Otter GPS Implant

Project Proposal

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Introduction

Wildlife biologists have recently started using advanced technology to monitor the behavior of animals in their natural habitat. In particular, the return of the North American river otter population in Illinois has piqued the interest of many local biologists. The otter was nearly considered extinct in Illinois around the 1800s due to human interactions. After a recent reintroduction of the otter to Illinois the animal seems to be doing well and populations are increasing. Scientists are now seeking the use of technology in order to learn why they are thriving and what effects they will have on the environment.

Scientists frequently use collar mounted GPS tracking systems in order to record the traveling habits of larger mammals. While these have proven useful for larger animals, animals such as the otter pose an interesting problem in that their heads are smaller than their necks. Any sort of collared device would simply slip off of the animal due to their active lifestyle. Similarly, harnesses or other exterior devices run the risk of getting caught underwater and potentially suffocating the animal. Biologists studying the otter are in need of sub-dermal tracking methods in order to safely monitor the animal without altering its usual behavior.

We are excited about this project because it will be pioneering the way that biologists study river otters in their natural habitats. There are currently no commercial products available to track otters in their day to day routines. Samantha Carpenter, the biologist who requested the device, informed us that there are 11 other species around the world that could benefit from this technology. If our project is successful, there could be a large demand for it from the entire biological community studying otters.

