Boston University
Electrical and Computer Engineering
EC463 Senior Design Project

Problem Definition and Requirements Review

Community Security

Submitted to:

Dan Ryan
724 Brannan Street
San Francisco, CA 94103
dan@vergesense.com

by

Team 24
Community Security

Team Members

Samuel Evans evanss@bu.edu
Daniel-John Morel djmorel@bu.edu
Steve Numata numatas8@bu.edu
Cameron MacDonald Surman csms@bu.edu

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Project Summary

Modern machine learning and artificial intelligence is starting to raise concerns about the volume and ownership of available surveillance video. This recent increase in processing capabilities has led to the increased privatization of surveillance/data and societal loss of privacy. The purpose of this project is to design and construct a prototype of a Community-Managed Security System, consisting of an outdoor solar-powered camera network tied to a cloud management tool with machine vision/analytics capabilities. The project will also include a cryptographic audit trail to log internal user activities to ensure that surveillance access is not abused by authorized parties. Through the Community-Managed Security System, communities have the power to take back their data while maintaining a secure and safe environment.

1. Need for this Product

Most surveillance systems in use today are either owned by private companies to support their physical security systems, or owned/operated by public entities (at the federal, state, and municipal levels). This has led to concerns over ownership and access to vast troves of video-surveillance data, since these systems are operated in a way that is opaque & unaccountable to the public (and in many cases funded with taxpayer money!). Recent advances in AI & machine learning allow for more sophisticated and scalable processing of video data, which is increasing concerns around nefarious uses of video technology. This project seeks to explore balancing the positive aspects of video surveillance technology (reduction in crime and aiding law enforcement) against the potential negatives (unaccountable surveillance and privacy for citizens).

From a customer perspective, a Community-Managed Security System would provide both societal value and improved security to the communities that wish to adopt it. The system should be easy to install and operate, and allows all members of a community equal access to video and data. Through the deprivatization of surveillance, the societal negatives associated with it disappear. This system allows communities to take back their surveillance data and privacy, while helping to reduce crime.

2. Objective and Deliverables

Objective

Our client would like us to develop a prototype for a Community Managed Security System. Ideally, this prototype would include a network of solar-powered security cameras with cellular data backhaul, as well as a community-accessible management panel with live viewing and video analytics capabilities. Another key factor in this project is the inclusion of a cryptographic audit trail, so user accessibility data is shared among all users in the network.

Deliverables

In order to demonstrate the functionality of the system, we will prototype a small scale version of the system with a minimum of two or more cameras. The system can be divided up into multistage hardware and software deliverables.

The initial hardware deliverables are a physical setup of at least two solar-powered cameras. A battery meter can be wired to the camera and left overtime to demonstrate that the solar cell will sustain the camera battery.

The next deliverable is to demonstrate the cameras can communicate to a cloud server via a microcontroller. This can be demonstrated by uploading minimally processed data from the microcontroller, to the server, and retrieving it to show the collected data (video) for example on a web application. The camera should also be able to halt uploading to cloud servers when no movement is detected, or be able to stream a compressed version of the data to servers. This is a part of the minimal on board processing the cameras can perform.

A third deliverable is to show that the system can analyze the collected data with machine learning for key relevant features such as a car or a person. This will be shown on the web application.

Finally, the system needs to be connected through several verified users who can access the security footage, and requires an implemented cryptographic audit trail to see what data has been accessed by all the users. This can be shown by creating several users and demonstrating that each one has access to the video footage, as well as information on which cameras were accessed by other users.

The final combined deliverable implements all of the piecewise deliverables together, as well as all source code documentation. The demonstration of the final deliverable will be to allow multiple users to join the community security server and demonstrate that each user has access

to the data as well as what data has been accessed by other users, and that the system can sustain itself while processing collected data.

3. Visualization

The project will have two main components: the security camera and then the user's web experience. The look of the camera will be quite standard of the industry. We would be dealing with a sturdy, simple camera design with a solar cell hood above it (at an angle). The web app for residents would follow a relatively simplistic and easy to use approach.

Figure 1.1

Figure 1.2

Figure 1.1 & 1.2

Both images are of existing security camera systems with simple designs that inspire thoughts of our own design. There needs to not only be a camera and an energy supplying solar cell but also infrared lights to aid detection in the evenings. Our mounting technique would likely be a form of clasp or grip in order to aid with easy installation. All recorded video is transmitted via the cellular module on the microprocessor to a cloud based data warehouse. Even before beauty, durability and reliability are key in our design decisions.

The main goal of the web access for users is that complexity is at a minimum seeing how people of various ages and technological savviness will be using it. There would be a general website hub to log into and then from there various tabs that give access to the resident's community video feeds as well as visual analytics. Within the analysis section there will be a list of possible breakdowns of objects that a specific camera has seen such as people, cars, etc over the course of different time periods.

