UNIVERSITY OF ILLINOIS
URBANA-CHAMPAIGN

OTTER STALKER SYSTEM

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Team 25

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1.0 INTRODUCTION

1.1 TITLE

Otter Stalker System

This project is in collaboration with Illinois Natural History Survey, Institute of Natural Resource Sustainability, University of Illinois Urbana Champaign in the study of the river otters.

1.2 HISTORY AND MOTIVATION

The main motivation of this project is to enhance the current technology available to wildlife researchers. The current otter habitat-monitoring method employs stationary trailing cameras with limited range of sensing mechanism and fixed camera view. In other words, they are only able to detect and record the wildlife behaviors in one direction. To address the limitations of current habitat-monitoring system, the Otter Stalker System is designed to have optimal monitoring coverage to enhance wildlife study experiences.

1.3 OBJECTIVES

The goal of this project is to improve the sensitivity of detecting the presence of otters which is limited by the conventional habitat-monitoring methods. This system enables habitat-monitoring in all directions without compromising the effectiveness of the wildlife data obtained. Besides, it also increases the monitoring coverage of the habitat and is able to operate autonomously for a relatively long period.

The Otter Stalker System is capable of detecting the presence of otters in a study site. When the otters are present, the PIR sensors will detect them and send a feedback wirelessly to the microcontroller. Then, the microcontroller will interpret the feedback and rotate the camera using a stepper motor to the specific location of the otters. The camera will also be turned on simultaneously. Thus, the video recording starts and will be saved in a SD memory card. When nothing is detected for 15 seconds, the video recording will be terminated and the camera will be turned off automatically for power saving.

1.3.1 Benefits

- ✓ Full monitoring coverage of 3m x 3m area of interest
- ✓ Memory-efficient since it only records while motion is detected
- ✓ Power-efficient
- ✓ Inconspicuous habitat-monitoring infrastructure
- ✓ Reduce the disturbance to the habitat by life-scientists/scholars.

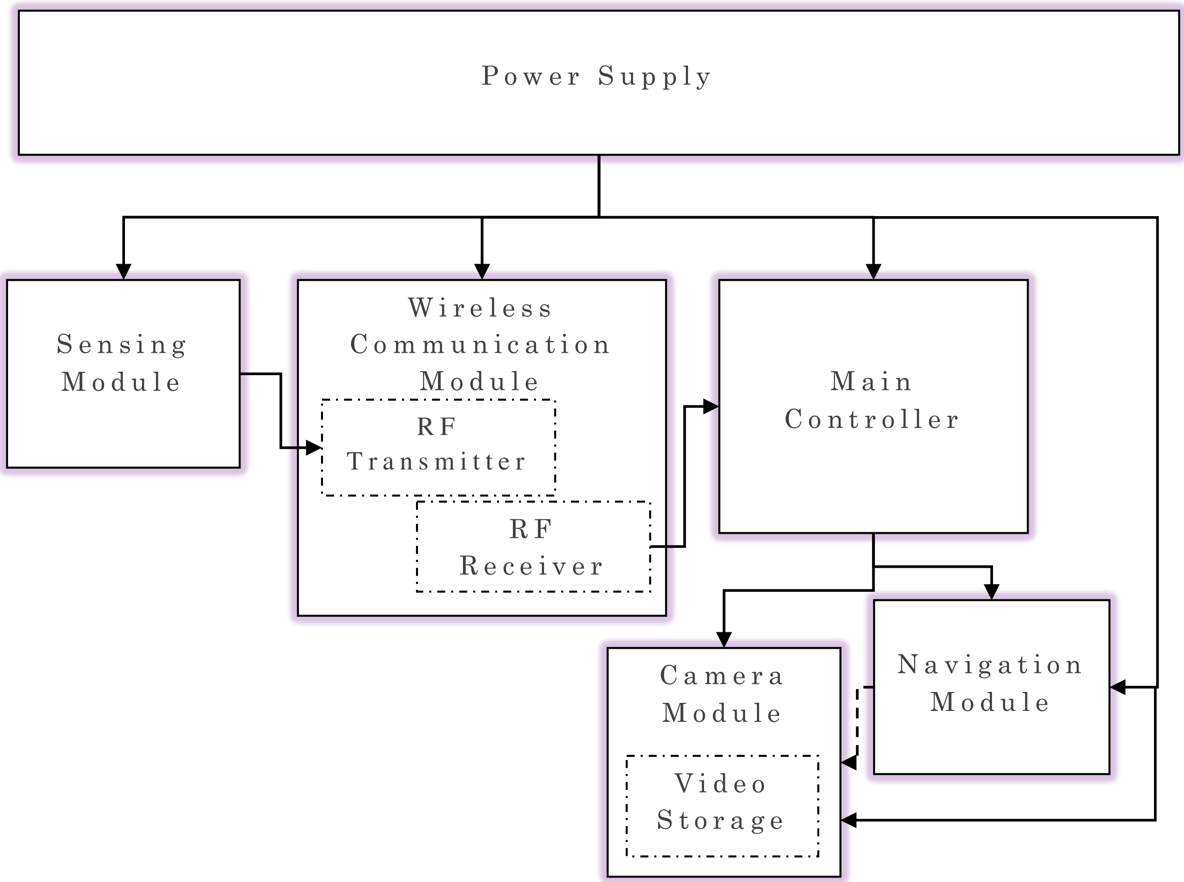
1.3.2 Features

- ✓ Infrared Camera with Virtually Invisible Infrared Technology with Audio Capability
- ✓ SD Memory Card
- ✓ 90 Degree Rotatable Camera Holder with Soundproof Protection

