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Forest Boundary Alert System for Animal Using RFID Collar System

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Abstract—An electronic containment system using positional satellites is provided for controlling the movement of animals relative to a selected confinement area. A portable programming transceiver is used to program the boundary of a selected confinement area as the device is moved along such boundary. A programmable collar transceiver worn by the animal provides GPS signals from the satellite to a remotely located control station. The control station tracks the movement of the animal relative to the boundary. If the animal crosses the boundary, the station transmits a stimulus activation signal to the collar so that a corrective stimulus may be produced for the animal. Tracking and containment of objects are accomplished by providing GPS-defined, user-programmable containment areas.

Key Words: Jordan Curve Theorem, GPS- Global Positioning System,

I. INTRODUCTION

A new approach to wildlife tracking using heterogeneous wireless networks is being presented here. In particular, the diversity of the animal kingdom is exploited in order that both small and large animals can be tracked and monitored using the same system. This research presents the design of a system that can acquire information from a wide range of sensors (not necessarily attached to animals) and deliver it to an end user. The thread that runs through this thesis is that of adaption to provide resilience in an uncertain and dynamic environment.

Wildlife tracking [1] involves acquiring information about the behavior of animals in their natural habitat. This information is used both for scientific and conservation purposes. The primary form of information that needs to be obtained is the location of the animal at certain points in time and this is generally referred to as tracking or radio–tracking. Other forms of information such as physiological parameters (for example: heart rate, body temperature, vaginal temperature) or activity (for example head tilt or defecation) can be acquired and this is referred to as telemetry. However, due to the similarities in obtaining the information, the terms are frequently used interchangeably. Essentially, tracking involves determining where an animal is, and telemetry refers to recording data that can be used to infer its activity at certain points in time.

For the most part, due to the difficulties in locating a biological entity over large areas, the creature is augmented with a tracking device (generally electronic). There are remote methods that can be used to track and identify animals visually and through acoustic signals. The drawback of these methods is that they are only suitable for some species and their detection range is limited. However, as they do not involve disturbance to the animal, they are an attractive option in the situations where they can be used.

II. LITERATURE SURVEY

The detection of animals is required in various fields of real life applications. As an example hundreds of camel-vehicle accidents were reported every year causing numerous deaths and loss of property running into millions of Saudi Riyals. To address this problem, a deployable and intelligent Camel Vehicle Accident Avoidance System (CVAAS) was designed using global positioning system technology [3]. M. S. Zahrani and C. Jiu Wang developed an algorithm for light detection and ranging (LIDAR) data to enable fisherman tond the right location of fishes in deep sea[5]. For maintaining human safety and security by detecting possible dangerous animal intrusions into the residential area, D. Tahmoush and J. Silvious used micro-Doppler signals[6]. The tracking of animals is important for monitoring or observing the locomotive behavior of animals and its surroundings. The S. H. Kim and D. H. Kim developed zoological systems for tracing an animal, identification, and anti-theft for the management and security of animal in zoo with the help of sensor, radio-frequency identification (RFID), and global positioning system (GPS)[7]. By tracking and observing the animal movements, it helps us to have a better understanding on how an animal behaves and interacts with its environment. The identification of animals is very important in identifying the targeted animal and its behavior. Identification of animals helps human being to monitor and manage animals easier. J. S. L. Ting and W. B. Lee designed and developed RFID-based mobile monitoring system for better management of animals in dynamic information retrieving, location tracking and to help users over a wireless network[8].

III. METHODOLOGY

As shown in block diagram, this system consists of three blocks which are Collar, Booster and Base station. Collar part or block is based on its location and work. So Collar part is on the animal's neck and along with part GPS device is attached. Another block is booster circuit, this part is to boost the signal which are transmitted by collar part and send to the Base station block.

This project aim is to stop animal from crossing the boundary and track the animal at any time as we need. The whole system block diagram as shown in fig-1.

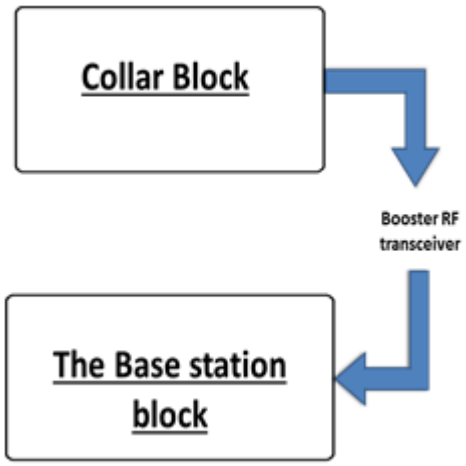

Fig-1 Block diagram

a. Collar part block

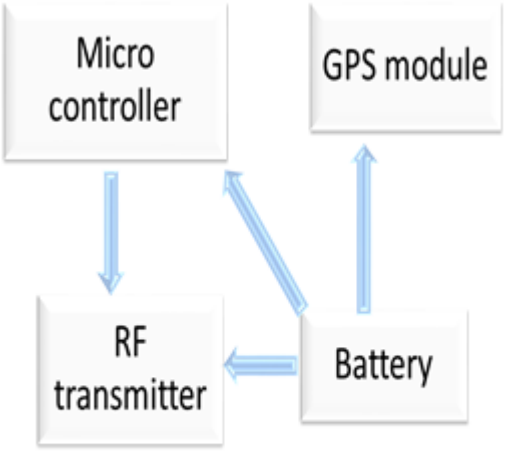

Fig-2 Collar part Block diagram

The Collar part block is sown in fig-2. In this part GPS receiver, microcontroller, RF transmitter is included along with battery the heart of this part because the main power supply given to all component. GPS get the location from satellite and this location is given to the controller. Controller transmits this data through the RF transmitter. This data is in form of latitude and longitude. In this side no process on data is done.

