IOT Based Smart Surveillance System

Syed Ifkat[1], Aman Kumar Mandal[2], Rubi Kumari Mandal[3], Nuruhusen Abubeker[4], Prof. Rohith Kumar[5]

[1]*Department of Computer Science & Engineering (Internet of Things), Jain Deemed to-be University, Bangalore,562112,India*
[2]*Department of Computer Science & Engineering (Internet of Things),Jain Deemed to-be University,Bangalore,562112,India*
[3]*Department of Computer Science & Engineering (Internet of Things),Jain Deemed to-be University,Bangalore,562112,India*
[4]*Department of Computer Science & Engineering (Internet of Things),Jain Deemed to-be University,Bangalore,562112,India*
[5]*Department of Computer Science & Engineering (Internet of Things),Jain Deemed to-be University,Bangalore,562112,India*
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A B S T R A C T

The "IOT Based Smart Surveillance System" project is described here. The main motive of our project is to develop smart surveillance techniques. In recent years, we have used security cameras to observe and document events. Surveillance and real-time monitoring, which has numerous uses in daily life, including security monitoring, is one of the most important and challenging fields of computer vision. Installation of surveillance cameras and a notice indicating that the area is being watched can considerably detect thieves and criminals because the recorded footagemay be used to identify people and trace their activities. It can become more sophisticated by using WIFI, a local area network that functions in a dispersed or local setting.

Here, our key recommendation is that anytime a person enters the camera's range of vision, the system should first scan its database for potential matches. If it couldn't finds a match, the module continues recording until someone arrives. If the culprit's face is recognized, alert of them will be transmitted to the relevant authority's email address or to Google/Excel sheets for tracking when thecriminal has been spotted.

Key word: OpenCV, Face recognition, Sheets, Surveillance

1. Introduction

As we all know the main identity of the person is their face. It is well Known for identifying any personface is the main part or main unique identifying substance. Human can recognize each other simply but for computers we need to train it to find out the person using face recognition technique.

To put it simply, face recognition involves taking the important details from an image, organizing theminto usable representation, and classifying those features[1]. The most instinctive method for human identification is likely face recognition based on the geometric aspects of a face[4]. The entire procedureis typically broken down into three key parts, with the first step being the search for a respectable database of faces that includes multiple photographs for each person. In order to recognize the personwe need to train the model. Finally, test the face recognizer to see if it can find the faces accordingly it was trained.

Secondly, the open-source library known as Open Command Visualization (Open-CV) is helpful in thevisual industries, such as image processing [5]. We are using face recognition to take photo using pythoncode and open cv library, to find out criminals/person from database is the main goal.

Lastly, we are adding our system to the car so, we can control it and able to move from one place to another accordingly. Sometimes we need to follow the criminal or have to spy on person in order confirm that they are culprit or not. We will control our car manually through mobile to follow the particular person and locate the criminal.[6]

Then after that only our primarily proposed system (surveillance system) will able to detect the known person from our database and send alert to the authority.

1.1 Tables

Here is a comparison of traditional CCTV model and a proposed system.

Table 1 - Comparison between CCTV & Smart surveillance

Item	CCTV (security camera)	Smart surveillance camera (proposedsystem)
Visibility to public	Visible to public	Hidden from public
Platform/use case	Public places, shops, office, bus,school/college	Military/crime department to find specific person stored in databaserelated to criminal activity.
Method of using	Simply recording the video andstoring it into the hard disk for future reference	face recognition technique by usingopen cv python code.
Device/hardware and software used	CCTV camera, Monitor (for monitoring it), Hard disk (storingfootage), power supply, cable etc.	Raspberry pi3, raspberry pi camera module, DC-motors, H-bridge, powersupply(battery), car model hardware and parts, jumper wires, Arduino uno (car controlling) etc.
Alert	Authority has to check footagemanually	Sends alert to authority if match found.Also, send name and time in sheets
Level of programming needed	Low as needed just simple setupand tools	High as high skills set of pythons withopen CV required to work on face recognition technique

1.2 Problem Definition

Our target for this project is to build a smart surveillance using raspberry pi 3 and open-cv by python code. Here, Criminal/person Recognition by using Raspberry pi and maintaining a secure environment is a top priority. The main piece of software being used in this project is Open CV (open-source computer vision). There are many algorithms for face detection in systems, including the Haarcascade, linear SVM, deep neural network, etc. The primary approach that is suggested in this work isthat, if a person approaches the pi camera module, it will first search for potential matches that we have already saved in the system. If the module discovers a match, it captures the subject and notifiesthe authorities with name and date.