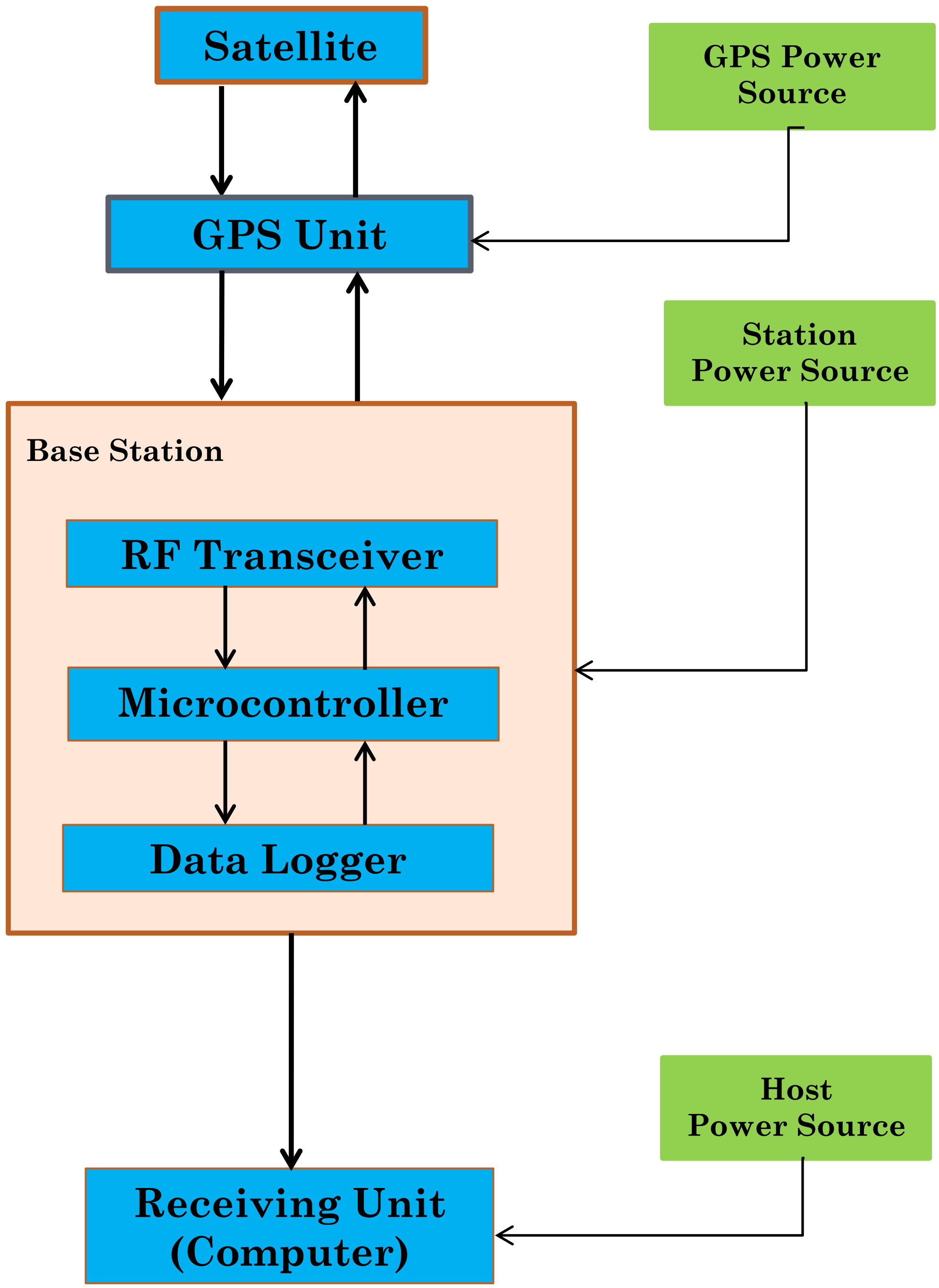
Benefits

- Energy efficient download station
- Provides accurate location data for use in analyzing otter's behavior
- Small, compact implant design with flexible antennae
- Automatic data collection

Features

- Solar panels for use with station
- Satellite GPS positioning
- Data stored to removable drive

Block Diagram:



Satellite:

There are a minimum of 24 GPS satellites orbiting the globe at all times. These can be utilized by the GPS implants to obtain positional information on the otters. We will determine specific intervals for communication with the satellite based on battery performance.

GPS Unit:

The GPS unit will consist of a programmable GPS chip with onboard storage and read/write capability. This will be implanted into the otter. It will receive positional coordinates from the satellites available, at periodic intervals. Then, the information will be conveyed to the base station.

Base Station:

The Base Station(s) will consist of a microcontroller, RF transceiver, and a data logger. The microcontroller will be used to control the RF transceiver to extract data from the GPS device when the otter is within an acceptable radius, modulate it, and finally store it in the data logger. The data obtained will then be passed onto the Receiving Unit via a flash or USB drive.

Receiving Unit:

The receiving unit is basically a host machine that will be used by the biologists to read the data obtained from the Base Station.

Power:

All our devices will be battery powered. We are thinking of using solar panels to charge some of the devices.

Performance Requirement

Perhaps the single most important feature of our project is the fact that it tracks the otter without need for a biologist to be on site at the time. Thus the most crucial component we need to optimize is our power supply for the GPS implant. The battery in the implant must be small and unobtrusive so we cannot change the amount of power we will have available. Thus we will optimize the number of time that the implant will take the otters location in order to provide both a good idea of its traveling habits and a reasonable battery life. Our goal is to provide at least 2 weeks of battery life.

Verification

Testing Procedure

Our first task for the testing of our circuit is to make sure our chip can transmit to the wildlife satellite. GPS chips will be programmable with read/write capabilities, so it will be possible to detect if the chip is contacting the satellite and getting the coordinates we need.

Next we will need to make sure that the implant's data can be read by the station. This can be tested simply by fabricating coordinates on the GPS chip and then making sure that the receiving station picks up the data and stores it onto its memory. We will need to ensure that the station can handle being sent large amounts of coordinates at once as it is unsure what intervals the otter will visit the station given their somewhat unpredictable behavior. We will need to also make sure that the implant's data can be read from at least 5 feet away, since that is about the maximum range an otter will be from our station.

Finally we will ensure that the receiving station can take the data received by the implant and write it to a removable drive that the biologists can pick up and take with them back to their lab. It is important that the format the receiving station outputs the data in is easily understandable by the user.

If all of these tests pass we can be completely positive that our chip/station system captures GPS coordinates, sends them to the receiving station, and then records the data in a way that the biologists can easily retrieve and analyze.

