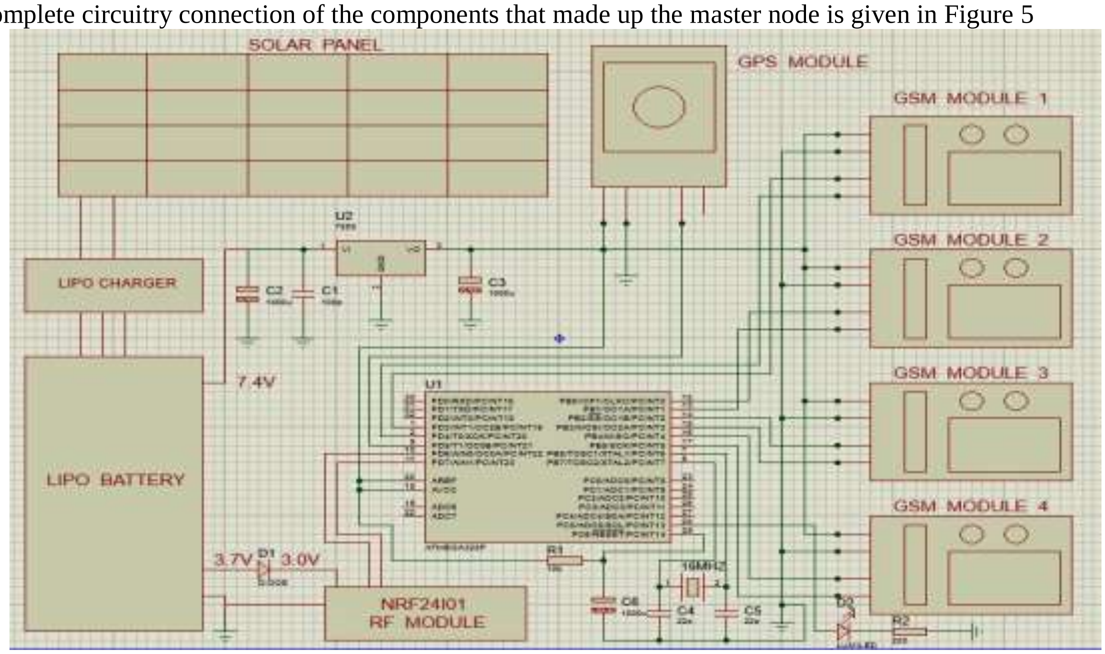

Figure 5: Complete Circuit of the Master Node

2.6 Slave Nodes

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The slave nodes are four in numbers and each have similar configuration with the master node but with the exception of the GSM modules. ATmega328p microcontroller was used as the brain chip for processing and execution of the tasks in the slave node. Receiver and transmitter terminals of the GPS module were connected to interrupt pin 0 and 1 of the microcontroller port while RF module transmitter and receiver terminals were connected to interrupt pins 22 & 23 respectively.

2.7 Complete Circuit Implementation of the Slave Node

In figure .6, the components which made up the slave nodes and how they interact with each other is shown.