Objective:

- To develop a smart surveillance which can detect the particular person which arepresent in database.
- Send alert to the authority if face match found from database.
- If a match is made, it also displays the specific person's name as it was entered into thedatabase.
- Embedding the whole system to the car for controlling it manually.

1.3 Problem Definition

The methodologies used here is Face recognition and the detection of certain people, such as criminals. The Raspberry Pi Camera Module is fitted to the Raspberry Pi 3 and is hidden from public view. Images of human faces can be retrieved from videos that are captured with the Camera Module. When face recognition is complete, OpenCV's library files are used to automatically verify the results against the database that already exists.

1.4 Hardware and Software requirements

Hardware Specifications:

- Raspberry pi 3
- Raspberry pi camera module
- Cables
- Power supply(battery)
- Robotic car model
- L298 H-bridge
- DC motors
- Arduino board

Software Specifications:

- Arduino IDE
- Raspbian OS
- Python IDE
- Open CV

2. Literature Survey

Here are some Literature surveys which we have covered for theimplementation of our project and finding the best route to deploy it.

Table 2 - Literature Survey

Year	Concepts which were researched and published
2017	IOT based home automation and surveillance system
2019	Smart Surveillance System for Public Safety Using IoT and CloudComputing
2020	A Smart Surveillance System for Real-Time Monitoring and Alerts
2020	Criminal Face Detection System Using Python
2020	IOT based facial recognition security system
2020	Design & Implementation of IOT based Smart Surveillance Systemhome automation
2020	Surveillance Camera Using IOT & Raspberry Pi
2021	Video Surveillance based security system using OpenCV &ArduinoUNO

2.1 Related Work

[1]   "A Smart Surveillance System for Real-Time Monitoring and Alerts" by K. Kumar and K. Dhanalakshmi (2020): This paper describes the development and deployment of an intelligent surveillance system that monitors in real-time and alerts the user of intrusions. The system is built using Internet of Things (IoT) technology, utilizing a Raspberry Pi camera module and an ultrasonic sensor for detecting intrusion events. Whenever an intrusion is detected, the system sends an alert to the user's mobile phone in real-time. Additionally, the system employs a machine learning algorithm to recognize and identify objects. Experimental results indicate that the proposed system is effective in detecting intrusions and issuing alerts in real-time.

[2]   "Smart Surveillance System for Public Safety Using IoT and Cloud Computing" by M. Hanif, A. Yaqoob, M. Imran, et al. (2019): The paper introduces a smart surveillance system that utilizes IoT and cloud computing technologies to ensure public safety. The system is capable of detecting and tracking suspicious activities in real-time by using a combination of cameras and sensors. The captured data isthen sent to the cloud for processing and analysis. The system also incorporates machine learning algorithms for object recognition and classification, and can send alerts to the authorities in the event of any suspicious activities. The test results demonstrate the fruitfulness of the proposed system in detecting and tracking suspicious activities in real-time.

[3]   In 2017 Syed Ali and his colleague has done a project entitled "Iot based homeautomation and surveillance system". Their system was made up of a DC motor connected to a Raspberry pi using a driver circuit. The driver circuit was L293D type. A USB port of the Raspberry pi board was used to connect a webcam to thesystem. After all the components were set-up according to their block diagram, they created a user interface web page. On the web page they had a user authentication window, in which the user will provide a username and password to get access for controlling the door. After the authentication window, if the username and password match the user was provided with a controlling window displaying open, close and capture. The implementation was successful to open &close the door remotely, while they can also have the live footage using the webcam to check on the individual on the door.

[4]   " IOT based facial recognition security system" was a project done in 2020 by Prof. K.T Jadhao and his student. Their project mainly focuses on the identification of a visitor. When a visitor comes to a house and presses a doorbell, the system will be triggered to capture an

image of the individual at the door. The implemented system was trained using different persons in the training phase of the system. They were comparing the captured image to the database images and send a notification for the owner to grant or decline entry of the visitor to the house. The whole system was controlled using a Raspberry pi board. Otherperipherals, like camera, relay driver etc. were interfaced to the RPI board. One thing that makes the system unique was that, it can store a new visitor's face to aseparate folder for future use. In this way they were able to get the desired outputin the project.

