Lake Bryan Thermal Security System

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CONCEPT OF OPERATIONS

REVISION - 1
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CONCEPT OF OPERATIONS
FOR
Lake Bryan Thermal Security System

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Change Record

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1. Executive Summary

Controlling access to public water areas is important for public safety. Rather than police or security officers remaining on site for surveillance, our aim is to provide an autonomous system that will detect and identify trespassing swimmers. The Lake Bryan Thermal Security System will address this issue with a long-wave infrared camera that will notify authorities when people are swimming in a targeted area. The LBTSS will provide more accurate data about human locations in large bodies of water to narrow the area security officers have to patrol. We also will limit the number of false notifications via rigorous image processing and thermal imaging over conventional securities systems. This will drastically limit the manpower and infrastructure needed on site for security.

2. Introduction

This document is an introduction to Lake Bryan Thermal Security System, a system capable of monitoring public or private bodies of water at night, and informing authorities of human trespassers. The LBTSS will serve as a deterrent to trespassers as well as a safety measure to help authorities locate people in the water. The system will also aid the efficiency of nightly patrols by alerting security or safety personnel to the locations of people in the water.

2.1 Background

The most common security systems today are video cameras that run continuously. These cameras store their data on-site or stream to a monitor, and generally, have an attendant monitoring them in real time. Because these cameras constantly store data, most businesses opt for low-end systems to save power, memory storage, and manpower. Everyday society moves to automate remedial tasks, but effective and efficient automated security systems have taken few strides.

The Lake Bryan Thermal Security System aims to provide accurate, reliable security surveillance in areas with limited power and internet access. The system will monitor areas of interest passively, and when motion is detected will activate the camera to determine the scope of the intrusion. Not continually capturing data from cameras saves on data storage, as well as allowing cameras to save on power. A single camera change could save up to $300 per year over conventional security cameras.

On Saturday, August 26, 2017, two students attending Texas A&M were visiting Lake Bryan with their friends. They decided to go swimming despite hurricane Harvey flood warnings in the Bryan area. While in the lake, a sudden current pulled the students deeper into the lake. Their friends left and found help from nearby police officers who rescued the students and performed cardiopulmonary resuscitation on them until medical personnel arrived on the

scene. The students were taken to a hospital in critical condition. One of the students died on August 30, 2017, and the other died on September 3, 2017. Tragedies like this could potentially be avoided if a system like the Lake Bryan Thermal Security System is implemented on the lake. Authorities could have been notified that people were swimming in the lake during a hurricane and could have responded to the scene much faster, possibly preventing any loss of life.

