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A Project Report

On

Surveillance Robot using Raspberry Pi

Submitted in partial fulfillment for the award of the degree of

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CERTIFICATE

Certified that the project work entitled ***"Surveillance Robot using Raspberry Pi"*** carried out by Mohammed Armaan D **[1JB21EC044],** Mohammed Irfan M **[1JB20EC045],** Mohan Teja K R **[1JB20EC046],** Vamshi T**[1JB22EC435]** are bonafide students of **SJB Institute of Technology** in partial fulfillment for the award of **"BACHELOR OF ENGINEERING"** in **ELECTRONICS AND COMMUNICATION ENGINEERING** as prescribed by **VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI** during the academic year **2024 – 25**. It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said degree.

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DECLARATION

We hereby declare that the entire work embodied in this project report has been carried out under the supervision of **Dr. Anitha P, Asso. Professor** in partial fulfillment for the award of "BACHELOR OF ENGINEERING" in ELECTRONICS AND COMMUNICATION ENGINEERING as prescribed by VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI during the academic year 2024 – 25.

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ABSTRACT

India's land border has extended over 15,207km with the coastal area extending over 7517 km in length. A total of ninety-two districts over seventeen states are meant for the bordered districts. Large tracts of India's political borders square measure controversial, poorly demarcated or not demarcated by natural features. In addition, the risk of conventional international disputes these unsure borders additionally gift the challenge of cross-border infiltration, smuggling, illegal migration, and other forms of criminal activity. Hence, the human labor is wasted in the form of mere monitoring activities. Instead it could be used productively in case of attacks and defense scenarios where the human intervention is really necessary. The main objective of this project is to develop a virtual environment for detecting suspicious and targeted places for user without any loss of human life. It is based on development of a robot vehicle for observing/spying the suspicious objects. It can continuously monitor the objects. Robot can move in every direction (left, right, forward and backward).It is used for video surveillance and remotely control the particular place using Wi-Fi as medium. The webcam which is placed on the robotic unit will capture the video and it transmits lively to the remote end.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The prior concept of this is to detect and target the living object or any movement in highly secured area such as Border by using automation. The automation is sensor base automated laser targeting system target the living object within the range of sensor. The automatic laser targeting is primary base on PIR sensors, microcontroller and RF transmitting and receiving unit with targeting gun. Until then, border is done by Iron Spike wires, and a watch tower from which a person continuously flashing the light over the border area day and night. Those persons are fully responsible for border security. This will not fully remove the responsibility from their soldiers, but shares the maximum responsibility and will reduce human mistake on the border.

The sensors will sense any living object within the provide range. Over the last ten years or so, face recognition has become a popular area of research in computer vision and one of the most successful applications of image analysis and understanding. Because of the nature of the problem, not only computer science researchers are interested in it, but neuroscientists and psychologists also. It is the general opinion that advances in computer vision research will provide useful insights to neuroscientists and psychologists into how human brain works, and vice versa. The goal is to implement the system (model) for a particular face and distinguish it from a large number of stored faces with some real-time variations as well.

A **Smart Motion Detection Surveillance Rover Monitoring System** is an innovative mobile platform that integrates motion detection, robotics, and artificial intelligence to provide advanced surveillance capabilities. It features smart sensors such as infrared, ultrasonic, and LiDAR for real-time motion detection, coupled with AI algorithms to distinguish between humans, animals, and objects, minimizing false alarms.

It gives us efficient way to find the lower dimensional space. Further this algorithm can be extended to recognize the gender of a person or to interpret the facial expression of a person. Recognition could be carried out under widely varying conditions like frontal view, a 45° view, scaled frontal view, subjects with spectacles etc. are tried, while the training data set covers limited views. The algorithm models the real-time varying lighting conditions as well. But this is out of scope of the current implementation.

This approach is preferred due to its simplicity, speed and learning capability. The autonomous rover is equipped with adaptable mobility systems like wheels, tracks, or legs, allowing it to navigate various terrains independently or under remote control. High-definition cameras with 360° vision, night vision, and thermal imaging enable continuous monitoring in challenging environments. Advanced AI ensures efficient threat analysis, behavior prediction, and facial recognition for identifying authorized personnel and escalating alerts.

Wireless communication using 5G, Wi-Fi, or secure RF channels facilitates real-time data transmission to a control center or mobile device, supported by edge computing for low-latency processing and cloud storage for long-term analytics. The system employs SLAM (Simultaneous Localization and Mapping) for generating and navigating 3D maps, ensuring situational awareness in complex environments. Power is managed through energy-efficient designs, incorporating solar panels or advanced batteries for extended operation, and docking stations for autonomous charging. With encrypted communication and tamper-proof hardware, the system is highly secure and suitable for applications such as military patrolling in high-risk areas, industrial perimeter surveillance, and public safety monitoring.

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1.2 Motivation

- **Enhanced Security**: Traditional fixed surveillance systems are limited by their static nature and field of view. A mobile rover adds versatility, allowing real-time monitoring and immediate response to threats in dynamic environments.
- **Reducing Human Risk**: Deploying autonomous rovers in dangerous or high-risk areas, such as conflict zones or hazardous industrial sites, minimizes the need for human personnel, ensuring their safety.
- **Efficiency and Precision**: AI-powered motion detection and pattern recognition improve the accuracy of threat detection, reducing false alarms and focusing on genuine risks, saving time and resources.
- **Scalability for Large Areas**: Rovers can navigate expansive areas such as warehouses, borders, or remote military bases, where deploying numerous static cameras would be impractical or cost-prohibitive.
- **Adaptability to Diverse Conditions**: Equipped with advanced sensors and mobility systems, these rovers can operate in varied terrains and weather conditions, ensuring consistent performance in any environment.
- **Real-Time Response**: The integration of wireless communication and edge computing enables instantaneous data processing and response, critical for time-sensitive scenarios like intrusions or emergencies.
- **Technological Advancement**: The system showcases cutting-edge technologies like AI, robotics, and IoT, driving innovation and inspiring further developments in smart security solutions.
- **Cost-Effectiveness**: Over time, mobile and intelligent systems can be more economical by reducing the need for extensive human involvement and infrastructure for surveillance.
- **Privacy Considerations**: Mobile systems can be selectively deployed, offering a more targeted approach to surveillance while minimizing invasive monitoring of non-critical areas.
- **Public Safety**: These systems enhance safety in public spaces such as parks, transportation hubs, and events by proactively monitoring for suspicious activities and deterring potential threats.

1.3 Problem Statement

The aim is to make a smart surveillance system which can be monitored by owner remotely through android application. As it is connected with the system with IOT, system will send the push notification to android device when an intrusion is detected inside the room. It is required to develop and implement and affordable low-cost web-camera based surveillance system for remote security monitoring.

Authorized user can access to their monitoring system remotely via internet with the use a mobile phone and monitor the situation on application. This entire work is done on raspberry pi with Raspbian operating system ported on it. Surveillance System consists of mainly two parts:

Hard-wired surveillance systems: These systems use wires to connect the cameras, motion detectors, power supply and LAN cable with the pi.

Remote Access Systems: These systems have the capability to monitor and control a security system from a location away from the surveillance area through android device.

1.4 Scope of the Project

Until now the border security was totally depending on soldier. In highly secured area the soldier detected the enemy and targets him. But if the solder was not able to detect the enemy the enemy could easily enter the secure area. So, for the increasing the security level microcontroller based automatic gun targeting system is introduced. The basic purpose of this automatic gun targeting system is to secure the border using automation and this will reduce the human effort. Current system is capable to detect any PIR radiation in the range of border and automatically target its position. The introduced system is based on PIR sensor The PIR sensor senses the temperature differences and then these signals are coded by microcontroller and transmitted toward the receiver on watch tower.