[5] MVD Prasad &N.Sai Kiran presented video surveillance based security system using Open CV and Arduino UNO . This use PIR sensor for motion detection. It is cost effective as it required less storage as it record video only if motion detected in particular area and sends image along with alert message to the userin Real Time so they can protect from culprits, theft & burglary incidents.

[6] Shiva Tamikar&Ayush Gupta present criminal face detection system using python. Most of the time country like Nepal and India criminals were detected using thumb print identification system where their thumb prints record must berecorded into the system while filing fir. However, this will not much affective as criminal these days obtaining cleverer to not leave their fingerprint on the scene.

[7] To overcome this, they have developed face detection system which sight faceand identify face mechanically.

[8] Prof. Ajay Lahane& Dr. Sanjay Pawar have proposed Design & Implementation of IOT based Smart Surveillance System home automation. The main motive is to monitor and control home device from somewhere at anytime by authorized user. Home automation has many different sensors like temperature, humidity, gas PIR, IR connected to the PIC microcontroller which sends data to the Raspberry Pi through RF module. When temperature increase/decrease fan can automatically switch ON/OFF or give alert message onthe persons entry along with video and image and can trigger the buzzer when gasleakage detected.

[9] Bandi Narasimha Rao & Reddy Sudheer presented surveillance camera usingIOT& Raspberry Pi. Now a days every organization as well as individual require security. Traditional way of CCTV monitoring requires manual observation and large amount of storage space. To overcome this, they have come up with the ideaof surveillance camera using IOT and Raspberry Pi which use PIR sensor for motiondetection and require less storage as it records the video and captures image onlyif motion is detected in particular area.

2.2 Existing Work

CCTV (closed circuit televisions) have grown in popularity as a security tool because of how easily the operate. An illustration of surveillance that is veryuseful to police enforcement in helping to recognize and monitor threats,analyze data, and protect you from criminal activities. Also, the deployment of surveillance technology has significantly improved the handling of burglary situations. These CCTV systems frequently monitor all activity continuously. This has the side consequences of using excessive amounts of memory and electricity. Additionally, it doesn't send alert to the authority if any suspicious activity is discovered.[2]

However, its signals are monitored for security and surveillance purposes but not made publicly available. It primarily depends on the positioning of cameras in key locations and the viewing of camera output on monitors located somewhere else.

[10]   Figure 1: CCTV (Closed circuit Television)

2.3 Problems in Existing Work

Here is some problem in the existing system which should be highly considered for present day.

- We have to manually open footage since it is situated in one placeand monitoring out coming from camera located somewhere else.

- Our system cannot be remotely controlled while being moved from onelocation to another.

2.4 Proposed System

The suggested technology uses face recognition to take pictures and alert the appropriateauthorities. Figure 2 depicts the architecture of the system. A Raspberry Pi Camera Module is mounted to a Raspberry Pi 3 and placed out of sight. from public. Its working phases consist of:

- Capturing image: A camera is used to record video with numerous frames, each ofwhich can be used for facial recognition.

- Creating Database: It is essential for enrollment of every person whose detection needs to be taken because a biometric method has been chosen for implementation. Every person's face is photographed in this instance and saved in a suitable database that also contains their name and at least 10 photos of each individual.

- Detecting Faces: In this proposed work, selecting an effective facial recognition method is crucial. Open CV offers a wide variety of face detection algorithms.

The Haar Cascade Algorithm for face detection and recognition has been chosen in light of the requirement for real-time recognition. It may be found in the Open CV source library and has proven to be effective.