4. Competing Technologies

There are many different security camera systems in the current market. Each security system uses cloud storage and some offer local storage. The most notable security camera systems include Google's Nest, Amazon's Ring Alarm, and Reolink. While the cameras in the current market all have similar base features such as cloud storage and apps to adjust camera configurations, the cameras tend to specialize in only a few of the following areas: solar-powered, cellular data backups, night vision, and human detection. Our product aims to not only include the base features of those products, but to also incorporate the specialized features into an all-in-one security system.

Nest

Google's Nest security system offers a wide variety of devices that can be controlled by a single app. The cameras save video footage into an encrypted, cloud-based video storage. Users have access to 24/7 live streaming video recording, and storage lasts up to 30 days for review. One of the camera models, the Nest Cam IQ, has person detection built into the security system. This particular model, however, is powered through a wall outlet. The Nest Cam IQ relies on a Wi-Fi connection to send information, and has a night vision range of about 50 feet.

Ring Alarm

Amazon's Ring Alarm security system also has a large variety of cameras users can purchase. The Ring Spotlight model is solar-powered, and can provide enough power for a day after a few hours of exposure to direct sunlight. The camera's solar panel is mounted separately from the camera itself, and the two modules are wirely connected. The security system requires an internet connection, but Ring does offer a cellular-based backup option for specific subscription plans. Ring also uses a centralized app to connect all devices and access live video feeds. The Ring Spotlight has motion detection, and a night vision range of 30 feet.

Reolink

The Reolink Go is a solar-powered security camera that uses 4G LTE cellular data for communication. Like the Ring Spotlight, this camera's solar panel is mounted separately from the camera itself, and the two modules are wirely connected. Like the other security cameras, the Reolink Go connects to an app to adjust settings such as motion detection, image resolution, and alarms. The app provides users access to a live video feed from the cameras. Video footage is saved in the cloud for up to 30 days, and the camera offers a local SD storage option as well. However, the local storage only saves motion detection clips rather than regular video footage. The Reolink Go does offer night vision, but is limited to a distance of 33 feet.

5. Engineering Requirements

Software:

- Cellular data flow using 4G
- Cloud management
    - Storage & Encryption of data
- Machine learning
    - Object Detection (people, cars, ect.)
- Cryptographic audit trail
    - Record date and time of recordings
- Community-based login
- Motion sensing for smart video capture
- Spatial awareness of each camera (GPS location)

Hardware:

- Raspberry Pi or other developer micro processor
- Camera module that integrates easily with said micro-processor
- Battery pack to support Pi and its various modules
- Strong and durable container for weather-proofing
- Solar Cell or other passive charging mechanism
- Functioning period of 24/7 for 1 year of battery life without access to charging base
- Outdoor functionality
- Day and night functionality
    - Infrared light for night cycle
- Cellular signal Chip to send video feed to cloud
- Easy mounting and installation mechanism

6. Appendix A References

Solar Technology Hub. “Best Solar Powered Security Camera 2019 - Top 11 Reviews.” *Solar Technology Hub*, Solar Technology Hub Https://Solartechnologyhub.com/Wp-Content/Uploads/2016/03/Solar-Technology-Hub-Logo-300x100.Png, 29 July 2019, solartechnologyhub.com/best-solar-powered-security-camera-reviews/. (Figure 1)

“2017 High Quality HD 1080P Microphone 48pcs 940nm Leds PIR Mini Pinhole Video Wireless Hidden WIFI IP Camera with IR-CUT.” *Alibaba*, www.alibaba.com/showroom/high-quality-pir-wifi-ip-camera.html. (Figure 2)

7. Appendix B Supportive Research

Cruz, Beth-uel De La. “Reolink Go Vs. Arlo Go: LTE-Enabled Security Cameras.” *Home Security & Smart Home Reviews*, HomeAlarmReport, 30 July 2019, homealarmreport.com/security-cameras/lte-enabled-cameras-review/.

Garcia, Andrew. “Nest Reviews 2019: Read the Latest Nest Secure and Camera Review.” *SafeHome.org*, 27 Sept. 2019, www.safehome.org/security-systems/nest-secure/reviews/.

Garcia, Andrew. “Ring Alarm Reviews 2019: Read the Latest Ring Alarm Review.” *SafeHome.org*, 27 Sept. 2019, www.safehome.org/security-systems/ring-alarm/reviews/.

Hu, Jenny. “Cellular Security Cameras: Top 6 Things You Must Know - Reolink Blog.” *Reolink*, Reolink, 18 July 2019, reolink.com/cellular-security-cameras-buying-guide/.

Whalen, Hannah. “Hands-On Ring Spotlight Cam Battery and Solar Review.” *Home Security & Smart Home Reviews*, HomeAlarmReport, 31 July 2019, homealarmreport.com/home-security/ring/ring-spotlight/.

Wollerton, Megan. “Nest Cam IQ Outdoor Review.” *CNET*, CNET, 14 Apr. 2018, www.cnet.com/reviews/nest-cam-iq-outdoor-review/.