b. Booster part

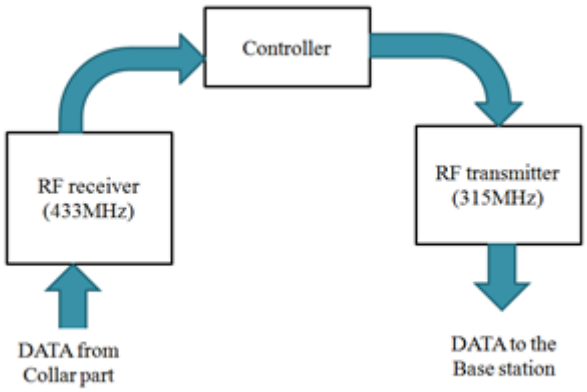

Fig-3 Booster Block diagram

The Booster circuit is used for sending the data to the longer distance. We use RF module in this project but the RF range is very low about 100m there for we put the booster part in this project. By this part we overcome the distance problem. In this part we use two different frequency RF transmitter and receiver so they don't interfere in between.

c. Base station block

This portion is working like movable or non movable device, this portion is the setup of the controller, PC and RF receiver. Transmitted data by booster part is received in this portion of the project. This received data process by the processor and stored in the PC. Then we manually plot the data on map using the software. The process on data means the data compare to the decided boundary for checking the animal is inside the boundary or not. If the animal is outside the boundary then the alert system is made on.

IV. WORKING

a. Algorithm

- The collar part is always kept active.
- Controller turns on the whole system i.e. GPS, RF, sensor.
- GPS gives the reading of longitude and latitude to the controller. The first reading of GPS is saved in the system as a reference of current position of animal.
- Now there are two possibilities of occurrence of any unusual activities. First is when there is precious change in the position of animal, the reading of GPS will not match with the reference reading i.e. the animal is misplaced from the original position. Second is when the proximity sensor sense any object.
- Jordan Curve Theorem shown in fig-5 illustrates how to detect the animal weather it is outside the boundary or not using the controller code in the base station side.
- In both of these conditions, the controller will send an alert message to the predefined mobile number i.e. mobile number of forest department. Forest department will also be sent the reading of GPS so it would be helpful to track the animal.
- If any problem occurs in the system, there is the switch of the master reset to reset the system.

b. Jordan Curve Theorem[2]

Calculating whenever a point is inside a polygon can sometimes be a hard and costly calculation. This article describes a quite cheap solution to calculate whenever a point is inside any closed polygon. In an open polygon it's hard to determine whether it is inside and outside the polygon. So naturally it won't work in that case.

The Jordan Curve Theorem states that a point is inside a polygon if the number of crossings from an arbitrary direction is odd. An image explains more than a thousand words so let’s take a look at the picture.

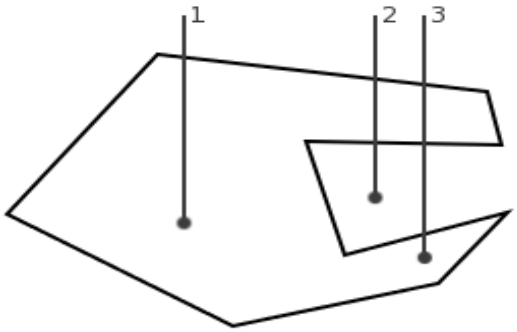

Fig 5- Jordan Curve Theorem

As you can see point 1 and 3 is inside the polygon but point 2 isn't. Follow the rays from each point and count each time you cross a line-segment. In this article only working with 2D polygons but it can easily used in a 3D-environment.

As a first step, if the ray is along y-axis, check if the point x-coordinate is between the two points connecting the line. If not it don't cross it either. You can also check if the y-coordinate is above both points. The next step is to find the equation of the line. The equation of a straight line is $y = kx + m$(Swedish notation). The slope is $k = \frac{\Delta y}{\Delta x}$ and offset is $m = y - kx$. Now, insert the x-coordinate of the point into the equation. If the result is larger than the y-coordinate the ray does not cross the line-segment. This is how we can locate the position of animal using the Jordan Curve Theorem and RFID Collar system.

CONCLUSION

Wildlife tracking using wireless networks has become recently possible due to the increasing miniaturisation of electronic technology. This has allowed wildlife tracking collars to form multi-hop networks to transfer information from the field to the end-user. This is a new way of being able to track and monitor animals automatically. However, research to date has concentrated on incrementing a single species of interest, resulting in a homogeneous (single tag design) solution. Zebra Net and Turtle Net placed GPS enabled wireless devices on zebras and turtles respectively. However, in both Zebra Net and Turtle Net, only one type of device was designed. However, their devices are only suitable for attachment to larger animals, thus limiting their deployment scope to a section of the Animal Kingdom.

The contribution of this work is to design wireless network that binds together two different technologies and unifies them into a single data gathering system, that allows both small and large animals to be monitored. Thus, a heterogeneous solution (multiple classes of tags differentiated according to size, weight and functionality) was proposed, which led to interesting research both in the system design and with regards to network management and discovery. This research did not solely focus on the network and communications design, but also considered how to intelligently sense data as well. To validate the research approach, real world testing was undertaken using custom designed wireless sensor tags.

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