Face Recognition: After detecting, it will match the faces with existing database and recognized the faces if matched with the following one and send the alert tosheets.
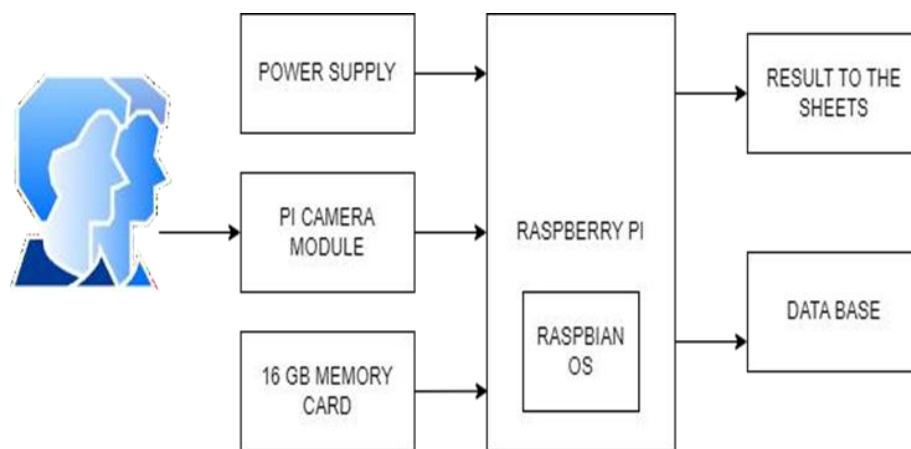

Figure 2: Proposed system Block diagram

3. System Design

3.1 Flowchart diagram
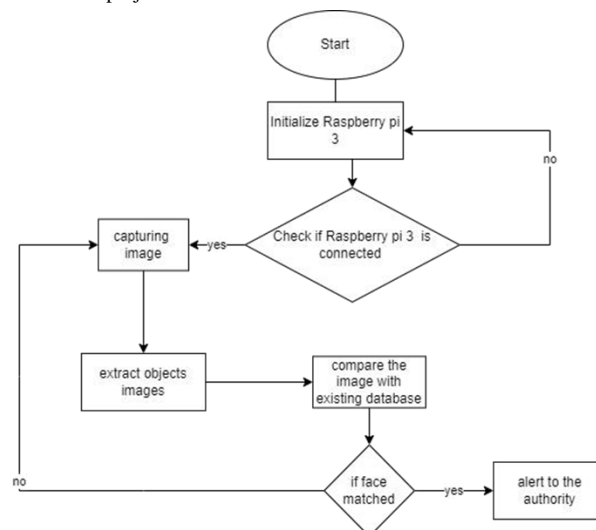
This flowchart shows the working model of our project.

Figure 3: Proposed working model flowchart

As per the Fig.3 - Proposed Flowchart which shows how the proposed system willwork accordingly.

1. First, we will start and initialize the working board Raspberry 3.

2. Then it will check the condition whether, it is connected to the power source or not.

3. If it is connected, it will start collecting the data like capturing image from thesurrounding using face recognition technique.

4. Once it will capture the image, it will extract the image and will compare the capturedimage of a person to the already existing database.

5. If match found with related database, it will immediately send alert to authority byusing sheets so that it can tell the name and time.

6. If face match not found, it will repeat the process from capture the image.

3.2 Circuit Diagram

For the deployment of our project, we need two circuit diagrams. One for our proposed modelsmart surveillance system and another for car on which we will embed our surveillance system to move it from one place to another.