In this, we present a real time method based on some video and image processing algorithms for Face detection. The motivation of this research is the need of disabling who cannot communicate with human. A Haar Cascade Classifier is applied for face and eye detection for getting eye and facial axis information. In addition, the same classifier is used based on Haar - like features to find out the relationship between the eyes and the facial axis for positioning the eyes.

Security and authentication of a person is a crucial part of any industry. There are many techniques used for this purpose. One of them is face recognition. Face recognition is an effective means of authenticating a person. The advantage of this approach is that, it enables us to detect changes in the face pattern of an individual to an appreciable extent. The recognition system can tolerate local variations in the face expression of an individual. Hence face recognition can be used as a key factor in crime detection mainly to identify criminals. There are several approaches to face recognition of which Principal Component Analysis (PCA) have been incorporated in our project. The system consists of a database of a set of facial patterns for each individual. The characteristic features called ‘eigenfaces’ are extracted from the stored images using which the system is trained for subsequent recognition of new images.

1.5 Challenges

- **Complexity of Development**: Designing a system that integrates advanced sensors, AI, robotics, and real-time communication requires significant technical expertise and coordination across disciplines.
- **Cost**: The initial investment in hardware, software, and infrastructure can be prohibitively expensive, especially for organizations with limited budgets.
- **Battery Life and Power Management**: Maintaining extended operational time for mobile rovers, especially in remote areas, requires advanced power solutions like efficient batteries or reliable solar charging.
- **Navigation in Complex Environments**: Ensuring precise movement and obstacle avoidance in crowded or irregular terrains remains a technical hurdle, especially for fully autonomous systems.
- **False Positives and Detection Errors**: Despite advancements in AI, differentiating between harmless activities (e.g., animals or wind-blown objects) and genuine threats can still lead to errors and unnecessary alerts.
- **Cybersecurity Risks**: As a connected device, the system is vulnerable to hacking, data breaches, and other cyber threats, necessitating robust encryption and security measures.
- **Maintenance and Repairs**: Regular upkeep of hardware, software updates, and repairs for moving parts like motors or cameras can be costly and time-consuming.
- **Environmental Limitations**: Extreme weather conditions, such as heavy rain, snow, or heat, can affect sensor accuracy, mobility, and overall system reliability.

1.6 Objectives

- **Enhanced Threat Detection**: Provide accurate, real-time detection of unauthorized or suspicious activities, distinguishing between humans, animals, and objects to minimize false alarms.
- **Comprehensive Surveillance Coverage**: Extend monitoring capabilities to areas where static cameras or stationary systems are impractical, ensuring 360° coverage and adaptability to diverse terrains.
- **Rapid Response to Incidents**: Enable swift action by autonomously tracking and analysing threats, relaying critical data to human operators or automated response systems.
- **Improved Safety**: Reduce risks to human personnel by deploying the system in hazardous or high-risk environments, such as conflict zones, disaster areas, or industrial sites.

- **Operational Efficiency**: Leverage AI and edge computing to filter and analyses large amounts of data locally, prioritizing actionable insights and reducing reliance on remote processing.
- **Adaptability to Environmental Conditions**: Ensure reliable performance in various settings, including low-light, extreme weather, and rugged terrains, using advanced sensors and robust design.

CHAPTER 2

LITERATURE SURVEY

2.1 "Army to deploy remote controlled guns at LoC to take on infiltrators"

Author: Dr. Shantanu K. Dixit, Mr. S. B. Dhayagonde**. Publisher:** HINDUSTAN TIMES**.** **Published**: 2023

Summary: The locally-developed integrated contraption uses a mix of infrared sensors radiating a grid of beams to detect any movement up to a distance of 80 meters ahead of the border fence. The distance between the fence and the LoC can vary from 50 meters to over 2km depending on the terrain. The sensors are linked to automatic guns mounted on rotors and mated to night-vision cameras providing live images to commanders manning workstations. A buzzer is sounded if the grid is broken, swiveling the weapon in the direction of the intrusion site.

2.2 "video capture system using Raspberry Pi"

Author: D. Jeevanand, et al**. Publisher:** IJISRT Journals**. Published**: 2024

Summary: The proposed system works on capturing video and distributing with networked systems. And besides alerting the administration person via SMS alarm as required by the client. Their system was designed to work in a real-time situation and based on Raspberry Pi SBC. Contrasting to other embedded systems their real-time application offers client video monitor with the help of alerting module and SBC platform.

2.3 "Eye Tracking System with Blink Detection"

Author: S. Naveed and B. Sikander**. Publisher:** IRJIET Journals**. Published**: 2024

Summary: The goal is to implement the system (model) for a particular face. And distinguish it from a large number of stored faces with some real-time variations as well. It gives us efficient way to find the lower dimensional space. Further this algorithm can be extended to recognize the gender of a person or to interpret the facial expression of a person.

2.4 "Design and Implementation of e-Surveillance Robot for Video Monitoring and Living Body Detection"

Author: Dr. Shantanu, Mr. S. B. Dhayagonde**. Publisher:** IRJIET Journals**. Published**: 2024

Summary: This system that consists of a mobile robot, controlled by Internet, which has camera mounted and a PIR sensor for detecting the living bodies. User will be able to control the robot through internet, thus, providing the wireless control of robot. Also, information regarding the detection of living bodies will be given to the user on the webpage from the PIR sensor. Simultaneously user will be able to access the video transmission from the robot

2.5 "Android Based Autonomous Intelligent Robot for Border Security"

Author: C. M. Naveen Kumar, et.al. **Publisher:** IEEE**. Published:** 2020

Summary: In our work-in-progress project that integrates educational robot technology into elementary school classroom, Digi-Robot is brought into children's learning of angle. In this paper, a real time tracking system by vision is presented. Thanks to it, the interaction between the human and the robot is simplified for example, in the case of the remote control of mobile robot.

Fig 2.1 Manual Border Security

2.6 "Real time video-controlled traction for surveillance robots in coal mine"

Author: Sarath Chandran.C and Anjaly k. **Publisher:** International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering**. Published:** 2024

Summary: An autonomous intelligent robot which identifies trespasser using PIR motion sensor, alerts security personnel. It captures image of the trespasser using camera. And mails this image to specified e-mail id using raspberry pi processor.