- ✓ Weatherproof and Durable
- ✓ Color Day Video Clips and Infrared Night Video Clips

2.0 DESIGN

2.1 BLOCK DIAGRAM



2.2 BLOCK DESCRIPTION

2.2.1 SENSING MODULE

This module is made of PIR sensors. The sensors are placed to ensure full coverage of the otter study site. The sensors are crucial to sense the presence and position of otters at the otter study site. The sensors will provide feedback to the main controller through the RF transmitter.

2.2.2 WIRELESS COMMUNICATION MODULE

This module consists of RF transmitters and RF receiver. This module functions as a mean of communication between the sensors and main controller. Each of the sensors is equipped with a transmitter and the main controller is equipped with receivers. Thus, the feedbacks from the sensors can be transmitted to the main controller for interpretation.

2.2.3 MAIN CONTROLLER

The main controller is the brain of the system. Based on the feedback from the sensors, it controls the field of view of the camera through navigation module. This is done through current manipulation that is supplied to the navigation module. Besides that, the main controller also controls the on and off of the camera module.

2.2.4 NAVIGATION MODULE

This module consists of a stepper motor. The PWM signals from main controller are converted into currents to power the stepper motor. Then, the stepper motor will rotate and control the field of view of the camera module. Utilizing the stepping motor's range of rotation, the field of view of the camera is increased.

2.2.5 CAMERA MODULE

The camera module contains a video camera with audio capability and data storage. The camera is weatherproof and has night-vision capability. The camera is controlled by the main controller and navigation module. The camera will record a short-length video and store it in memory storage.

2.3 PERFORMANCE REQUIREMENT

Otter Stalker System should be able to sense the presence of wildlife within an area of 3m x 3m. It has to be weatherproof and should have the capability of taking color day video clips and infrared night video clips with audio recording. Besides, it should be inconspicuous to the otters, such that the noise made by the system must be lower than 30dB, and does not harm the well-being or obscure the movements of the otters. The camera, which are attached to the robotic joint unit, is capable of rotating for a maximum of 90° range horizontally to the specific location where the wildlife is being detected by the PIR sensors. The maximum time length for the camera to rotate for 90° should be within 2 seconds. Then, the camera will start taking the video and it will be rotating continuously according to the location of the wildlife. The video recording will be turned off automatically when no movements are sensed in the area of interest within 15 seconds. The signal to noise ratio (SNR) from the transmitters to the receivers should be larger than 10dB. Batteries that support this system must have a lifetime of at least four days as the researchers will visit the site twice a week to collect data and change the batteries.

2.4 SPECIAL CIRCUIT

Special circuit not required.

3.0VERIFICATION

3.1 TESTING PROCEDURES

3.1.1 Sensing Module

Testing Plan:

Within an area of 3m x 3m in a dark room, the locations of the sensors are arranged as designed. Then, heat-radiating object will be allowed to roam randomly within the area. NI MyDAC or NI USB 6009/8 will be used to acquire basic data inputs from the sensors. By using LabView, the probability of an object been detected by the sensor will be calculated. This test will be repeated with the light on. Then, in the same test area (light/dark), the same equipment is set up, but with no motions in the 3m x 3m area. The probability of false trigger will be calculated.

Purpose:

To test the sensitivity of the system, the conditional probability of false alarm or miss should be lesser than 10%. This is to make sure that the monitoring coverage is optimal in most of the time.

3.1.2 Wireless Communication Module

Testing Plan:

It can only be tested after the sensing module passes the test plan. The signal to noise ratio (SNR) will be examined with Vector Signal Analyzer (VSA). Then, the sensing module is connected to this module. LEDs will be used to represent the output of the transmitter. Each LED will light up when the respective sensor detects a motion.

Purpose:

The SNR of the receiver should be at least 10dB to eliminate the interruption of background noise. LEDs are used to make sure the transmitter and receiver function correctly.

3.1.3 Main Controller

Testing Plan:

The microcontroller outputs a signal based on the inputs from the receivers. When one of the input signals is high, the micro-controller should produce a high signal to turn on the camera. After all the input signals are off, the micro-controller will produce a low signal within 15 seconds.

Purpose:

This testing plan is to ensure the camera will be on when motions are detected. It will be off within 15 seconds when the motions are no longer detected.

3.1.4 Navigation Module

Testing Plan:

The stepper motor will be able to turn 90 degree in 2 seconds. When the motor is operating, it will be measured with a decimal meter. The noise produced by mechanical units should be lesser than 30dB.