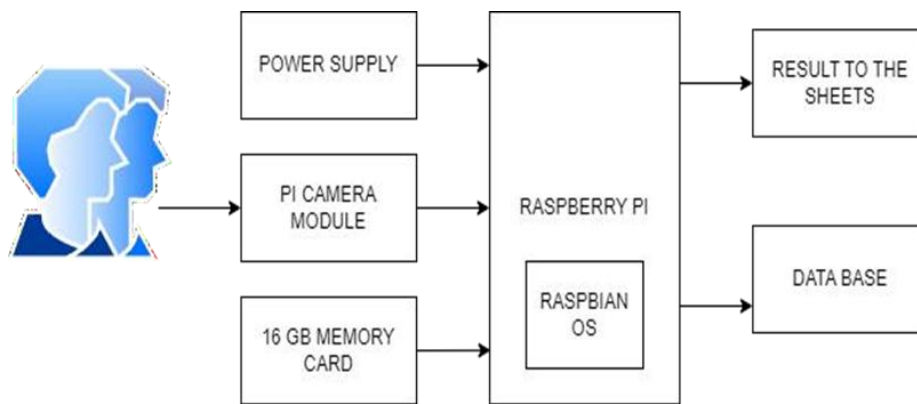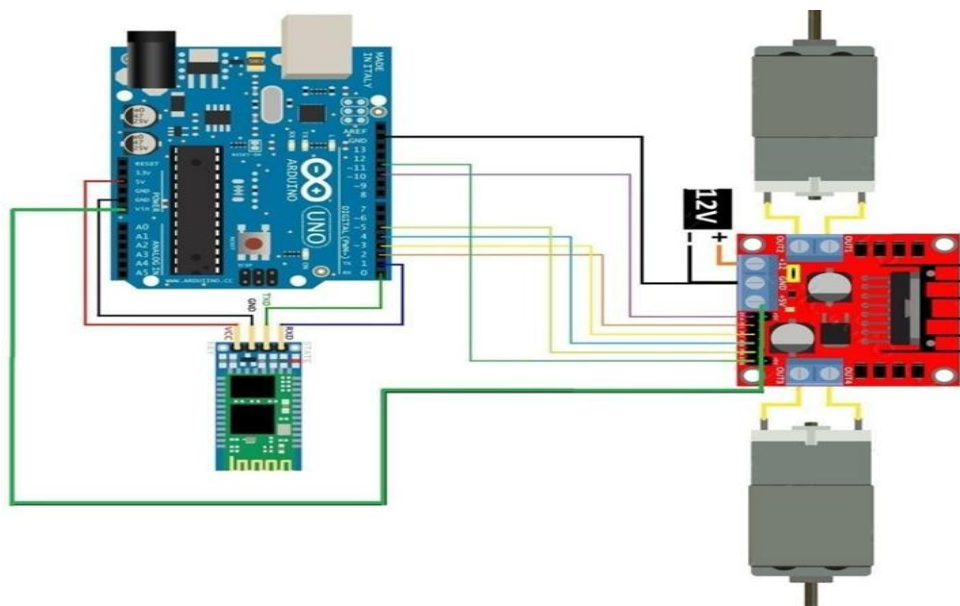Block diagram for Surveillance system:

Figure 4: Raspberry pi 3 internal and external connection

Circuit Diagram for car:

[11]   Figure 5: circuit diagram for remote control car

Tool Description

Hardware Requirements:

4.1 Raspberry pi 3:

The Raspberry Pi is similar to ATM card size, modest device that connects to a desktopor television and makes use of a regular mouse and keyboard.

It is similar to a PC in that it has a specialized processor, memory, and graphics driver.Moreover, it includes the Linux-based Raspberry Pi OS operating system.

Similar to a desktop computer, Raspberry Pi can do word processing, spreadsheets, andgames in addition to browsing the internet and streaming high-definition video.[3]
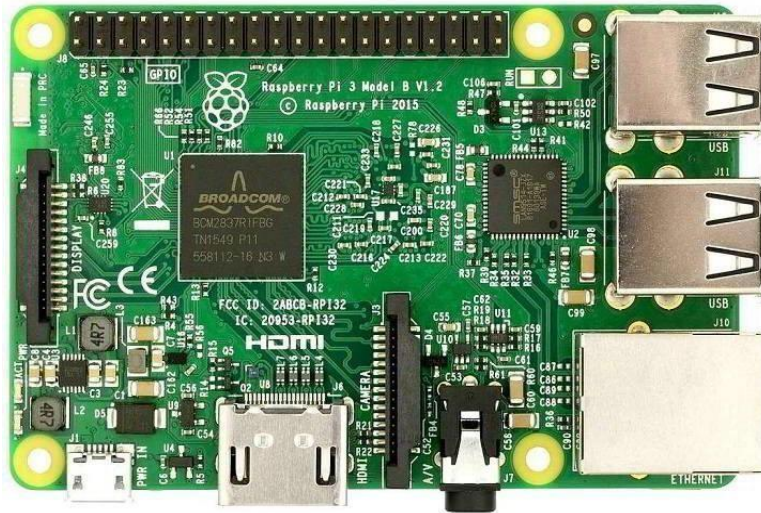
[12]　Figure 6: Raspberry pi 3

Arduino UNO:

An Arduino is the eco-friendly board to the projects of the IOT students orelectronic department. Widely, it is used for big and small project like car robot, gas detection system, irrigation monitoring system, Bluetooth controlling device and so on. Itconsists of main pins like I/O pins, 5v power pins, GND pins, Analog and Digital pins, serialpins and so on.[1]
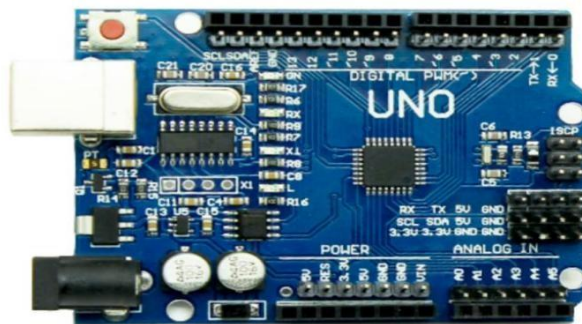
[9] Figure 7: Arduino Uno

L298 MOTOR DRIVER:

A dual H-bridge driver module called the L298 is frequently used to manage motors. In addition, it serves various functions including DC to DC conversion and voltageregulation. Two H-bridges on the module can be used to regulate the direction and speedof DC motors. AC motor voltage and current can also be managed by the module. Usually,the module is employed to manage motors.[2]
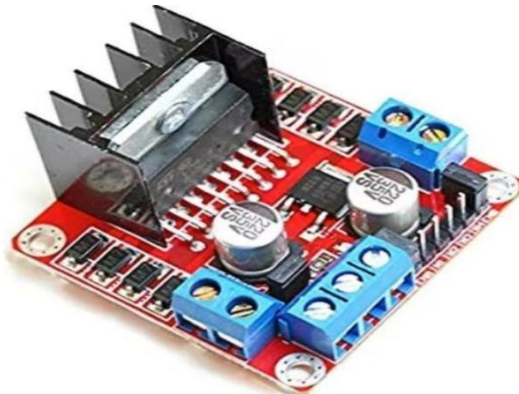

Figure 8: L298 MOTOR DRIVER

DC MOTOR:

A DC motor is an electronic device which working generally on the principle "Faraday's law of electromagnetic Induction". while applying the current to the Dc motor, it will generate magnetic field which in occurs to convert electrical energy to mechanical energyso, motor started rotating. Dc motors is generally used for robot cars, fans, windmills etc.

Figure 9: DC MOTOR

Raspberry pi 3 camera module:

There are numerous of camera module available into the market. But as requirement of our proposed model. We have used Raspberry pi 5MP camera module. It has 5-megapixelresolution which supports 1030p, 720p, video recording support. It is especially designedto get mount on raspberry pi board. Before buying camera module, we need to check whether camera module is supportable to the board or not as we need separate cameramodule for raspberry pi zero.

Figure 10: Raspberry pi camera module 5mp

Jumper Cables and Wires:

Jumper wires allow you to link two locations without soldering by just having connector pins at either end of the wire. Jumper wires are widely used together breadboards and some other prototyping tools to make modifying a circuit as needed straight forward. One of the most basic instruments accessible are jumper wires.
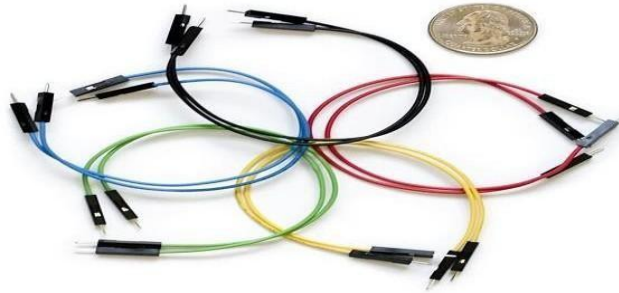

Figure 11: Jumper Cables

Bluetooth module:

Bluetooth module is widely used communication module to connect two device through Bluetooth. Nowadays, almost every electronic device contains inbuilt Bluetooth module integrated into the chip itself. In order to control devices remotely, BLE is highly prioritized whenever its to control car, click pictures remotely, or to open the car gate remotely, to play music with air bud, air pods, and speakers etc.