Sarath Chandran.C and Anjaly presented a novel video-based coal mine rescue robot. If the coal mine disaster occurs, the situation will be unknown and it is very dangerous to go to the mine without knowing any environment situation. The first mission of the rescuers is to detect the mine situations by considering various parameters

CHAPTER 3

PROPOSED METHODOLOGY

3.1 Functional Block Diagram of Rover

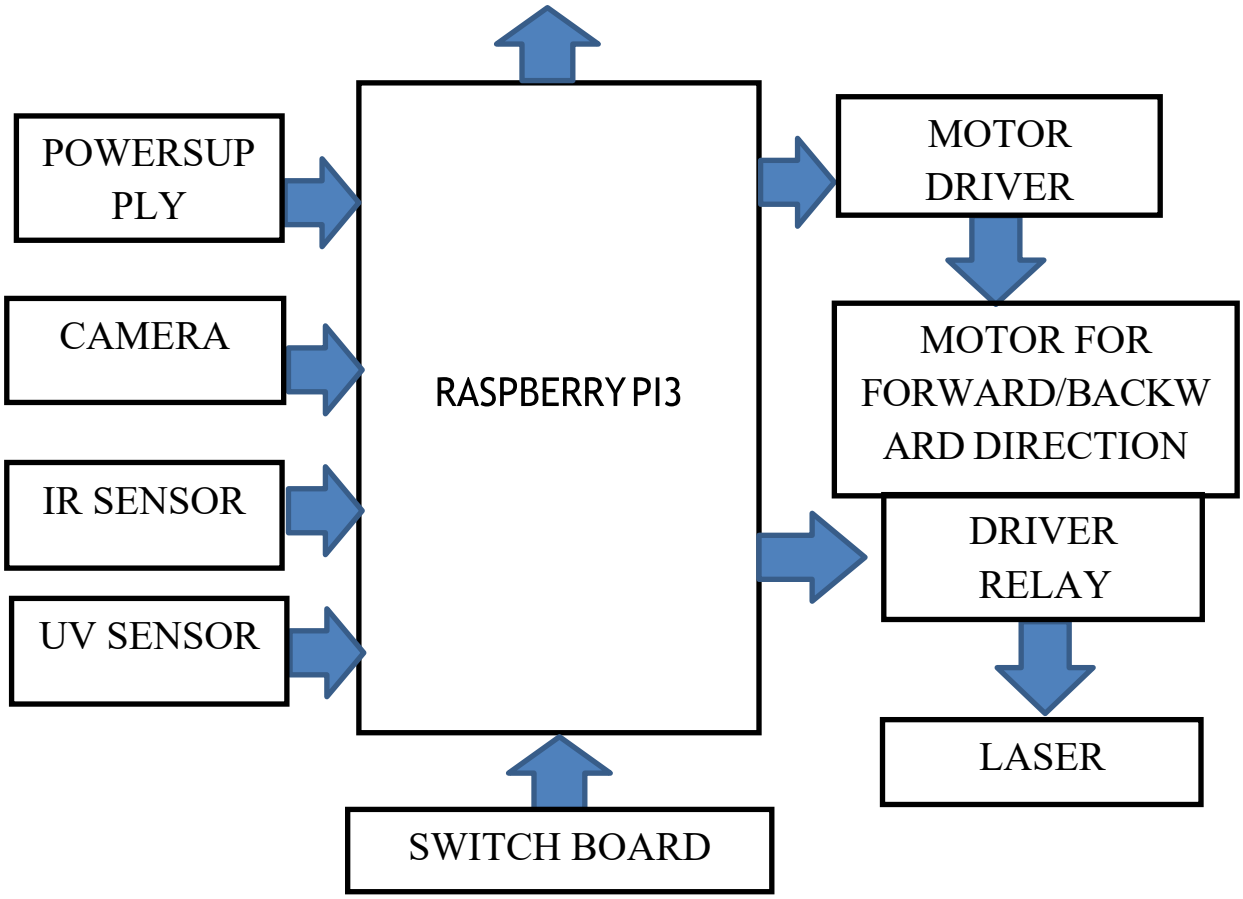

Fig 4.1 Functional Block Diagram of Rover

If it detects any obstacle, it has a web camera mounted over it, through which we will get real time image and the webcam will capture the image with regards to its surroundings and then send it to a desired device through internet. The user will be observing this data on the monitor at the user end. According to the desired movement, it will send database to the user end. Rover compares the real time image with our database, if it is known then rover moves forward if it is unknown then it triggers the laser towards the intruder using the relay.

3.2 Face Detection

The Haar classifier is used in EBCM algorithm for face detection. Haar classifier rapidly detects any object, based on detected feature not pixels, like facial feature. However, the area of the image being analyzed for a facial feature needs to be regionalized to the location with the highest probability of containing the feature. By regionalizing the detection area, false positives are eliminated. As the result, the face is detected and marked with color rectangle and will be used later to approximate an axis of the eyes for eye detection step.

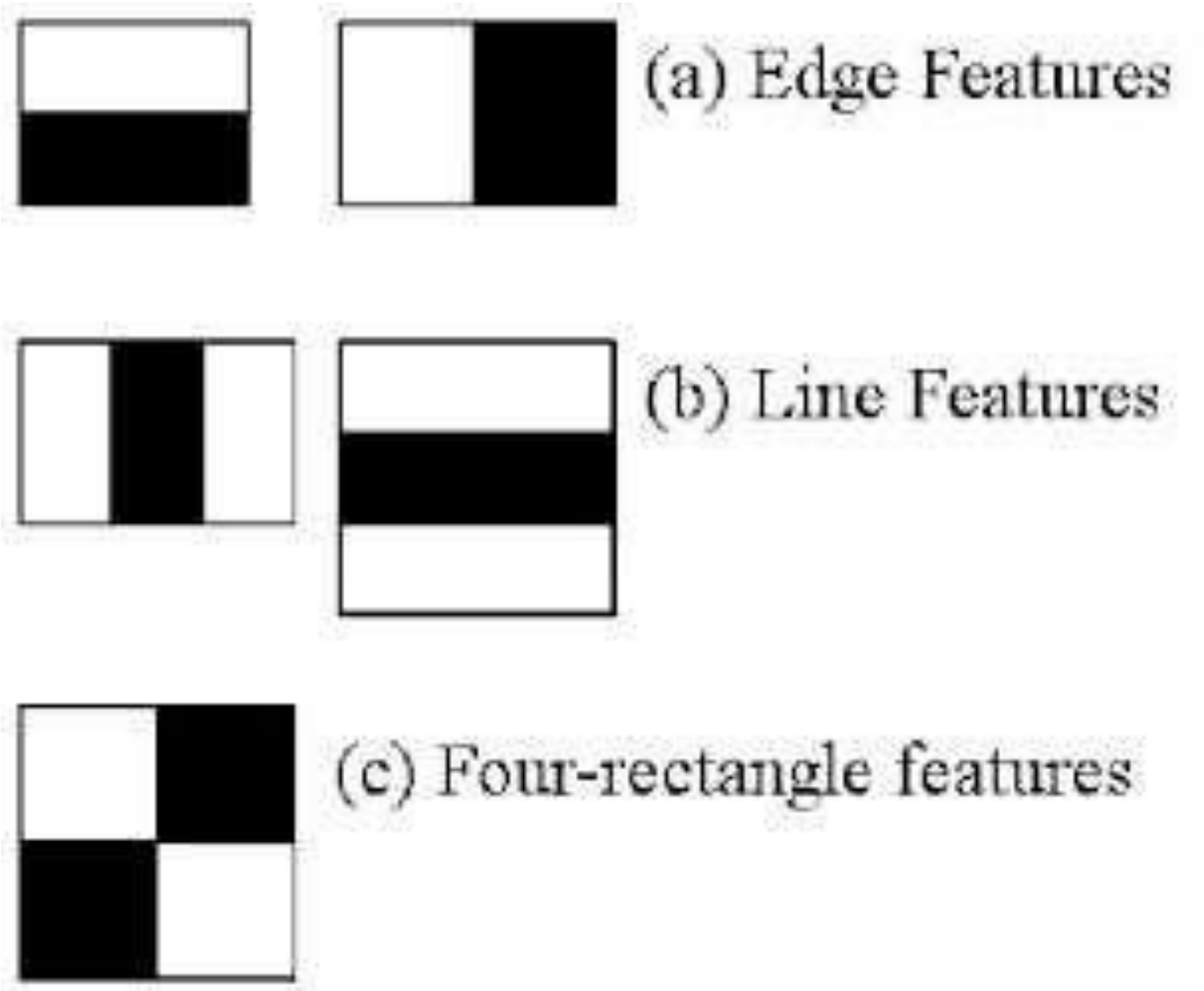

Fig 3.1 Pixels

Initially, the algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier. Then we need to extract features from it. For this, haar features shown in below image are used. They are just like our convolutional kernel. Each feature is a single value obtained by subtracting sum of pixels under white rectangle from sum of pixels under black

rectangle. Now all possible sizes and locations of each kernel is used to calculate plenty of features. For each feature calculation, we need to find sum of pixels under white and black rectangles. To solve this, they introduced the integral images. It simplifies calculation of sum of pixels, how large may be the number of pixels, to an operation involving just four pixels. Top row shows two good features. The first feature selected seems to focus on the property that the region of the eyes is often darker than the region of the nose and cheeks. The second feature selected relies on the property that the eyes are darker than the bridge of the nose. But the same windows applying on cheeks or any other place is irrelevant.

