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ENTIRE HOME SURVEILLANCE APPROACH USING PI AND INTELLIGENT CAMERAS WITH MOBILE APP NOTIFICATION

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Abstract— *Home surveillance aims to allow the homeowners to observe their home at any time virtually from any location. Home automation has increased in popularity in recent years as a result of its low cost and ease of use, through smartphone and tablet connectivity. Homeowners who want to save money often opt for a home security provider's simple kit. For instance, criminals may find an unprotected entry point into the home if there is only a front and backdoor sensor. By taking a tour around the perimeter of the home to spot any security weaknesses and order the required equipment pieces to protect all areas. In this project the home is protected with multiple Raspberry Pis that communicate among themselves to accomplish a common goal. The beginning may be by building a case for security with an emphasis on the lack of flexibility of commercially available systems — that's where Raspberry Pis are brought to the rescue. Also, this interoperable system will involve Raspberry Pi, cameras and a mobile application for alert by predicting the presence of unknown person. The algorithms used are Single shot multi-box detector algorithm for face detection, Mobile facenet algorithm for face recognition and Image ZMQ algorithm for image transportation. A mobile application is developed using react native to enable live streaming and options are given for the user to alert the police, lock the door or can even ignore when an unknown trespasser enters the property. As a result, the solution is flexible, affordable, and interoperable with other IoT devices and services that are worth paying for.*

Keywords — *Home surveillance, Face detection, ZMQ Algorithm, SSD Algorithm, Neural Networks, mobile app react native*

I. INTRODUCTION

Home security is both the security hardware in place on a property as well as personal security practices. Security hardware includes doors, locks, alarm systems, lighting, motion detectors, security camera systems, etc. that are installed on a property; personal security involves practices such as ensuring doors are locked, alarms activated, windows closed, extra keys not hidden outside, etc. According to an FBI report, 58.3 percent of burglaries in the United States involved forcible entry. Per the most recent statistics, the average burglary in the United States lasts for about 90 seconds to 12 minutes and, on average, a burglar will break into a home within 60 seconds. Most thefts target cash first followed by jewels, drugs, and electronics. Common security methods include never hiding extra keys outside, never turning off all the lights, applying small CCTV stickers on doors, and keeping good tabs with neighbours. Convergence of technologies in machine learning and omnipresent computing as well as the development of robust sensors and actuators has brought interest in the development of smart environments to emerge and support valuable functions in Daily Living Activities (ADLs). The need for such technologies to be developed is underlined by population aging, the cost of formal health care, and the importance individuals place on remaining independent in their own homes. Individuals need to be able to complete daily living activities such as eating, dressing, cooking, drinking, reading, taking medicine, sleeping, to function independently at home. Automating activity recognition is a crucial step towards monitoring a smart home resident's functional health and helping them perform these activities effectively. Before smart home

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technologies can be deployed for these older people, several challenges should be resolved, including data collection, algorithms for activity recognition, etc. This technology can be used wildly in the future if the accuracy is sufficiently higher. There is a research project called the Advanced Studies Center in Adaptive Systems (CASAS) where only passive, non-intrusive sensors are deployed at Washington State University to create an intelligent home environment.

II. EASE OF USE

Home automation systems have definitely proven themselves in the arena of energy efficiency. Automated thermostats allow you to pre-program temperatures based on the time of day and the day of the week. And some even adjust to your behaviors, learning and adapting to your temperature preferences without your ever inputting a pre-selected schedule. Traditional or behavior-based automation can also be applied to virtually every gadget that can be remotely controlled – from sprinkler systems to coffee makers.

Actual energy savings ultimately depend on the type of device you select and its automation capabilities. But on average, product manufacturers estimate the systems can help consumers save anywhere from 10 to 15 percent off of heating and cooling bills.

In today's fast-paced society, the less you have to worry about, the better. Right? Convenience is another primary selling point of home automation devices, which virtually eliminate small hassles such as turning the lights off before you go to bed or adjusting the thermostat when you wake up in the morning.Many systems come with remote dashboard capabilities, so forgetting to turn off that coffee pot before you leave no longer requires a trip back to the house. Simply pull up the dashboard on a smart device or computer, and turn the coffee pot off in a matter of seconds.

