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Tracking Wildlife Counts Using the Internet Of Things

Matthew Bell[1]

BSc Computer Science

Supervisor: Dr Kevin Bryson

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Abstract

Conservation experts, park rangers, and biologists frequently aim to try to track the location and count of various species of animals. This is, more often than not, extremely time consuming, since researchers have to install camera traps with motion sensing shutters, and manually look back through images to identify and count the animals.

This project and report explores the possibility of using a low-power computer with sensors, connected to a web server over a wireless Internet connection (a paradigm frequently referred to as *The Internet Of Things*) to automate this task to save researchers hours of time when conducting studies using camera traps.

The project also explores various methods in which species of animals could be identified automatically, given various constraints of how the system can work, including the availability and speed of the network link.

Contents

Chapter 1

Introduction and background

1.1 Motivation and need

Wildlife conservation experts constantly need to keep track of the location and movements of wildlife for a number of reasons, including monitoring species migration patterns and population counts [2]. Other options exist, like line transect surveys (counting animals or traces of animals, like tracks and droppings) or track surveys (physically visiting the area and counting animals); but in the comparison study by Silveira et al [4], they found that camera traps, despite their longer initial setup time and cost, "can be handled more easily and with relatively [lower] costs in a long term run".

Based on this, it would be logical to assume that running costs and analysis time could be reduced further by automating the classification of photos taken by camera traps and sending the results back to a cloud server. This would enable research teams to store, access, analyse and visualise wildlife counts with ease, using an Application Programming Interface (API) provided by the web service.

The biggest advantage of automating the classification stage of camera trap studies is that it would save a lot of time after the main study has ended, and results can be analysed as soon as possible.

1.2 Requirements

A list of requirements for the solution were reasonably easy to devise. Most of the requirements are defined by the limits of the environments where this system may be deployed, such as woodlands, grasslands, and national parks.

Most of the locations where this solution could be deployed may have very limited cell network coverage, and definitely would not have WiFi connectivity available. Therefore, the system would have to use LoRaWAN, which has a theoretical range of up to twenty kilometres. However, the lower data rate of LoRaWAN means that photos captured by the camera traps would not be able to be sent back to a web server, so any kind of image processing and classification would have to be performed on-device.

Another limitation is the devices being used for the project. The main “base station” device is the Creator Ci40 developer board, designed to “allow developers to rapidly create connected products” [3]. This ability to rapidly prototype on the board, which has a MIPS-based processor and runs the OpenWRT Linux distribution. It also contains a WiFi radio, useful for communicating with the device and debugging code on it during development, and a 6LoWPAN radio, useful for communicating with nearby devices.

The sensor devices were also provided as part of the project. They consist of each sensor board integrated onto a *MikroElektronika* 6LoWPAN clicker board [1]. This board runs a Real-Time Operating System (RTOS), which allows the board to respond very quickly to changes in sensor input, as well as the ability to be battery powered and the inclusion of a 6LoWPAN radio, to communicate with the base station.

Another requirement arising from the intended deployment scenario is that the system needs to be able to run on battery power, or indeed a low-voltage power source, for a considerable amount of time. The intention of the project is to reduce long-term study costs, and a need to replace sensor batteries regularly would be failing this. Consequently, the system would have to rely on hardware interrupts as much as possible, so that the devices can remain in a “sleep mode” when they are not needed.

1.3 Initial research and similar problems

Chapter 2

Design

2.1 System Architecture

2.1.1 Base Station

As previously mentioned in the requirements, the base station is a *Creator Ci40 IoT Hub* device [3].

2.1.2 Motion Detection Sensor

2.1.3 Camera Sensor

2.1.4 Cloud Server

Chapter 3

Implementation and Testing

Chapter 4

Conclusion

Appendix A
Glossaries

Glossary

Symbols

6LoWPAN Short-range wireless data transmission standard. Short for “IPv6 over LOw Power Wireless Personal Area Networks”; alternative to protocols like Bluetooth and Zigbee. 3

L

LoRaWAN Wireless data transmission standard designed for long range communication at low power, at the cost of a lower data transmission rate. 2

Acronyms

A

API Application Programming Interface. 2

M

MIPS Multiprocessor without Interlocked Pipeline Stages, a type of processor architecture. 3

R

RTOS Real-Time Operating System. 3

Appendix B

Bibliography

[1] MikroElektronika d.o.o. *6LoWPAN clicker - a compact development board | MikroElektronika.* URL: `https://www.mikroe.com/clicker-6lowpan` (visited on 04/12/2018).

[2] K Ullas Karanth. "Estimating tiger Panthera tigris populations from camera-trap data using capture—recapture models". In: *Biological conservation* 71.3 (1995), pp. 333–338.

[3] Imagination Technologies Limited. *Creator Ci40 IoT Hub - Build your Internet of Things Product.* URL: `https://creatordev.io/ci40-iot-hub.html` (visited on 04/12/2018).

[4] Leandro Silveira, Anah TA Jacomo, and Jose Alexandre F Diniz-Filho. "Camera trap, line transect census and track surveys: a comparative evaluation". In: *Biological Conservation* 114.3 (2003), pp. 351–355.

Appendix C

Other appendices, e.g., code listing

Put your appendix sections here