2.2 Overview

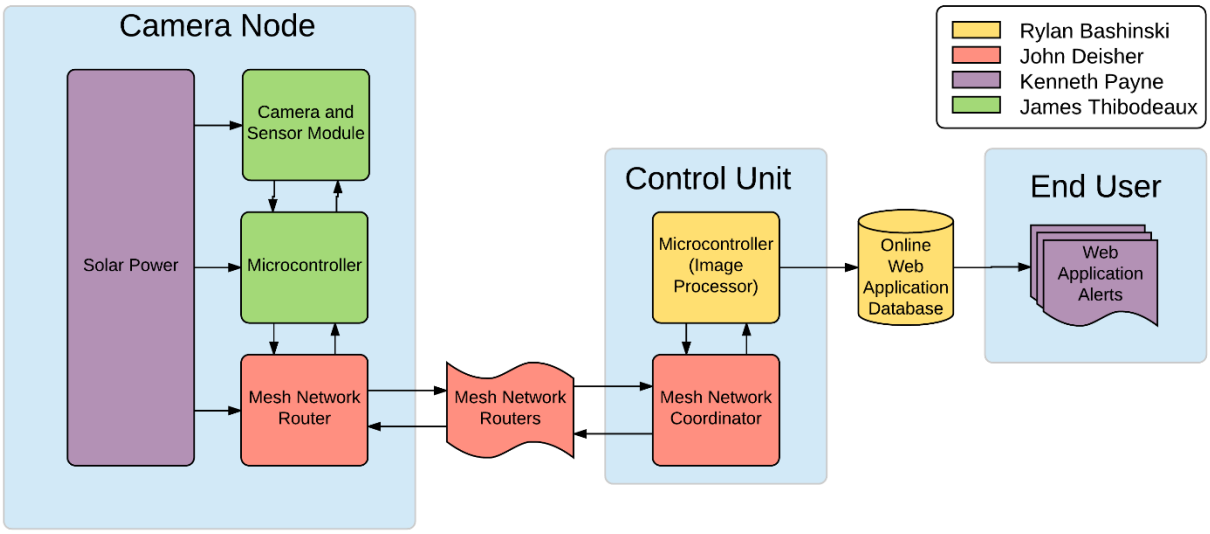

Figure 1: Lake Bryan Thermal Security System Block Diagram

Our system will be used to monitor infrared waves to check for human presence in restricted or dangerous areas. We will detect this information using infrared cameras mounted with other sensors to determine human versus non-human presence. Using a network of cameras and sensors that can transmit information between each other, we can watch large areas of hard to patrol water lines using minimal human interaction. Each camera node will be solar powered to help limit the need for extra infrastructure to be installed. A microcontroller will read data from low power sensors to keep the camera from having to run constantly and drain the battery. Once a sensor detects a possible trespasser, the camera will take thermal images and relay them using a secure mesh network to the main control unit for the image to be processed. After an image has been received by the control unit it will be run through an algorithm to determine if authorities need to be notified of a trespasser. Using a network connection, the control unit will send out a notification to the proper authorities so that action can be taken.

2.3 Referenced Documents and Standards

- IEEE Wi-Fi communication standards: IEEE 802.11
- C95.1-2005 - IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
- Rechargeable battery http://www.epectec.com/batteries/battery-standards.html
- http://www.solarabcs.org/codes-standards/IEEE/index.html

3 Operating Concept

3.1 Scope

The Lake Bryan Thermal Security System (LBTSS) will empower safety and security personnel to passively monitor a body of water after posted operating hours. When a trespasser is detected, a thermal camera captures an infrared image of the target area. This image will then be sent via an RF network to the main control unit, where a microcontroller will analyze the image and request more images as needed. After this analysis, if a person is detected, a website will be updated with a notification to alert authorities about trespassers. For demonstration and testing purposes, a scaled-down system will be built. While there are many security cameras on the market and even thermal security systems, the LBTSS is specifically designed to identify “persons in water” or PIWs. Not only will LBTSS immediately benefit those wishing to secure pools, ponds or lake; there is also the potential for military applications when scaled up.

3.2 Operational Description and Constraints

The Lake Bryan Thermal Security System is intended to be used by security personnel or law enforcement agencies to monitor large bodies of water such as ponds and lakes and locates trespassers. Several camera and sensor nodes will be installed around the border of a body of water. The main control unit will receive and process images captured from the cameras and notify the proper authorities. The system will verify that the swimmers are human, and provide location information.
The resulting constraints from this operational description are as follows:

- The master controller must be stored close enough to the lake to communicate with the system of cameras as well as have access to an internet connection.
- The camera nodes must be placed in an area of optimal sunlight to allow solar charging of their internal batteries.
- The camera and sensor nodes should be directed towards the area of interest.
- Each camera sensor node must be within the range of the mesh network, and be able to communicate with the main control unit.
- The budget is $500 which limits the quality of parts that can be used for this project.
- System nodes must be robust, durable and capable of functioning in most weather conditions.

3.3 System Description

- Solar Power Network: This subsystem will provide power to the camera and sensor node as well as the transmission network. It will consist of a battery and solar panel for each camera node. This solar panel will charge the battery during the day and the battery will provide the necessary power to the system during operating hours. This subsystem will help to make the overall system self-sustainable and less dependent on infrastructure since power lines will not need to be run to every camera. A backup battery will be incorporated to maintain a minimum power supply in the event of poor solar irradiance.
- Camera and Sensor: Our system will be triggered by the motion sensor. The use of a sensor to trigger an image capture will reduce the activity factor of the camera, and reduce power consumption. The sensor will have a specified zone to monitor, and when the sensor detects motion the thermal camera will capture an infrared image of a specific area. This image is then transferred to a microcontroller inside the mesh network.
- Mesh Network:

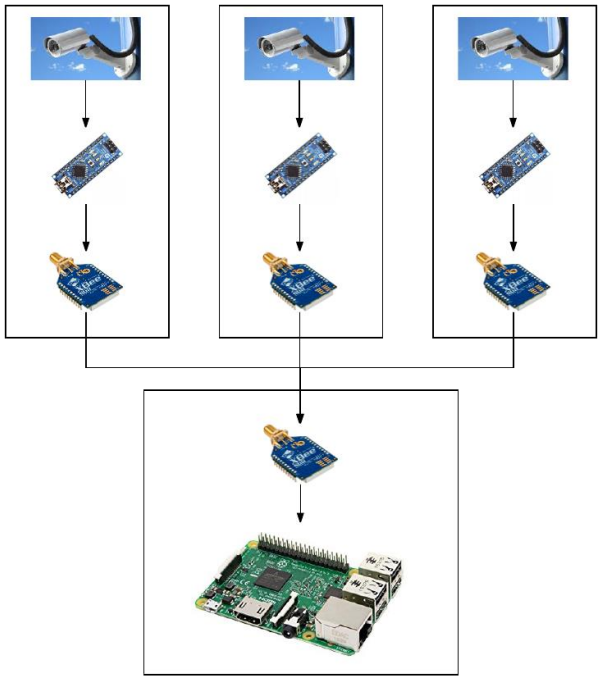

Figure 2: Mesh Network Overview

The mesh network will be used for communication between all devices used for monitoring a specific location. Using a mesh network, the system can be scaled to a very large size to help with large remote bodies of water. Our system will be using radio frequency for data transmission since Wi-Fi or other normal data transmission options are not going to be viable.