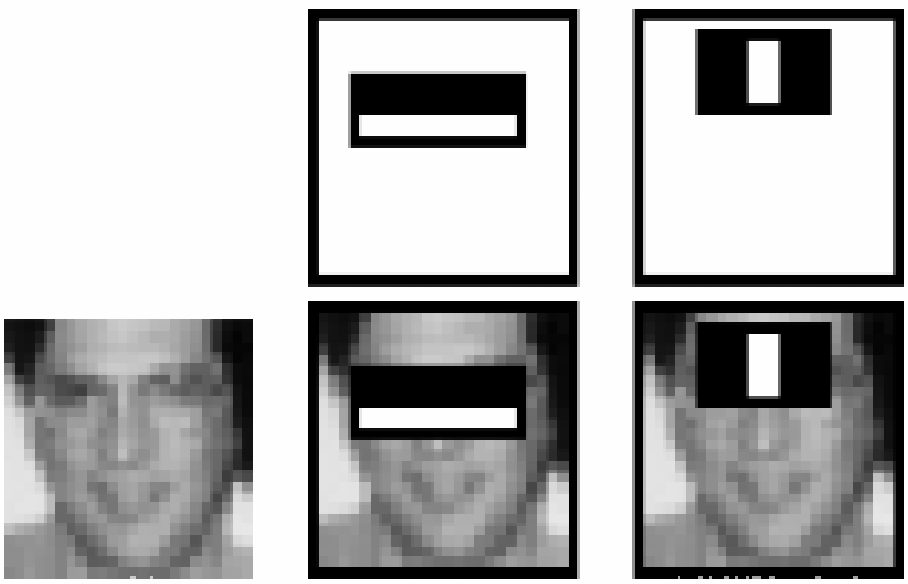

Fig 3.2 Face Detection

3.3 Obstacle Detection

IR sensor module is used for obstacle detection. It is connected to Raspberry pi and it detects the obstacles in the straight-line path. If the obstacle is detected it sends the signal to the Raspberry pi and the direction of the rover will be changed according to which it is programmed. An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only infrared radiation, rather than emitting it that is called as a passive IR sensor. Infrared Obstacle Sensor Module has built in IR transmitter and IR receiver that sends out IR energy and looks for reflected IR energy to detect presence of any obstacle in front of the sensor module.

3.4 Image Processing

Web camera is used for capturing the images, of about 2 per second instead of sending a greater number of images as it increases the network traffic. The image processing is done in raspberry pi using C or python instead of MATLAB. Only the images are taken and processed instead of video as the images are enough. We can view the images in the remote host which is sent through internet.

Multiple object detection and trailing in outside setting may be a difficult task owing to the issues raised by less lighting conditions, variation in human poses, shape, size, clothing, etc. In case if the image is dark, the exposure will be increased with the image processing techniques and similarly vice versa. During motion, the surveillance system detects other moving objects and identify them as humans, animals, vehicles. For this purpose, Image can be split into several sections and comparison of the segments is performed

3.5 Frame Capturing

The first step of the proposed EBCM application is the initialization. After taking a short video of the participant's face using the front camera of the Samsung mobile. A process Frame method will be used to create the frames from the captured video. Afterwards the colored frames will be converted to gray scale frames by extracting only the luminance component as shown in figure.

Ever since this tiny, less than credit-card-sized computer, Raspberry Pi zero w, it's appeared in the market, it has caught the imagination of every electronics and computer hobbyist around the world. The powerful Linux operating system combined with 40 input- output (I/O) pins can do many amazing things out-of-the-box. This article explains how to interface a USB camera and Wi-Fi with Raspberry Pi. It also to capture the image.

- Install fswebcam.
- Basic image capturing usage.
- Set specify a resolution.
- Set full a resolution with no banner.
- Bash script.
- Python with Bash script.
- Time lapse using CRON.

Fig 3.3 Frame Capture

Number of pictures for the selected video fragment. The number can vary from 1 to 300 frames. Select a corresponding option button and choose a value from the list or set it manually. Time interval to capture a picture. The interval can vary from 1 to 30 seconds. Select a corresponding option button and choose a value from the list or set it manually.

3.6 Laser Module

Depending on the input received from camera if face recognition fails then immediately Pi initiates Motor and initializes the laser to shoot the unauthorized entered person. In the circuit diagram the gun firing control mechanism is replaced with LED. When the LED will not glow, means no object sensed by the sensor, so the gun will not fire means the LED is off.

When the port will be high on the object detection by the sensor, the transistor LED on means the object completely destroyed by targeting gun. a device that generates an intense beam of coherent monochromatic light (or other electromagnetic radiation) by stimulated emission of photons from excited atoms or molecules. Lasers are used in drilling and cutting, alignment and guidance, and in surgery; the optical properties are exploited in holography, reading barcodes, and in recording and playing compact discs.

3.7 Getting Location

GPS module is connected to the Raspberry pi in order to find the current location of the bot. The GPS statement is being sent as a set of packets of data, so that it can be decoded to find International Journal of Pure and Applied Mathematics Special Issue 70 required data (i.e.) direction, timing, location and lot more. Each electric panel contains switches that redirect electricity. An electrical switchboard is a single large panel or can be a combination of electrical panels on which switches and other power control equipment are mounted.

The main purpose of the board is to control the flow of power. It divides the main current supplied to it into several smaller chunks and distributes it to the devices. In precise, switchboards supply power to transformers, panels, and other equipment and from there power further gets distributed. The GPS statement we receive should be sent by at least three or more satellite such that it becomes valid.

3.8 Rover Movement

Raspberry pi is used for two modes of action. The Remote-Control mode, where the rover is controlled manually from remote International Journal of Pure and Applied Mathematics Special Issue 69 device through the web server connecting it with an internet connection. This is done when the signal is passed from the Raspberry Pi and being the master controls the movement of the rover. The movement of the

robot is controlled with keys for all four directions besides with start and stop function in the web server. During autonomous mode the rover is programmed through the Raspberry Pi while the ultrasonic sensor detects in case of any obstacle and changes its direction accordingly.

A direct current, or DC, motor is the most common type of motor. DC motors normally have just two leads, one positive and one negative. If you connect these two leads directly to a battery, the motor will rotate. If you switch the leads, the motor will rotate in the opposite direction. To control the direction of the spin of DC motor, without changing the way that the leads are connected, you can use a circuit called an H-Bridge.

