International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 4 Issue: 5 543 - 545

Migratory Birds Tracking System using RF as Communication Medium and Android Mobile Base Station

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***Abstract*—**This project aims to develop an Asset Tracking System and specifically focuses on tracking migration patterns of birds found in and around the Indian subcontinent. The important challenges in developing such a system are reducing the size of the tracker, optimizing battery usage and tracking birds without recapturing them. The main aim of this system is to encourage crowd sourcing and lower the commercial cost for ornithologists and research purposes in academia. We plan to use RF medium for efficient data transmission (geolocation, temperature, speed, etc). This data can be analyzed and can be used by ornithologists for behavioral study of birds.

Keywords*—Radio Frequency, Embedded System, Bio-logger, Migration, Location tracking, Mobile Application, Web Application, Crowd Sourcing*

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I. INTRODUCTION

Birds play an important role in the natural ecosystem. Taking into consideration our current environmental changes and rapid industrial encroachment, it has become mandatory to conserve our flora and fauna. Many bird species have been affected and some are on the verge of extinction.

The Indian vulture and the white-rumped vulture species have suffered a 99%–97% population decrease in Bangladesh, Pakistan and India[1]. Other than the usual reasons there were other factors which influenced the decline of these bird species which were largely unknown. Thus it has become essential to monitor their movements continuously to gain more insights into these factors.

Numerous bird species migrate to certain areas during specific seasons every year. These birds are sighted at particular locations but their routes of migration remain largely unknown. As compared to other animals, tracking birds is a difficult task as there are stringent tracker constraints like size, weight and power source. It is also extremely difficult to recapture birds for data retrieval.

We propose a system which will monitor these migratory birds and which will eliminate the need for bird recapture. Usually bird tracking systems have receiving base stations established at popular birding sites. These base stations require substantial investments to set up thereby increasing the system cost. We propose to eliminate the need for fixed base stations by substituting them with mobile transceiver units pluggable into mobile phones. These low cost and small size transceiver units will enable environmentalists, wildlife photographers and bird enthusiasts to actively use these units increasing crowd participation, expanding the reception areas other than the usual birding sites. This paper focusses on building a low cost bird tracking system using RF medium for communication with android devices acting as base stations along with a central cloud database. The system comprises of: bird tracker device, transceiver unit attached to the mobile phone, Android application and a Web application.

II. EXISTING TECHNOLOGIES

UvA Bird Tracking System:

Developed at the University of Amsterdam, this is a bird tracking system[3] characterized by light weight, solar-powered, high energy efficient GPS-devices, with two way wireless ZigBee (2.4 GHz) data communication to a groundstation network. The system consists of one base-station, one or more relay station(s) on the ground and (many) GPS devices in the sky. The base-station is the system coordinator and holds the data-collecting computer. The relay stations are important signal repeaters. Together with the base it establishes the area of reception. The groundstation network is initialized and controlled by the base. The energy supply is achieved by a solar panel, charging unit and battery.

The GPS tracker weighs 12 g and includes a GPS receiver, micro-processor, 4 MB of memory for data storage, solar panel and battery. It has a tri-axial accelerometer to monitor behaviour. To maximize flexibility, it is equipped with a radio transceiver for bidirectional communication with a ground-based antenna network, which enables data to be downloaded and new measurement schemes to be uploaded remotely.

Pinpoint GPS Datalogger:

PinPoint GPS series has opened up new opportunities for obtaining accurate locations from smaller creatures. These store-on-board GPS tags need to be retrieved to download the data` which keeps them tiny and can last months despite their small size[5]. Can find out birds weighing less than 50g migrate to (PinPoint-10), or collect home ranges of 70g birds without the effort and inaccuracy of radio-tracking triangulation (PinPoint-50). Models can be scheduled, downloaded and recharged from the same interface. Scheduling is extremely

flexible with the possibility for daily schedules, fixed intervals or even individual times on specific days. Up to 50 fix attempts, flexible programming, more accuracy then Geolocation and rechargeable for repeat deployments are some of the benefits.

Intigeo® series geolocator:

Developed at Migrate Technology Ltd, Intigeo is a miniature archival logger capable of recording near full range ambient light with complementing temperature and conductivity indicators allowing location tracking and behavioral studies of far ranging animals[6]. Intigeo loggers must be retrieved to obtain recorded data. Using the threshold level geolocation method, primary tracking data can be derived from the identification of sunrise and sunset events in the light record enabling latitude and longitude calculation twice daily. There are various models having battery life ranging from 9 months to 5 years. However, the internal memory may fill before the batteries expire depending on the mode selected at start of logging and the behaviour of the bird. Intigeo range has been designed with glitch recovery technology so that if an unpredictable source of electrical interference occurs (e.g. a lightning strike or high power radio transmitter), the internal logging computer has the best chance of continuing the recording, rather than resetting or crashing.