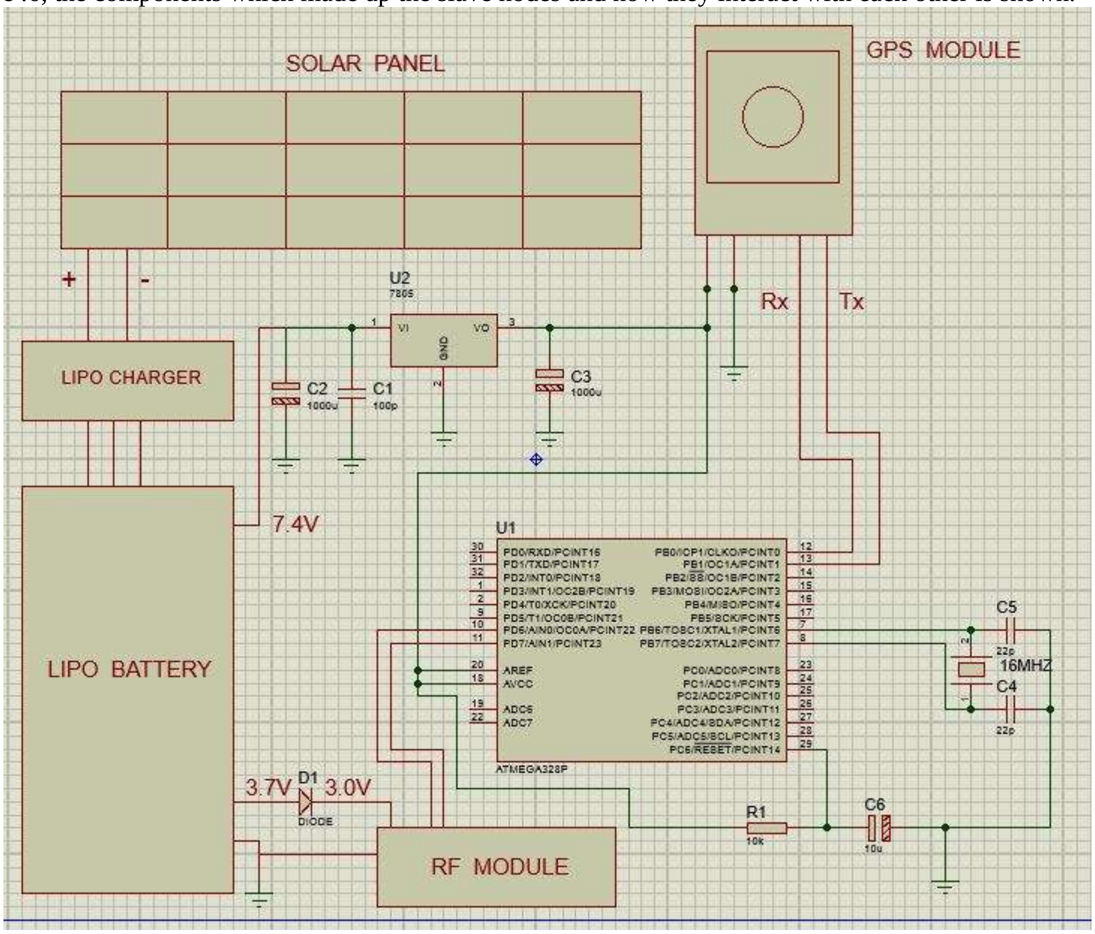

Figure 6: Complete Circuitry of the Slave Node.

2.8 User Node

The user node is made up of the mobile phone enabled with the capability of receiving SMS message containing data. Mobility of this node make it more efficient and effective means of acquiring nodes information at any instance of time and from any location on the globe.

III. RESULTS AND DISCUSSION

3.0 Extracted Position Coodinates from the GPS.

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Table 1Nodes Position Coordinates

Time	Query Command	Master		Slave1		Slave 2		Slave 3		Slave 4	
		Latitude	Longitude	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
10:23 AM	What are your locations?	96^{0}12”09’	65^{0}66”14’	96^{0}12”09’	65^{0}66”14’	96^{0}12”09’	65^{0}66”14’	96^{0}12”09’	65^{0}66”14’	96^{0}12”09’	65^{0}66”14’
12:53PM	What are your locations?	96^{0}12”04’	65^{0}66”14’	96^{0}12”11’	65^{0}66”15’	96^{0}12”06’	65^{0}66”15’	96^{0}12”09’	65^{0}66”15’	96^{0}12”08’	65^{0}66”12’
3:09PM	What are your locations?	96^{0}12”08’	65^{0}66”12’	96^{0}12”05’	65^{0}66”15’	96^{0}12”17’	65^{0}66”16’	96^{0}12”04’	65^{0}66”18’	96^{0}12”04’	65^{0}66”14’
5:47PM	What are your locations?	96^{0}12”09’	65^{0}66”15’	96^{0}12”11’	65^{0}66”14’	96^{0}12”04’	65^{0}66”16’	96^{0}12”07’	65^{0}66”17’	96^{0}12”05’	65^{0}66”15’

3.2 Position Visualization.
The extracted positions coordinates given in Table 1 were used to develop a map using Google Earth application installed on a personal computer system.

In Figure 7, it can be seen that all the animals were grazing in close distance between themselves with the master node being in the middle of the four slave nodes.

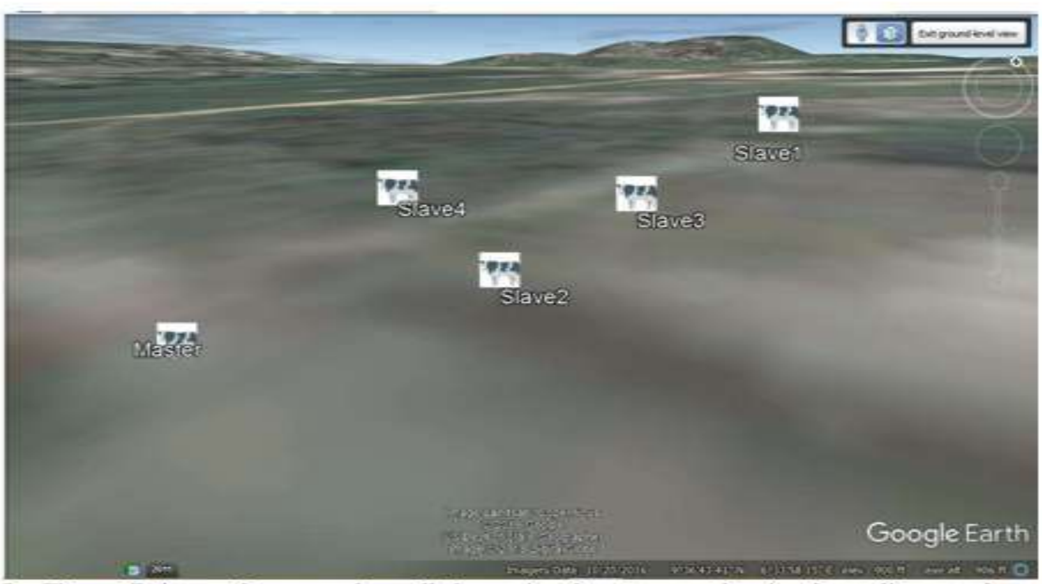

Figure 7: Visual Map of the Nodes at time 05:47pm

IV. CONCLUSION AND RECOMMENDATION.

4.1 Conclusion

In this research work we have been able to track animal movement by using WSN & GPS that is capable of detecting location. A visual map of the animals location was achieved through the use of google earth application installed on a personal computer (PC). The developed system architecture is such that the nodes (animals) can communicate with each other just like in a mesh topology and the master node keep track the information so as to prompt the user node whenever the conditions of tracking is violated.

4.2 Recommendation.

- A portable and more efficient source of energy for the WSN should be considered.
- Real time visualization system can be incorporated into the system

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