An H bridge is an electronic circuit that can drive the motor in both directions. H-bridges are used in many different applications, one of the most common being to control motors in robots. It is called an H-bridge because it uses four transistors connected in such a way that the schematic diagram looks like an "H."

3.9 Capturing Image

A webcam is a video camera which feeds its images in real time to a computer or computer network, often via USB, Ethernet or Wi-Fi. Their most popular use is the establishment of video links, permitting computers to act as videophones or video conference stations. This common use as a video camera for the World Wide Web gave the webcam its name. Other popular uses include security surveillance and computer vision. The Webcams are known for their low manufacturing cost and flexibility, making them the lowest cost form of video telephony. They have also become a source of security and privacy issues, as some built-in webcams can be remotely activated via spyware. To take pictures in 0.025s with picamera you'll need a frame-rate greater than or equal to 80fps. The reason for requiring 80 rather 40fps (given that 1/0.025=40) is that currently there's some issue which causes every other frame to get skipped in the multi- image encoder so the effective capture rate winds up as half the camera's framerate. The Pi's camera module is capable of 80fps in later firmwares (see camera modes in the picamera docs), but only at a VGA resolution (requests for higher resolutions with framerates >30fps will result in upscaling from VGA to the requested resolution, so this is a limitation you'd face even at 40fps). The other problem you'll likely encounter is SD card speed limitations. In other words, you'll probably need to capture to something faster like a network port or in-memory streams (assuming all the images you need to capture will fit in RAM).

CHAPTER 4

HARDWARE SOFTWARE COMPONENTS

4.1 Hardware components

4.1.1 Raspberry Pi 3

The Raspberry Pi 2 uses a 32-bit 900 MHz quad-core ARM Cortex-A7processor.The Broadcom BCM2835 SoC used in the first-generation Raspberry Pi is somewhat equivalent to the chip used in first modern generation smartphones (its CPU is an older ARMv6 architecture), which includes a 700 MHz ARM1176JZF-S processor, VideoCore IV graphics processing unit (GPU), and RAM. It has a level 1 (L1) cache of 16 KB and a level 2 (L2) caches of 128 KB. The level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible.

The earlier V1.1 model of the Raspberry Pi 2 used a Broadcom BCM2836 SoC with a 900 MHz 32-bit quad-core ARM Cortex-A7 processor, with 256 KB shared L2 cache. The Raspberry Pi 2 V1.2 was upgraded to a Broadcom BCM2837 SoC with a 1.2 GHz 64- bit quad-core ARM Cortex-A53 processor, the same SoC which is used on the Raspberry Pi 3, but under clocked (by default) to the same 900 MHz CPU clock speed as the V1.1. The BCM2836 SoC is no longer in production (as of late 2016). The Raspberry Pi 3+ uses a Broadcom BCM2837B0 SoC with a 1.4 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache. Along with the Pi itself, the microSD card, and power supply, you'll need a HDMI cable and a suitable display. As with a traditional computer, you'll also need a USB keyboard and mouse. The Raspberry Pi 3 has built in Wi-Fi and Bluetooth, but if you're using a different model, you'll need compatible USB dongles (you can check compatibility at elinux.org's Raspberry Pi Hub). If you prefer to use Ethernet, however, the Pi is equipped with an Ethernet port. Once you're set up, and have your preferred operating system installed (unless specified, all of these projects require the latest version of Raspbian), you'll find all of the tools you need to run your Raspberry Pi like a desktop computer.

The only way to find the answer to these questions is with some sort of security system. With the Raspberry Pi Camera Module attached, or a generic USB webcam, you can build a motion capture security system. Note that you will need a high-capacity microSD card, or a USB storage device, for storing footage from the device. This Raspberry Pi project combines the motion software with uvccapture, a tool for capturing the footage from your webcam.

The ffmpeg software is also used to for managing the bitrate and time lapse. Once it's all up and running, you can expect the system to start recording whenever motion is detected. Email alerts can also be configured.

Fig 4.2 Raspberry Pi 3

4.1.2 Power Supply

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable DC voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. DC voltages are required to operate various electronic equipment.

These voltages are 5V, 9V or 12V which cannot be obtained directly. Thus, the input to the circuit is applied from the regulated power supply. A power supply takes the AC from the wall outlet, converts it to unregulated DC, and reduces the voltage using an input power transformer, typically stepping it down to the voltage required by the load. For safety reasons, the transformer also separates the output power supply from the mains input. A power supply is an electrical device that supplies electric power to an electrical load.

The primary function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are separate standalone pieces of equipment, while others are built into the load appliances that they

power. Examples of the latter include power supplies found in desktop computers and consumer electronics devices. Other functions that power supplies may perform include limiting the current drawn by the load to safe levels, shutting off the current in the event of an electrical fault, power conditioning to prevent electronic noise or voltage surges on the input from reaching the load, power-factor correction, and storing energy so it can continue to power the load in the event of a temporary interruption in the source power.

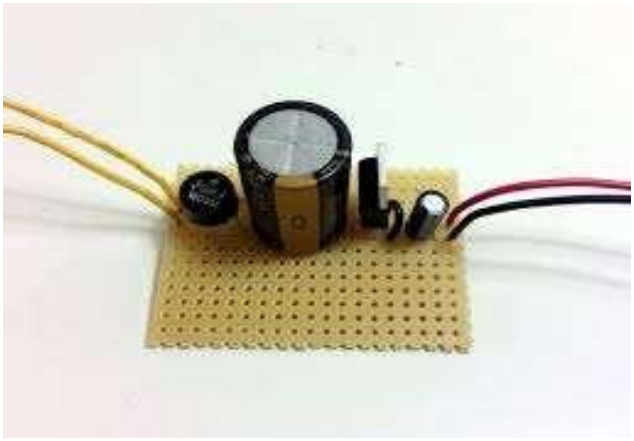

Fig 4.3 Power Supply

4.1.3 Infrared Sensor

It is an electronic instrument. It is used to sense certain characteristics in its surroundings by emitting infrared radiations. Capable of measuring heat and detection of moving object. This type of sensor measures only infrared radiation, rather than emitting it. Specifications: Size:3mm TX: Transmitter RX: Receive The living or non-living object can be detected using this sensor by sensing the heat from the object. It has 4 pins, vcc, gnd and out. The operating voltage is 5V. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. An IR sensor typically consists of an emitter (like an LED) and a receiver (such as a photodiode). Infrared (IR) sensors are devices that detect infrared radiation, widely used for sensing heat and motion. They work by detecting IR light emitted or reflected by objects. These sensors can operate as active, emitting and detecting IR light, or passive, sensing naturally emitted infrared radiation, like in PIR sensors. Common applications include motion detection in security systems, proximity sensing in robots, non-contact temperature measurement, remote controls, and industrial process monitoring.

Fig 4.4 IR Sensor

4.1.4 Relay

A 5-volt relay is an electromechanical switch that allows a low-power circuit (e.g., from a microcontroller like Arduino) to control a high-power circuit or device. It acts as an interface between the low-voltage logic of microcontrollers and high-voltage devices such as motors, lights, or appliances**.** The relay uses an electromagnetic coil to mechanically switch contacts.

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. The relay's switch connections are usually labelled COM(POLE), NC and NO. In order to trigger the laser, we use driver relay. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations. A **relay** is an electrically operated switch that uses an electromagnet to mechanically operate one or more sets of contacts. It allows a low-power electrical signal to control a high-power circuit, providing electrical isolation between the control and the operated circuits.