Tolerance Analysis

One of the most critical parts of our design is the power supply; specifically the battery life to transmission ratio. In terms of data analysis, the biologists would ideally have as many coordinates as possible in order to draw the most accurate conclusions about otter traveling behavior. Unfortunately, the more often our implant gathers coordinates from a satellite, the faster the battery will be depleted.

Thus we will need to test various data acquisition intervals and see how quickly our power supply gets depleted. This will involve increasing the data gathering rate and then monitoring the remaining charge left in batteries. Our goal is to collect as many coordinates as possible while still maintaining a reasonable battery life so that the biologists will not have to recapture the otter too often.

Cost and Schedule

Estimated Costs for Parts and Labor

Parts

Parts	Description	# of Units	Cost per Unit	Total Cost of Units
GPS Chip (built-in antenna)	Chip-scale GPS receiver	1	$65.00	$65.00
Housing (implant)	Clear heat-shrink wrap	1	$6.00	$6.00
Housing (station)	Durable plastic or metal box – roughly 10”x10”x10” dimensions or smaller (dimensions can vary) - from ECE store	1	$0.00	$0.00
Station Solar Panel	Roughly 15.4V @ 50mA solar cell	1	$26.95	$26.95
Weather-Proof Solar Panel Cover	Clear, square material for covering/protecting solar panel from damaging weather - from ECE store	1	$0.00	$0.00
Implant Battery	3-volt Duracell lithium battery	2	$2.00	$4.00
Station Back-up Battery	A 9-Volt battery, which can be easily replaced by the biologists	1	$8.00	$8.00
Microcontroller	1 for implant and 1 for station - from ECE store	2	$0.00	$0.00
RF Transceiver / Antennae	1 for implant and 1 for station - for GPS data communication - from ECE store	2	$0.00	$0.00

Total Parts Cost = $89.95

Labor

Engineers	Rate	Hours/Week	Total # of Weeks	Multiplier	Total
Sugato Ray	$40/hr	10	13	2.5	$13,000
Nick Gruebnau	$40/hr	10	13	2.5	$13,000
Andrew Beugelsdijk	$40/hr	10	13	2.5	$13,000

Total Labor Cost = $39,000

Grand Total = Labor + Parts = $39,000 + $89.95 = $39,089.95

Schedule and Responsibilities

Date	Task	Group Member(s)
6-Feb	Finish Proposal	All
	Research RF Transceiver / Parts	Sugato
	Research GPS Chip and Antennae / Parts	Nick
	Research Microcontroller and Programing / Parts	Andy
13-Feb	Finish Design Review	All
	Implant Design	Nick
	Microcontroller and RF Design	Andy
	Power and RF Design	Sugato
20-Feb	Design Review	All
	Order Implant Parts / Setup Wildlife Satellite	Nick
	Order Microcontroller Parts / Circuit Simulations	Andy
	Order Power and RF Parts / Circuit Simulations	Sugato
27-Feb	Build Implant (GPS - Antennae)	Nick
	Build Implant (Power System/Microcontroller)	Sugato
	Build Implant (Programming/Connection Setup)	Andy
5-Mar	Build Station (RF Unit)	Nick
	Build Station (Power System)	Sugato
	Build Station (Programming)	Andy
12-Mar	Finish Implant/Test GPS Satellite Connection	Nick
	Finish Station/ Station Power Systems	Sugato
	Finish Programming Components	Andy
19-Mar	Spring Break	All
26-Mar	Prepare for Mock-up Presentation	All
	Testing Battery Life to Transmission Ratio	Nick, Andy
	Testing Transmission Range	Sugato
2-Apr	Mock-up Presentation	All
	Test Proper Storage on Removable Drive	Andy
	Test Battery Life to Transmission Ratio	Sugato, Nick
9-Apr	Preparation for Demo/Presentation	Nick
	Last Minute Debugging/Testing	Sugato, Andy
16-Apr	Preparation for Demo/Presentation	All
23-Apr	Demo/Presentation	All
30-Apr	Demo/Presentation/Checkout	All

Note: All group members are responsible for each part of the project. While someone may be given lead of a task, everyone is expected to contribute to each part.