III. Proposed Application

We propose a low cost bird tracking system which will use RF medium for communication and Android phones as the transmission unit between the tracker and the cloud database. The proposed system eliminates the need for fixed base stations which are replaced by mobile transceiver units pluggable into Android phones. This system comprises of four modules: a tracking device mounted on the bird, mobile transceiver unit attached to the Android phone, Android application and a Web application.

Tracker Device:

The tracker device mounted on the bird includes a GPS sensor, microcontroller, power source (DC battery and solar panel), memory and an RF transceiver.

Mobile Transceiver:

The transceiver module is used to transfer data between the Android device and the bird tracker. It includes an RF transceiver and a UART to USB component which enables it to be connected to the mobile phone.

Android App:

The Android app is used to download data from the tracker device and upload it to the cloud database.

Web App:

The web app is used to view the migration routes and patterns of required bird species in a Google Maps interface.

IV. Project Requirements

Hardware Requirements:

The project would require a location sensor (Quectel L80) to get the location fix, RF transceiver (TI CC1101) for sending and receiving data, microcontroller (Arduino Pro-Mini) for location logging and data transmission, Android phone with OTG support and a power source (DC batteries and solar panel).

Software Requirements:

The Windows and Mac operating systems are used for development and testing purposes along with Android OS for the mobile app. The IDEs used are: Android Studio for the app development, ArduinoCC for the firmware coding and any suitable IDE for web development. The Firebase database service is used as the third party cloud storage for the project.

V. Design Description

As stated in section III, the system has four modules namely tracker, transceiver, mobile app and web app (Figure 1). The tracker operates on a periodic wake-up cycle. The sensors in the tracker collect the geo-location, orientation and temperature data and store it in the form of records in the tracker memory (EEPROM). The mobile app generates and broadcasts requests through the transceiver to connect to the closest tracker in the vicinity. After successfully establishing a connection, the data records from the tracker are received by the transceiver and then transmitted to the app in the mobile device via UART-to-USB. Upon availability of mobile networks, the app pushes all its data to the cloud server. The web app takes user queries as the input, fetches data as per the query and displays the result in the form of migration routes on the Google maps interface.

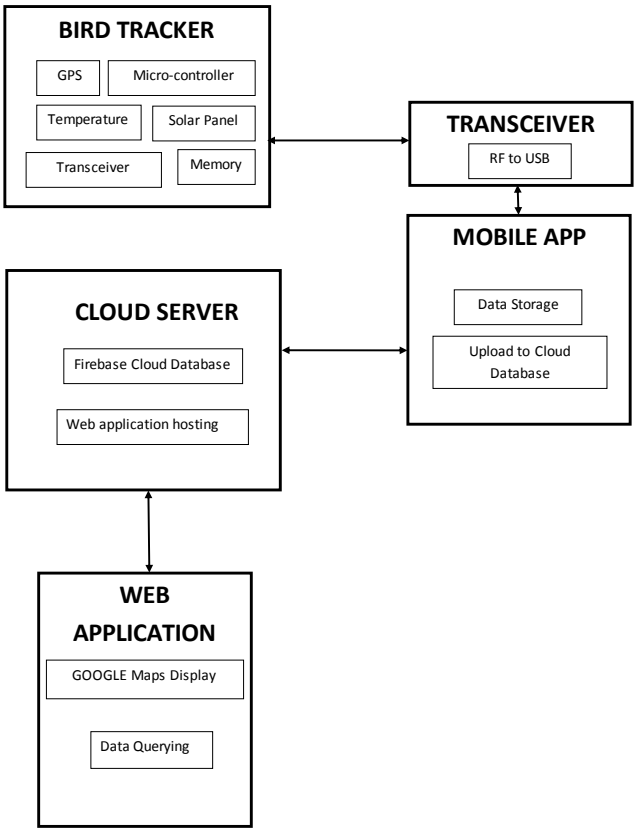

Fig. 1. System Architecture

VI. User Interface

The mobile app (Figure 2) consists of four activities: login activity, registration activity, device list activity and the console activity. The user interface is built using XML in Android Studio.

The web app (Figure 3) consists of the login/signup page, the user profile page and the Google map interface page. The UI of the web app is built using the basic web technologies along with AngularJS and Bootstrap.