Fig. 4.5 Relay

4.1.5 DC Motors

DC motors convert electrical into mechanical energy and they consist of permanent magnets and loops of wire inside, when current is applied, the wire loops generate a magnetic field, which reacts against the outside field of the static magnets. The interaction of the fields produces the movement of the shaft/armature. Thus, electromagnetic energy becomes motion. Here we use two DC motors for the movement of rover.

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A **DC motor** is an electric motor that converts direct current (DC) electrical energy into mechanical energy.

It operates based on the interaction between the magnetic field generated by the motor's windings and a fixed magnetic field or permanent magnets. A DC motor's speed can be controlled over

a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances.

Fig 4.6 DC Motor

4.1.6 Camera

USB Cameras are imaging cameras that use USB 2.0 or USB 3.0 technology to transfer image data. USB Cameras are designed to easily interface with dedicated computer systems by using the same USB technology that is found on most computers. A **USB camera** is a digital camera that connects to a computer or other devices via a USB (Universal Serial Bus) interface. It captures images and videos, transmitting the data directly to the connected device for processing, storage, or real-time viewing. USB cameras are commonly used for video conferencing, streaming, surveillance, and imaging applications due to their plug-and-play convenience. They come in various forms, including webcams for personal use, high-resolution cameras for professional photography, and specialized cameras for industrial or scientific purposes. Modern USB cameras often support advanced features such as autofocus, high-definition resolution, and compatibility with software for customization and control. Their ease of use and versatility make them essential for both casual and professional users.A camera is an optical instrument to capture still images or to record moving images, which are stored in a physical medium such as in a digital system or on photographic film. A camera consists of a lens which focuses light from the scene, and a camera body which holds the image capture mechanism. The still image camera is the main instrument in the art of photography and captured images may be reproduced later as a part of the process of photography, digital imaging, photographic printing. The accessibility of USB technology in computer systems as well as the 480 Mb/s transfer rate of USB 2.0 makes USB Cameras ideal for many imaging applications. An increasing selection of USB 3.0 Cameras is also available with data transfer rates of up to 5 Gb/s.

Fig 4.7 USB Camera

4.1.7 H-Bridge

An H bridge is an electronic circuit that switches the polarity of a voltage applied to a load. These circuits are often used in robotics and other applications to allow DC motors to run forwards or backwards. The H-bridge arrangement is generally used to reverse the polarity/direction of the motor, but can also be used to 'brake' the motor, where the motor comes to a sudden stop, as the motor's terminals are shorted, or to let the motor 'free run' to a stop, as the motor is effectively disconnected from the circuit.An H Bridge is a set of four switches that are assembled in such a way that an arbitrary load impedance is decoupled from a direct current (DC) power rail and ground. These switches can then be used to control the direction of current running from the DC source to ground in either direction across the connected impedance. The “H” in H Bridge comes from the shape of the bridge, where either side of the H is different two switches in series between the DC rail and ground while the centerline of the H is an arbitrary impedance. An example of a simple H Bridge with four switches and single load impedance is shown in Figure 1 to the right. Each of the switches in this figure are independent from each other and only have two positions, either conducting current (ON) or blocking current (OFF). H Bridges can be found in many different applications where there is a desire to have control over the direction current can flow. Some common examples of this would be controlling the direction an electric motor can turn by allowing current to flow in one direction and then reversing that direction in the bridge, thus causing the motor to turn in the opposite direction. In the case of the high-powered inverter being constructed by Team 7 of ECE 480 Fall Semester 2014, an H Bridge is being utilized to create an Alternating Current (AC) waveform from a high voltage DC Rail. This is done by reversing the direction of current flow across the load impedance at a frequency of 60 Hz which in turn results in an alternating current signal at the same frequency of typical line current in the United States.

Fig 4.8 H-Bridge

4.1.8 Laser

A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. The term "laser" originated as an acronym for “Light Amplification by Stimulated Emission of Radiation”. The term "laser" originated as an acronym for "Light Amplification by Stimulated Emission of Radiation". The first laser was built in 1960 by Theodore H. Maimane at Hughes Research Laboratories, based on theoretical work by Charles Hard Townes and Arthur Leonard Schawlow. A laser differs from other sources of light in that it emits light coherently. Spatial coherence allows a laser to be focused to a tight spot, enabling applications such as laser cutting and lithography. Alternatively, temporal coherence can be used to produce pulses of light with a broad spectrum but durations as short as a femtosecond ("ultrashort pulses"). Spatial coherence also allows a laser beam to stay narrow over great distances (collimation), enabling applications such as laser pointers and lidar. Lasers can also have high temporal coherence, which allows them to emit light with a very narrow spectrum, i.e., they can emit a single color of light.

Fig. 4.9 Laser

4.1.9 Battery

A battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smartphones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, thin cells used in smartphones, to large lead acid batteries or lithium-ion batteries in vehicles, and at the largest extreme, huge battery banks

the size of rooms that provide standby or emergency power for telephone exchanges and computer data centers. The free-energy difference is delivered to the external circuit as electrical energy. Batteries come in many shapes and sizes, from miniature cells used to power hearing aids and wristwatches to small, thin cells used in smartphones, to large lead acid batteries or lithium-ion batteries in vehicles, and at the largest extreme, huge battery banks the size of rooms that provide standby or emergency power for telephone exchanges and computer data centers.

Fig 4.10 Battery

4.1.10 UV Sensors

Ultrasonic sensors are devices that use electrical–mechanical energy transformation to measure distance from the sensor to the target object. Ultrasonic waves are longitudinal mechanical waves which travel as a sequence of compressions and rarefactions along the direction of wave propagation through the medium. Apart from distance measurement, they are also used in ultrasonic material testing (to detect cracks, air bubbles, and other flaws in the products), Object detection, position detection, ultrasonic mouse, etc.

These sensors are categorized in two types according to their working phenomenon – piezoelectric sensors and electrostatic sensors. Here we are discussing the Ultrasonic sensors are devices that use electrical–mechanical energy transformation to measure distance from the sensor to the target object. Ultrasonic waves are longitudinal mechanical waves which travel as a sequence of compressions and rarefactions along the direction of wave propagation through the medium. Apart from distance measurement, they are also used in ultrasonic material testing (to detect cracks, air bubbles, and other flaws in the products), Object detection, position detection, ultrasonic mouse, etc.

A **UV sensor** is a device that detects and measures ultraviolet (UV) radiation from the sun or artificial sources. These sensors are designed to sense UV light within specific wavelength ranges, typically categorized into UVA (320–400 nm), UVB (280–320 nm), and UVC (100–280 nm) bands.

Fig. 4.11 UV sensor

4.1.11 Switch Board

4.1.1 Electrical power systems work as power is sent from the utility provider which then in line moves through an electric switchboard. That switchboards then relays the electricity throughout a number of circuits. The power is then moved to feeders and then distributed to locations throughout the reach of the power grid. An electric switchboard is an electrical device that distributes electricity from one electrical source to another electrical source. It is a major component used in power distribution process. It is made up of several electric panels. Each electric panel contains switches that redirect electricity. An electrical switchboard is a single large panel or can be a combination of electrical panels on which switches and other power control equipment are mounted. The main purpose of the board is to control the flow of power. It divides the main current supplied to it into several smaller chunks and distributes it to the devices. In precise, switchboards supply Raspberry Pi 3

power to transformers, panels, and other equipment and from there power further gets distributed.

