Public Safety Surveillance System

TCSS573 Internet of Things Group-9

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ABSTRACT

Public safety is a big concern in metropolitan cities and with advancing technology it is now possible to provide solutions that can cater to this basic need. Internet of Things helps to easily setup the system and monitor areas from a GUI dashboard. It's integrated with a mini computer that is as powerful as a Supercomputer. The computer module is of the size of a credit card. The setup requires minimal power and wifi connectivity. The sensors are connected to track loud sounds, motion of human beings, and monitor activity via cameras at regular intervals. This is an effective system for when a victim is unable to inform the cops or call 911 during an emergency situation, as the threat situation is automatically detected, and the police are automatically notified so that they can respond quickly. Also, this aids in finding the suspect faster and better by making note of the direction the suspect has fled and their physical appearance captured on the camera. This system aims at increasing public security and reduce the crime rate.

KEYWORDS

Surveillance System, Internet of Things, IoT, Outdoors, Security Camera, Public Safety, Crime Detection, Image Recognition, IBM Watson, Raspberry Pi, GrovePi

1 INTRODUCTION

Public Security is a big concern in the society we live in. We earn money to cater the basic needs such as food, clothing, shelter and education and wish to live a peaceful and secure life. A lot of money is spent by the Government for building good infrastructure, general safety of the people, hospitals, schools, food supplies, etc. However, the biggest aspect that is left unattended is the safety of people outdoors and in public areas. People are always worried about crime that can take place when they are outdoors. This is not how we are intended to live! There should be a freedom to travel, explore the world without the fear of being attacked for thefts, assaults, or physical abuse by criminals. The lack of security encourages the crime rates in cities big or small. This notion triggered the idea to build a safety system for the public that can detect crime in real time and reduce the crime rate tremendously. With advancing technologies, it has now become possible to tackle this problem. At the University of Washington, we came up with the solution in our Internet of Things course and were successful in building a system that can detect a life-threat by any other human being in a couple of seconds and notify authorities through email and an interactive user interface, with a timestamp and real-time image of the incident, allowing authorities to take immediate necessary action. We have built a prototype of the system and is ready to be put into use in real world.

2 RELATED WORK

There have been instances of security systems implemented using Raspberry Pi as the basis of the system previously. Many of these systems have been implemented for use at home or for small businesses.

In "Raspberry Pi Based Advanced Security System Using IoT" the authors created a system that uses a PIR motion sensor and captures images upon activation. Their system notifies the homeowner when motion is detected and emails the captured images to them. Their system is used as a simple notification system, they do not implement any type of image recognition.

A similar paper titled "Smart Surveillance System Using Raspberry Pi and Face Recognition" also uses a PIR motion sensor to detect motion. In this system, the creators have implemented a facial recognition aspect. They have a database with authorized users. When motion is detected, images are captured and examined for faces. When a face is detected, it is compared to the database of known people, if recognized, nothing happens. If the face is not recognized, then a notification is sent to the homeowners.

The biggest difference between these types of security systems and ours is that our proposed system is not limited to use at a home, rather it is intended for wide-spread use in public areas. Additionally, instead of simply detecting for motion and notifying someone, we have incorporated image recognition to look beyond and detect if someone is

in danger. We are making the use of advanced technologies of Internet of Things, Cloud Computing, Machine Learning techniques to build a robust, fast, effective, and energy saving solution. From our research, we have not seen a system of this caliber.

3 ARCHITECTURE AND DESIGN

This system is built upon Internet of Things module. We have used the powerful Raspberry Pi and the Grove Pi as the base for our System. We used the PIR motion sensor, sound sensor and the cameraPi as the sensors and actuators for our system. We have integrated our system with the IBM Watson Visual Recognition to perform the main computations on the Cloud, IBM Bluemix Cloud Database to store the data on the Cloud. We have used Node-Red to connect the components and process the data on the web. We have also utilized the Node-Red UI dashboard to allow the user, the Police or other responsible authorities in this case, to track the status of the crime-location. In an event of an incident, an email notification will be sent to the authorities with the image of the incident classified as a threat, date and time of the event, and the camera id to track the location of the incident.