Purpose:

This testing plan is to ensure that the camera is able to follow the movement of the otter without disturbing or alerting it.

3.1.5 Camera Module

Testing Plan:

This module can only be tested after the Main Controller passes the testing plan. By connecting the camera to the micro-controller, the camera should be on when motions is detected. The quality of the video and audio will be examined by inspections.

Purpose:

This testing plan is use to examined the interface between the micro-controller and the camera.

3.2 TOLERANCE ANALYSIS

The Sensing Module is the most important factor of our design. The presence and position of the otter is determined by the sensitivity and accuracy of the sensors. The functionality of other modules also depends on the sensors. The sensors distribution has to cover the entire otter site. The sensors must be sensitive enough to detect otter's presence but not over-sensitive which will produce a lot of false trigger. Thus, the failure of the sensing module will most likely fail the whole system. The other equally important factor is the overall delay of the system. The delay of the system from sensing module to camera module must be very small so that the camera could lock on and follow the movement of the otter. To test the sensing the module, a test is carried out to determine the effective range of the sensors during the day and night. Furthermore, a heat-radiating object is used on the sensor to determine the probability of miss in trigger. The probability of the false trigger is also determined.

4.0 COST AND SCHEDULE

4.1 COST ANALYSIS

4.1.1 LABOR

NAME	RATE/HR	HOURS	TOTAL (=RATE*HOURS*2.5)
Yon Chiet	$30.00	240	$18000.00
Yong Siang	$30.00	240	$18000.00
Hui Lin	$30.00	240	$18000.00
		TOTAL	$54000.00

4.1.2 PARTS

PART	COST	QUANTITY	TOTAL
Camera	$150.00	1	$150.00
PIR Sensor (Visonic Miniature PIR Detector Spy 1)	$40.00	6	$240.00
Robotic Joint Unit (Stepper motor)	$100.00	1	$100.00
XBee Radios	$18.00	6	$108.00
C-Cell batteries	$1.80	12	$21.60
Microcontroller	$25.00	1	$25.00

PVC Casing	$10.00	1	$10.00
Resistors, Capacitors, Inductors and Diodes	$20.00	1	$20.00
Tripod	$15.00	1	$15.00
		TOTAL	$689.60

4.1.3 GRAND TOTAL

SECTION	TOTAL
Labor	$54000.00
Parts	$689.60
GRAND TOTAL	**$54689.60**

4.2 SCHEDULE

DATE	TASK	MEMBER
6-Feb	Writing proposal (introduction, design)	Yon Chiet
	Writing proposal (verification, design)	Yong Siang
	Writing proposal (cost and schedule, design)	Hui Lin
13-Feb	Signing up for Design Review	Yon Chiet
	Researching on microcontroller	Yon Chiet
	Researching on transmitter and receiver	Yon Chiet
	Researching on camera	Yong Siang
	Researching on stepper motor	Yong Siang
	Researching on sensor	Hui Lin
	Ordering parts	Hui Lin
20-Feb	Design Review	Yon Chiet,
	Designing wireless communication system (transmitters and receivers)	Yon Chiet
	Designing video capturing system	Yong Siang
	Designing sensing system	Hui Lin
27-Feb	Combining wireless communication system and sensing system	Yon Chiet
	Designing navigation system (stepper motor)	Yong Siang
	Measuring and testing PIR sensing range and placement of sensors	Hui Lin
5-Mar	Microcontroller programming (video capturing system)	Yon Chiet
	Microcontroller programming (navigation system)	Yong Siang
	Microcontroller programming (wireless communication and sensing system)	Hui Lin
12-Mar	Writing individual report	Yong Siang

	Testing and collecting data (video capturing system)	Yon Chiet
	Testing and collecting data (navigation system)	Yong Siang
	Testing and collecting data (wireless communication and sensing system)	Hui Lin
19-Mar	SPRING BREAK	
26-Mar	Checking and helping the progress of other group members	Hui Lin
	Debugging (video capturing system)	Yon Chiet
	Signing up for Mock Presentation	Yong Siang
	Debugging (navigation system)	Yong Siang
	Debugging (wireless communication and sensing system)	Hui Lin
2-Apr	Mock Presentation	Yon Chiet
	Field testing and collecting data (video capturing system)	Yon Chiet
	Field testing and collecting data (navigation system)	Yong Siang
	Field testing and collecting data (wireless communication and sensing system)	Hui Lin
9-Apr	Compilation of test data and debugging (video capturing system)	Yon Chiet
	Compilation of test data and debugging (navigation system)	Yong Siang
	Compilation of test data and debugging (wireless communication and sensing system)	Hui Lin
16-Apr	Writing final report (video capturing system)	Yon Chiet
	Writing final report (navigation system)	Yong Siang
	Writing final report (wireless communication and sensing system)	Hui Lin
	Signing up for Demo and Presentation	Hui Lin
23-Apr	Demo	Yong Siang
	Compiling and finalizing final report	Hui Lin
30-Apr	Presentation	Yong Siang