4.2 Software Components

4.2.1 Python:

It is an easy to learn, powerful programming language. It has efficient high-level data structures and a simple but effective approach to object-oriented programming. Python's elegant syntax and dynamic typing, together with its interpreted nature, make it an ideal

language for scripting and rapid application development in many areas on most platforms. The Python interpreter is easily extended with new functions and data types implemented in C or C++ (or other languages callable from C). Python is also suitable as an extension language for customizable applications.

4.2.2 OpenCV:

OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was later supported by Willow Garage then Itrez (which was later acquired by Intel).

The library is cross platform and free for use under the open-source BSD license. OpenCV supports deep learning frameworks TensorFlow, Torch/PyTorch and Cafe. It has C++, Python, Java and MATLAB interfaces and supports Windows, Linux, Android and Mac OS. OpenCV leans mostly towards real-time vision applications and takes advantage of MMX and SSE instructions when available. A full-featured CUDA and OpenCL interfaces are being actively developed right now. There are over 500 algorithms and about 10 times as many functions that compose or support those algorithms. OpenCV is written natively in C++ and has a templated interface that works seamlessly with STL containers.

In 1999, the OpenCV project was initially an Intel Research initiative to advance CPU intensive applications, part of a series of projects including real-time ray tracingand3D display walls. The main contributors to the project included a number of optimization experts in Intel Russia, as well as Intel ‘s Performance Library Team. In the early days of OpenCV.

4.2.3 Raspberry Pi OS:

Raspbian OS, now officially called Raspberry Pi OS, is designed to support a wide range of languages beyond its default English setting. During the initial setup or first boot, users are prompted to configure system settings, including language, time zone, keyboard layout, and Wi-Fi country, ensuring a tailored experience for various regions. The OS supports many global languages, such as French, Spanish, German, Chinese, Hindi, and more, making it accessible to users worldwide.

If changes are needed post-setup, users can access the Raspberry Pi Configuration tool via the Preferences menu on the desktop. Under the Localisation tab, they can modify the locale, keyboard layout, and time zone. Alternatively, these configurations can be adjusted through the terminal using the command `sudo raspi-config`, where the Localisation Options menu offers similar flexibility. Once changes are applied, the system requires a reboot to fully implement the new settings. This

multilingual capability underscores Raspberry Pi OS's adaptability and usability across diverse user bases.

4.2.4 Linux:

Linux operating systems, including distributions like Raspberry Pi OS, offer extensive support for various languages to accommodate global users. While English is typically the default language, users can configure their preferred language, keyboard layout, and regional settings during installation or through the system settings afterward. On systems with a graphical interface, these settings can be adjusted under the **Region & Language** or **Locale** sections in the preferences menu. For those using the terminal, tools like the `locale` command allow users to view or modify language-related settings. Additionally, the `sudo dpkg-reconfigure locales` command enables the generation and selection of new language configurations. These options ensure that Linux distributions remain versatile and accessible to diverse user bases.

4.2.5 Proposed System

IR sensor is being connected to Raspberry pi and the corresponding program is deployed for the motion of the rover within the Raspberry pi. The rover consists of four wheels, a relay connected to each set of wheels. When an obstacle is detected, the signal is sent to Raspberry pi and the rover is turned to the suitable direction according to the program. Raspberry Pi is connected to the following - Wi-Fi repeater, web camera, GPS module and Raspberry pi. Windows 10 IoT core is installed in the Raspberry Pi. The Pi is connected with 5V, 2A battery power supply.

When the rover is in autonomous motion the image is captured for every second and it is updated within the folder in the Pi. The image is sent to the remote PC through Wi-Fi and the image is being monitored by the security people in the host area. When the rover is controlled manually through the remote host, the intrusion is detected by capturing each frame and image processing is performed.

In case of any difference found, the remote device will receive an alert message. GPS module is connected to the Raspberry Pi in order to find the current location of the rover. The GPS statement is decoded to find the direction, timing, location and lot more. The GPS statement we receive should be sent to the satellite must be at least three or more so that it becomes valid. The color in the webserver represents the manual control of the bot where each color represents the direction for the bot.

Image subtraction is the process where the numerical values for individual pixels from two images are subtracted from one another, and the resulting values are used to construct a new image. The resulting image is analogous to a map of the differences between the two pictures. In a Search and Rescue

context, this could feasibly use to determine the difference between aerial photographs over time, and locate a subject that has moved or caused disturbance. This is practically difficult for a variety of reasons, but other applications are easier to implement.

4.2.6 Python:

4.2.6.1 Algorithm

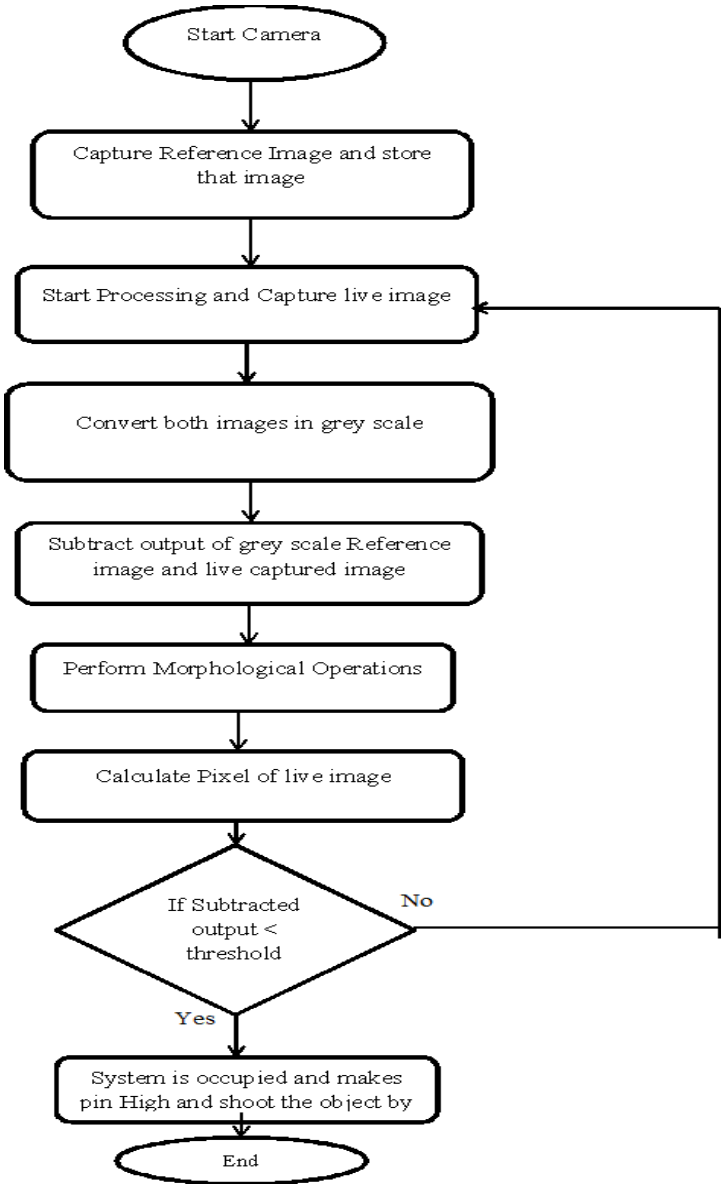

Fig 4.12 Flow Chart of The System

Object detection using Haar feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones in their paper Rapid Object Detection using a Boosted Cascade of Simple Features in 2001. It is a machine-learning-based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images. Here, we will work with face detection. Initially, the algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier.