- Image Processing: Once an image has been received by the main control unit it will be analyzed to determine if there is a human swimming in the water. This will be done by analyzing the thermal data provided in the image, compared to the heat given off by a human being. If the image analyzer determines that a human is swimming in the body of water it will pass the information to the web notification application.
- Web Notification Application (TBD): When the system has detected a human trespassing in the water, the web application will upload the thermal image to a website. The website will provide the user with the time and location of the triggered node, as well as the infrared image captured. The proper authorities will be able to use this information to catch trespassers.

3.4 Modes of Operations

The Lake Bryan Thermal Security System will only have one mode of operation which we call “automatic”. In this mode the user can define the times when the system will function, otherwise, it will be based on day and night cycles. While operating in automatic the sensors will detect motion and activate the camera to take an infrared picture. That picture will be automatically transferred to the main control unit for processing. After the image is processed and our algorithm detects human presence a notification will be sent to a website with the location the picture was taken from, the time it was taken, and the actual image.

3.5 Users

Our monitoring system will be marketed to local government law enforcement or security agencies in charge of large bodies of water that wish to be more effectively secured. This automated monitoring system will enable these agencies to better schedule patrols through hard to reach water edges by notifying them of swimmers’ locations.

The Lake Bryan Thermal Security System could also be marketed to agencies like the coast guard and installed on buoys to make a network of human detectors off the coast. This would help in search and rescue at night near the shore by providing a trail of images for a lost boat.

3.6 Support

Support for the Lake Bryan Thermal Security System will be provided in the form of a detailed user manual providing information on the system installation, maintenance, and usage. The user manual will also describe how the user can interface will the online website to view system alerts and the pictures that triggered them.

4 Scenarios

4.1 Public Access Lake

The primary use of the Lake Bryan Thermal Security System will be for public access lakes that have restricted hours to visitors. If there is an agency responsible for safety at a lake in hard to patrol areas they can use our system to help schedule patrols or do spot checks during the restricted hours. One problem with lakes is that there are a large number of access points, and patrolling the area completely would require extensive employee time and resources. Using our automated system will help to show exactly where people are accessing the lake and allow for more active and accurate patrolling.

4.2 Near Coast Tracking and Notifications

Because our system does not require external power or internet for the camera nodes, they can be installed on buoys to make an imaging network. Groups like the Coast Guard can use a network like this while searching for lost mariners near the coast. Using images and time stamps they can make an accurate timeline for where smaller vessels traveled and help to narrow the search field.

4.3 Large Area Intruder Detection System

The Lake Bryan Thermal Security System can be deployed on land to help keep large areas under surveillance. Government groups or private owners that need to track if people trespass on large pieces of land without wanting to constantly patrol the border can deploy our system instead. Through the use of the Lake Bryan Thermal Security System networks, the users will be able to track when people reach the thermal cameras and where trespassing individuals are coming onto the land to deploy security.

5 Analysis

5.1 Summary of Proposed Improvements

- The system will be solar powered which means it will be self-sustainable.
- The cameras will be activated by motion sensors, preventing the system from constantly taking pictures, depleting its energy, and wasting image analyzer computation time.
- Each camera will be programmed to have a delay on the image capturing for when its sensors are constantly detecting movement. This will further help to limit the energy usage and computational load of the system.
- The system provides both an alert and the image that triggered it, allowing users to better determine the need for security and safety personnel to investigate the body of water.
- The system will run on a predetermined schedule and will not require personal interaction to maintain upkeep.

5.2 Disadvantages and Limitations

The Lake Bryan Thermal Security System will have some limitations which include:

- The system will be optimized to detect adult swimmers and may have difficulty detecting infants or small children.
- Due to budget constraints, the camera range will be limited.
- The system mainly surveys along the edges of the water and may not detect people far from the camera.
- The camera nodes should be placed high to decrease the possibility of vandalism or flood damage.
- Camera nodes must be placed in areas with high sunlight to allow the solar panels to generate energy for the system.

5.3 Alternatives

Some alternatives to the Lake Bryan Thermal Security System are:

- Conventional Security System monitored by a user.
- No security system just signs deterring people from swimming at night.
- Hiring security personnel to make nightly patrols of the body of water.
- Power for the system can be provided by running power lines to each individual camera node.
- Transmission could be made through a WIFI system or by hardwiring all of the camera nodes together to allow communication.