3.1 Working of the System

The basic idea of this project is as follows:

Setup the system in crime prone areas with multiple modules that can cover the whole area, taking the note of the range the sensors can work for so that there is no gap in coverage. Each system has a sound sensor, motion sensor and camera to monitor and capture the activity in the area.

We have used the PIR motion sensor that tracks the motion of any activity in the camera's vicinity. It has an adjustable range up to 6 meters. This allows each module to be customized so that complete coverage of the area can be achieved. On the occurrence of a motion, the camera is triggered to capture images. The images are continuously captured while motion is being sensed. When there is no motion or sound activity sensed, the module is able to "sleep" and save energy by not continuously capturing and processing images when it isn't necessary. The captured images are then sent to IBM Watson's Visual Recognition for classification into either "Threat" or "Safe" activity. We have built a custom classifier with 20 images each for the 2 classes, Threat and Safe for performing the image classification. The classification is returned to the system and the GUI dashboard is updated accordingly. If there is a weapon or harmful activity detected in the images that pose a threat as classified by the Visual Recognition system, then a notification is sent via email to the responsible authorities so that they may take necessary action.

Additionally, we have a sound sensor that can detect any sound. We have set up our system to monitor any sounds in the area and if the sound sensed goes above a set threshold, then they camera is activated just as in the case of the motion sensor. The purpose of the sound sensor is to listen for loud noises such as a gunshot or a person screaming, which could indicate someone is in danger. The images captured are sent to IBM Watson's Visual Recognition for classification and the GUI is updated in real-time. Just as in the case of the motion sensor, if a threat is detected in the images, then an email is sent to the proper authorities.

The location of each module is detected by the sensor ID and since each module is stationary, it is easy to track the location of activities in real-time. Constant image notification helps the authorities to track the latest activity at the crime location. Also, the Dashboard on the IBM Watson displays the real-time motion, sound and image information so that you can see when the most recent occurrence of a detected loud noise or motion happened.

Each time a motion or sound is detected, and an image is captured and sent to the Visual Recognition, the data with the image and the timestamp is stored in the database on IBM Bluemix Cloud.

We have used a flow-based development tool, Node-Red, originally developed by IBM, for connecting out hardware devices, APIs and online services as part of the Internet of Things.