Then we need to extract features from it. Features are nothing but numerical information extracted from the images that can be used to distinguish one image from another; for example, a histogram (distribution of intensity values) is one of the features that can be used to define several characteristics of an image even without looking at the image, such as dark or bright image, the intensity range of the image, contrast, and so on. We will use Haar features to detect faces in an image. Here is a figure showing different Haar features:

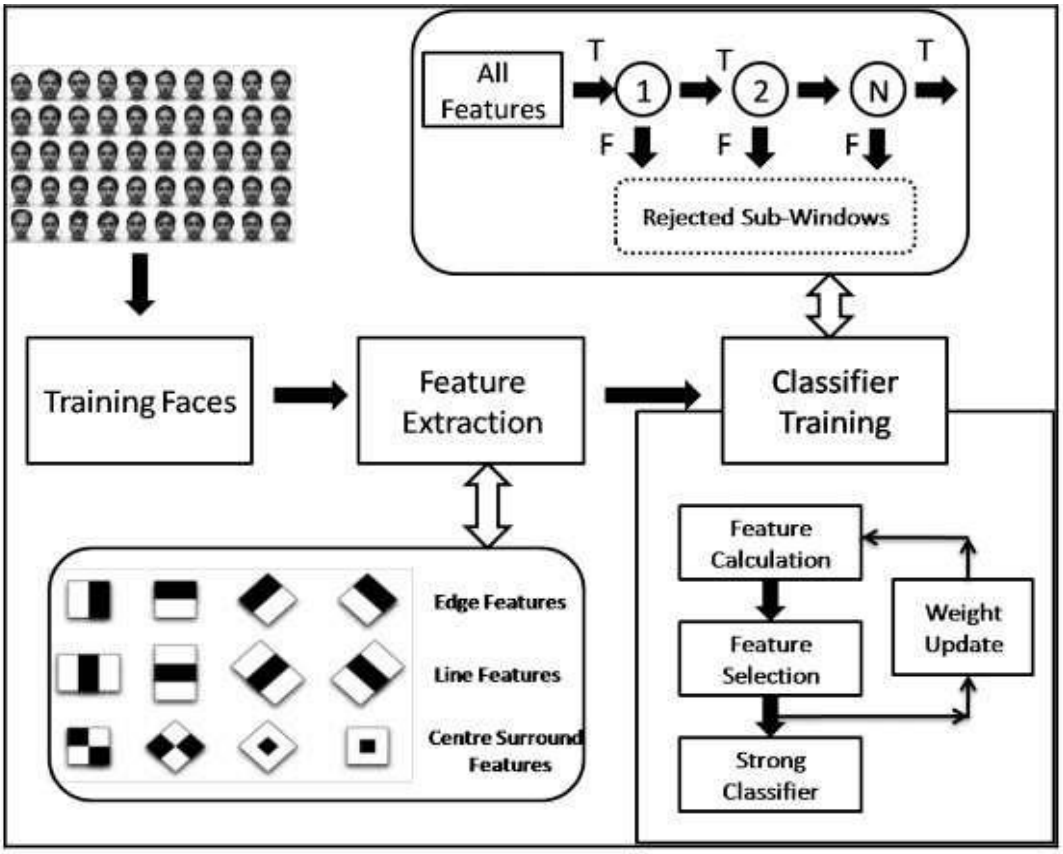

Fig. 4.13 Face detection framework using the Haar cascade

CHAPTER 5

RESULTS

5.1 Result Analysis

The border area is so large that effective patrolling is not possible and it require a very large amount of manpower, so this kind of security system which can effectively provide more security. In this the system can be implemented using face recognition, so that the system will work more efficiently. Sensor sense the temperature and humidity; IR sensor detect the obstacles on the way in the manual mode. Sensor sense the temperature and humidity; IR sensor detect the obstacles on the way in the manual mode. Laser gun attached works when any adverse condition happens or robot is being attacked by any person.

Fig 5.11 Rover Setup

In this, we have developed a rover system which is operated using Raspberry pi 3. A software code embedded into microcontroller controls the working of sensor and camera and laser embedded on the robot.

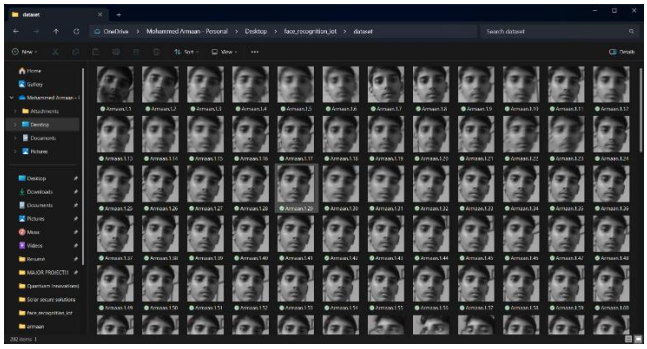

Fig 5.12 Face datasets for training using haarcascade algorithm

Receivers receives the image signals from camera and image shown on the pc with the help of TV tuner. Specific id is given to the respective soldiers. If the image shown is Known then it will do nothing and the rover moves forward if it is unknown then it triggers the laser towards the intruder using relay.

CHAPTER 6

CONCLUSION & FUTURE SCOPE

6.1 Conclusion

A serious problem that has arisen in this century is attacks and smuggling. Due to improper and less security near border area. It is a major challenge on our part to project to detect these smugglers, intruders, terrorists and other illegal activities breaking the security. Since the border area is so large that effective patrolling is not possible and it require a very large amount of manpower, there has to be some kind of security system which can effectively provide more security. A border security system would cease all kind of illegal movements near the border and help BSF in controlling these activities in a better and more precise way.

The border area is so large that effective patrolling is not possible and it require a very large amount of manpower, so this kind of security system which can effectively provide more security. In future the system can be implemented using face recognition, so that the system will work more efficiently.

The surveillance robot serves as a security monitoring device which replaces the human security at less critical areas where humans are really not necessary without compromising security. The outcome of this project deals with the recorded evidences of images when an unusual activity occurs and alerts to the remote host immediately.

Henceforth, by enhancing the capabilities of these technologies and integrating them, we hope to introduce the 'Motion Detection' system and to contribute to the current security system. This system would be an alternative for expensive security systems being used in the present day. This system does not require any special modifications to the infrastructure where installation is required and can be implemented without any hassle. I have tested these system for180 days and have found 99.9% accurate notifications and results.

6.2 Future Enhancement

The future work of robot will solely be limited by our imagination. This extremely customizable chassis was designed in order that the user will easily add on components. The map creation ought to be added and rover ought to be able to return to the source. A night vision mode might even be enforced in addition to video streaming instead of image being sent to remote host. One application should be developed which include pushetta notification as well as the controlling power of raspberry pi from the window. User can also view captured image remotely on this application. Live video streaming can be

added as per the user requirement. Power management should also be there and system went on sleep mode when it is no longer in active mode. One application should be developed which include pushetta notification as well as the controlling power of raspberry pi from the window.

User can also view captured image remotely on this application. Live video streaming can be added as per the user requirement. Power management should also be there and system went on sleep mode when it is no longer in active mode. There are lots of improvements that can be made on the current design and technology and lots of additional feature scan be added. We can use different types of sensors so that we can use robot in different field i.e., Temperature Sensor, Pressure Sensor, Heat Sensor, Position Sensor, Proximity Sensor. A multipurpose robot can be made by wireless network, ranging from surveillance and home security to industrial applications where the user need not be present at the work place in person but can do it from his home itself.

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