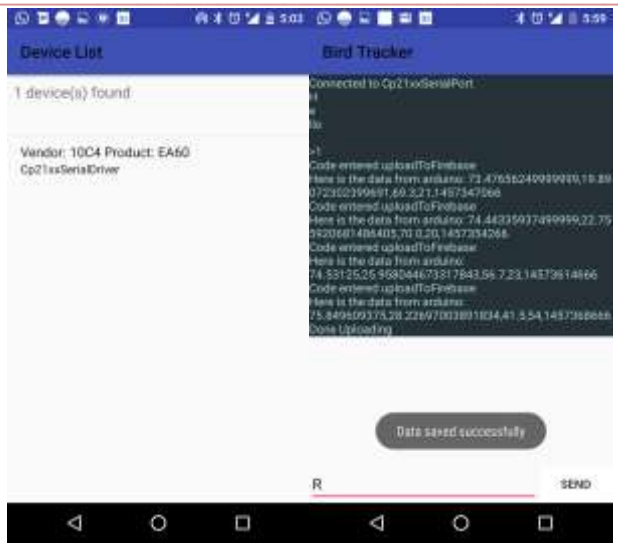

Fig. 2. Sample prototype of the mobile app

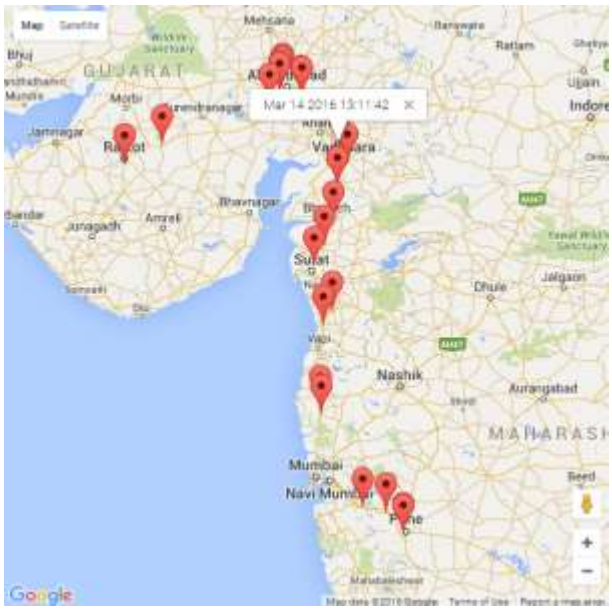

Fig. 3. Sample prototype of the web app display

VII. Conclusion

In recent times, there has been increasing research going on in the field of Ornithology with the help of bird trackers across the globe. Many techniques such as ringing, satellite monitoring and manual observations are still used. However they prove to be inefficient; the need to recapture birds remains. Improvements to traditional technologies, such as satellite tracking, along with innovations related to global positioning systems, cellular networks, solar geolocation, radar, and information technology are improving our understanding of when and where birds go during their annual cycles and informing numerous scientific disciplines, including evolutionary biology, population ecology, and global change[7]. There are systems developed which use smart trackers in some developed countries, however the cost to implement such a system is very steep. By substituting fixed receiving base stations with mobile transceivers pluggable into Android mobile phones we aim to reduce the initial investment of setting up the system. With such mobile transceivers units which could be purchased off the shelf enabling bird enthusiasts from varied backgrounds to participate and contribute to the system. We propose a smart bird tracking system whose cost would be affordable to ornithologists and bird enthusiasts in India. With increasing crowd participation, the reception area could be expanded so that data could be fetched from unconventional birding locations as well. We hope to create an infrastructure so as to encourage better research and crowd participation in the field of Ornithology.

This tracking system can be used to track various other assets such as luggage, vehicles, hospital equipment with slight modifications to the system and using various other communication media such as WiFi, ZigBee, Bluetooth and cellular networks.

Acknowledgment

The authors acknowledge the continuous support and guidance of Mr. Anant Gokhale and Prof. Mrs. Shilpa Sonawani. The authors would also like to thank the Dept of Computer Engineering, MIT, Pune for providing the opportunity and the infrastructure to work on the project.

References

[1] Indian vulture - Wikipedia, the free encyclopedia https://en.wikipedia.org/wiki/Indian_vulture
[2] Indian Vulture Crisis https://en.wikipedia.org/wiki/Indian_vulture_crisis
[3] UvA Birdtracking System http://www.uva-bits.nl/
[4] Willem Bouten, Edwin W. Baaij et al. “A flexible GPS tracking system for studying bird behaviour at multiple scales”, Springer, J Ornithol (2013) 154:571–580 DOI 10.1007/s10336-012-0908-1
[5] Pinpoint GPS Datalogger by SIRTRACK http://www.sirtrack.co.nz/images/pdfs/Pinpoint_GPS_Datalogger.pdf
[6] Intigeo® series geolocator http://www.migratetech.co.uk/IntigeoSummary.pdf
[7] Eli S. Bridge, Kasper Thorup et al. “Technology on the Move: Recent and Forthcoming Innovations for Tracking Migratory Birds”, BioScience, September 2011 / Vol. 61 No. 9