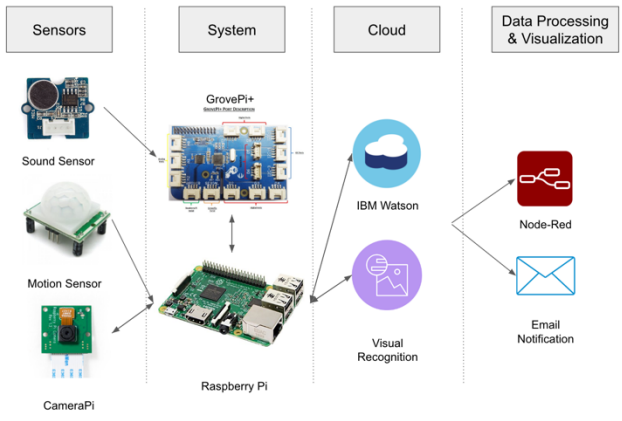

Figure 1: System Architecture

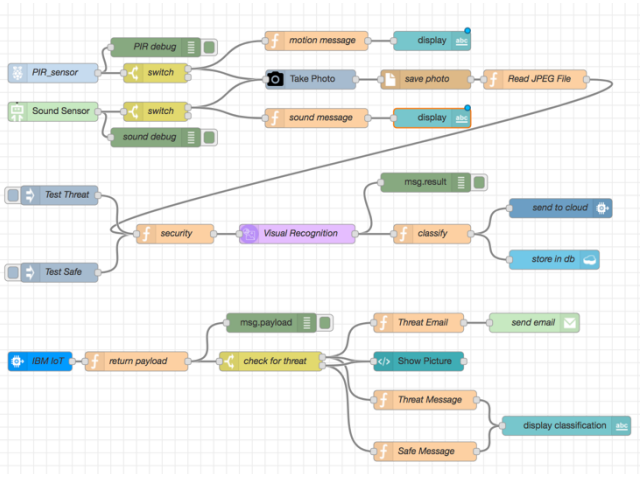

Figure 2: Node-Red Flow

4 DISCUSSION

Public security is an ever-growing concern. While there exist security systems that can monitor areas and even notify owners when there is activity at their home or office, there are no systems currently that monitor areas and analyze activity to detect actual danger. Having a system that can be widely implemented in public areas to help ensure the safety of the public is a necessity. People should not have to go through life worried about possible threats while walking around during their daily lives. The system we have proposed and created would be able to monitor wide areas, detect various crimes and threats, and notify authorities so that they may respond quickly, helping people and saving lives.

We have been able to successfully build a prototype of our proposed security system. Our prototype would be one of many modules placed throughout public areas that could monitor for suspicious and dangerous activity. The modules would be places with slightly overlapping coverage, so to not leave any gaps in surveillance where crime could take place unnoticed. Each module would have a sensor ID that holds its exact location. This way when a threat is detected in the system, the location of the incident can be easily retrieved and sent with the threat notification. This allows authorities to know exactly where to respond to so that they can respond to the threat more quickly.

Implementing this system in public areas would allow for many types of incidents that could go unnoticed to be detected and responded to in a timely manner. The modules are compact and require low power and a network connection. These would be easy to install in metropolitan areas where power and networks are already wired throughout the cities.

The current limitations of our prototype is in the Image Recognition model. The custom classifier we built on IBM Watson's Visual Recognition includes only 20 images for each class (Threat and Safe). This is due to issues training the custom classifier model on the free version of IBM Watson. Ideally the classification model would have hundreds of images for each class, allowing the system to detect more types of threats and incidents. Our current model is extremely accurate at classifying incidents where weapons are present, people are being actively attacked by another person, or blood is present. However, there can be false threats detected as the model is currently limited. We have not experienced false safe classifications. This circumstance is more ideal because the threat notifications include the flagged picture, allowing the authorities to make the final call on the situation. If threats were being classified as safe, this could pose a problem, but we have not encountered this.

5 CONCLUSION

The Public Safety Surveillance System performs as per our expectations and can be put into live use by the Governments all over the world. It is a cost-effective smart solution that can solve the big problem of Public Security. The time lag is just a couple of seconds and can be neglected as compared to the other available security systems. It is automatic in terms of detecting the crime without the requirement of a human constantly monitoring the cameras.

6 EXTENDING THE SYSTEM FOR FUTURE WORK

There are many features that could be added to our prototype that would enhance its ability and effectiveness in public safety. By creating a larger and stronger model on IBM Watson's Image Recognition would allow us to expand the types of incidents the system can identify. Currently we are limited to identifying incidents where the victim is being harmed with a weapon, if their mouth is being covered, or if blood is present. We would like to expand the model to also detect incidents such as thefts, falls, fires, car accidents, etc.

Additionally, we would like to incorporate video recording and video recognition. Currently we are limited to individual snapshots taken, and since there is a delay between pictures being taken that leaves time for someone

to be harmed without it being fully detected. Implementing video into the system would allow for a more seamless recognition system without any gaps.

Our current security system is equipped with Raspberry Pi's CameraPi, which is ideal for taking pictures and video in well-lit areas. Adding a secondary camera, such as the Pi NOIR camera, along with infrared lights, we would be able to enhance our system to work at night and in poorly lit areas as well. This would allow our system to function properly in many more cases and help protect many more people.

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