Remote monitoring can put your mind at ease while you're away from the house. With remote dashboards, lights and lamps can be turned on and off, and automated blinds can be raised and lowered. These capabilities – combined with automated security systems – can help you mitigate the risks of intrusions: you will be alerted immediately if something uncharacteristic happens.

III. SYSTEM OVERVIEW

In this project we will arm our home with multiple Raspberry Pi that communicate among themselves to accomplish a common goal. We will begin by building a case for security with an emphasis on the lack of flexibility of commercially available systems — that's where we bring in Raspberry Pis to the rescue. Our interoperable system will involve Raspberry Pi, cameras, a mobile application for alert by predicting the presence of unknown person.To detect intruders and for face recognition we have used advanced SSD(Single Shot multi-box Detector), Ultra-light Detector and ZMQ Algorithm. A mobile application is developed using react native to enable live streaming and options are given for the user to alert the police, lock the door or can even ignore when an unknown trespasser enters the property. Our solution is flexible, affordable, and interoperable with other IoT devices and services that are worth paying for.

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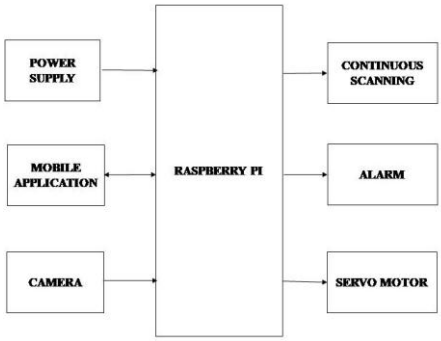

Fig 1: Block Diagram

IV. SYSTEM DESIGN

This section contains the circuit design and methodology to develop the prototype. The circuit diagram of this device is shown in fig 2.This device consists of the Raspberry Pi zero interconnected with CSI camera, Servo motor and Buzzer.The Raspberry Pi is a popular Single Board Computer (SBC) in that it is a full computer packed into a single board. The introduction of the Raspberry Pi Zero allowed one to embed an entire computer in even smaller projects. This guide will cover the latest version of the Zero product line, the Raspberry Pi Zero - Wireless, which has an onboard WiFi module. While these directions should work for most any version and form factor of the Raspberry Pi, it will revolve around the Pi Zero W. A servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. If motor is used is DC powered then it is called DC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in a small and light weight packages. They are being used in many applications like toy car, RC helicopters and planes, Robotics, Machine etc. Servo motors are rated in kg/cm (kilogram per centimeter) most hobby servo motors are rated at 3kg/cm or 6kg/cm or 12kg/cm. This kg/cm tells you how much weight your servo motor can lift at a particular distance. The Raspberry Pi Camera Board plugs directly into the CSI connector on the Raspberry Pi. It's able to deliver a crystal clear 5MP resolution image, or 1080p HD video recording at 30fps! Latest Version 1.3! Custom designed and manufactured by the Raspberry Pi Foundation in the UK, the Raspberry Pi Camera Board features a 5MP (2592?1944 pixels) Omnivision 5647 sensor in a fixed focus module. The module attaches to Raspberry Pi, by way of a 15 Pin Ribbon Cable, to the dedicated 15-pin MIPI Camera Serial Interface (CSI), which was designed especially for interfacing to cameras. The CSI bus is capable of extremely high data rates, and it exclusively carries pixel data to the BCM2835 processor. The board itself is tiny, at around 25mm x 20mm x 9mm, and weighs just over 3g, making it perfect for mobile or other applications where size and weight are important. The sensor itself has a native resolution of 5 megapixel, and has a fixed focus lens onboard. In terms of still images, the camera is capable of 2592 x 1944 pixel static images, and also supports 1080p @ 30fps, 720p @ 60fps and 640x480p 60/90 video recording. The camera is supported in the latest version of Raspbian, the Raspberry Pi's preferred operating system.

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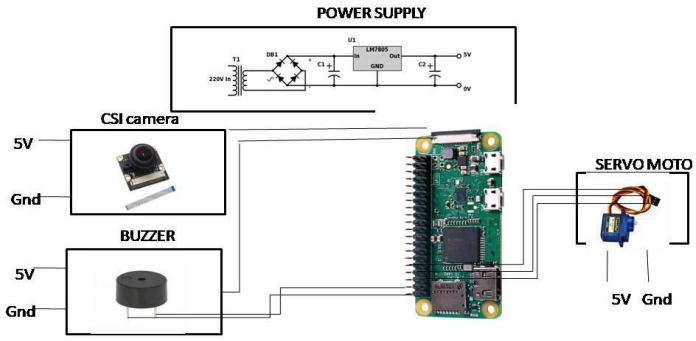

Fig 2: Circuit Diagram

V. ALGORITHMS USED

SSD (Single Shot Multi-Box Detector) algorithm is used in Object detection model and it is a popular algorithm in object detection. It's generally faster than Faster RCNN. A typical CNN network gradually shrinks the feature map size and increase the depth as it goes to the deeper layers. The deep layers cover larger receptive fields and construct more abstract representation, while the shallow layers cover smaller receptive fields objects and deeper layers to predict big objects, as small objects don't need bigger receptive fields and bigger receptive fields can be confusing for small objects.

The "Ultra-Light-Fast-Generic-Face-Detector" is designed for general-purpose face detection applications in low-power computing devices and is applicable to both Android and iOS phones as well as PCs (CPU and GPU). The model is a real-time ultra-lightweight universal face detection model designed for edge computing devices or low-power devices. It can be used in low-power computing devices such as ARM for real-time common scene faces. Facial recognition technology is widely applied in security monitoring, surveillance, human-computer interaction, entertainment.

Image ZMQ is an easy to use image transport mechanism for a distributed image processing network. For example, a network of a dozen Raspberry Pis with cameras can send images to a more powerful central computer. The Raspberry P is perform image capture and simple image processing like flipping, blurring and motion detection. Then the images are passed via image ZMQ to the central computer for more complex image processing like image tagging, text extraction, feature recognition.

FLOW CHART AND IMPLEMENTATION

A hardware setup is integrated with raspberry pi and camera for face detection and face recognition. The hardware sertup is installed near the doors of the house. A monile application is developed using react native node js for monitoring and alerting the owners of the house. Single Shot muli-box Detector and Ultra light detector algorithm is used for image detection and recognition. Image ZMQ algorithm is used to find the image being captured is regristered or unregistered face. This ensures safety and house is being monitored.

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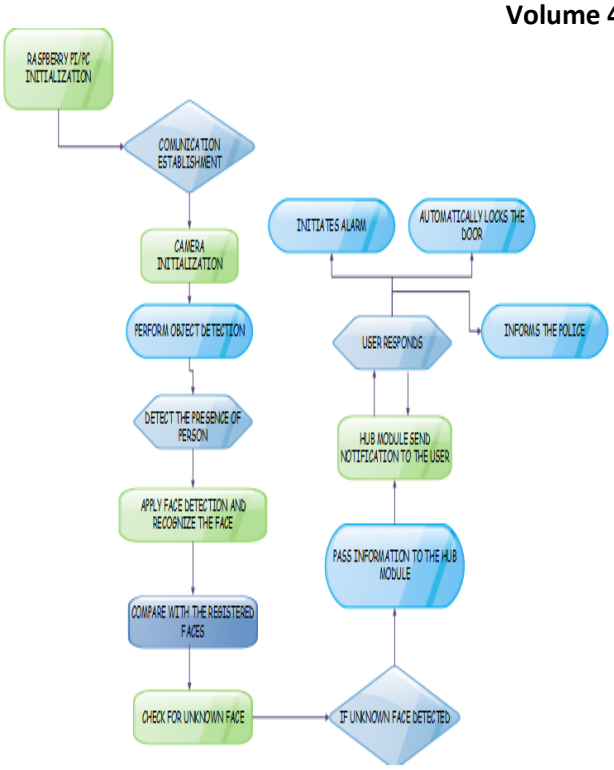

VI. CONCLUSION

Criminals may find an unprotected entry point into the home if just a front and backdoor sensor or a camera is used. By taking a tour around the perimeter of the home to spot any security weaknesses and with the help of cameras, raspberry pi, buzzer, mobile application, surveillance is done. So, in this way of home surveillance by intruder detection, recognition and alerting protection can be ensured.

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