Figure 12: Bluetooth module

4.2 Software Requirements:

Arduino IDE:Arduino

Arduino IDE is generally used by all the electronics/iot students in order to program the devices or Arduino board. It contains almost all the board library which is needed to run theboard and to perform the specific task as per requirement. It supports operating system like Windows, Mac, Linux etc. The main task of Arduino IDE is: Writing sketch, Uploading, Serial Monitor, Preferences, Compile, Run etc.[2]
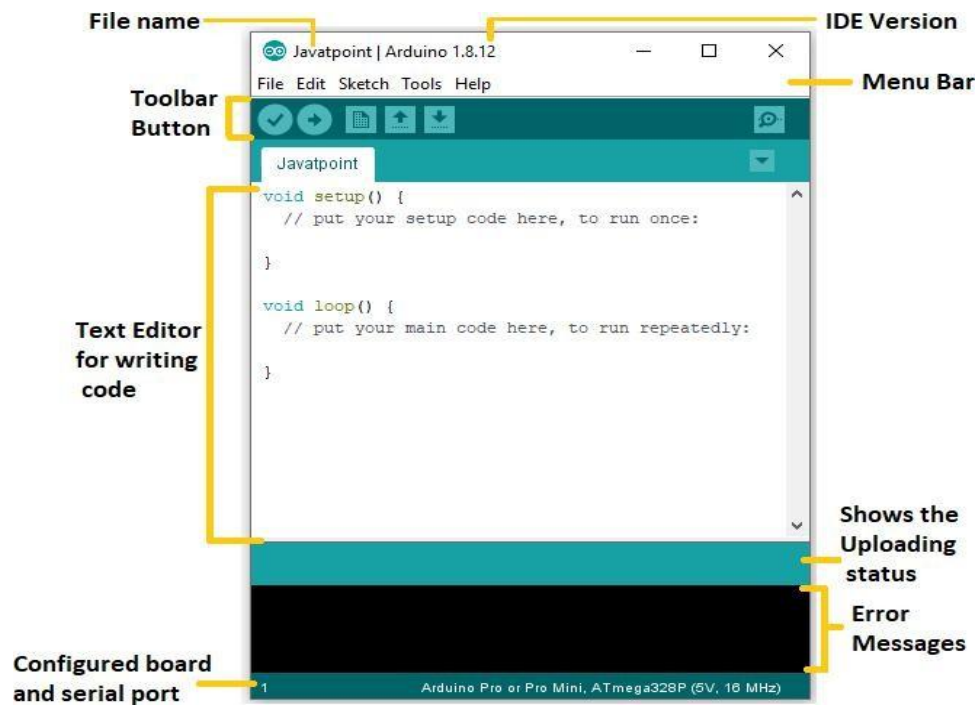
The Arduino IDE will appear as:

Figure 13: Arduino IDE

4.3 Software Requirements:

The python library which is define as an open-source library for AI and computer visiontask is called as Open CV. In order to handle the detection and recognition of the object in real time, it is widely used using its predefined algorithm like Bayes classifier, K- Nearest Neighbors, support vector machines, Neural networks etc. It stands for open-source computer vision library, which is most usable python library in surveillance system.

The following task can be carried out using OpenCV:

- viewing a picture
- obtaining a pixel's RGB values
- Getting the Interest Region (ROI)
- Image Resizing
- turning the picture
- Make a rectangle
- text display

4.4 Raspbian OS:

Raspbian OS is the commonly used operating system for the Raspberry pi board. In order to work on Raspberry pi board, we must have to install Raspbian Operating System. In manyplaces Raspbian is used for to build hardware project and to manage the automation inside that. Project based on drones, and surveillance uses raspberry pi board, and that board requires Raspbian in order to code that. In order to install Raspbian, we need to install the memory to the system and have to boot it.
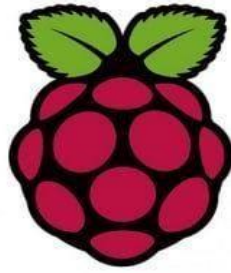
Figure 14: Raspbian OS

4.5 Python IDE:

A tool designed specifically for software development is known as a Python IDE (or Python Integrated Development Environment). As suggested by the name, IDEs combine anumber of tools specifically made for software development. A few examples of these toolsare:an editor made specifically to manage code (with, for example, syntax highlighting and auto-completion) constructing, running, and debugging toolsvarious types of source control

5. Implementation

5.1Implementation:

Here, we have done the implementation of the project by collecting all the required hardwareand software essential tools. By combining all, we embed our system to remote control car using car robot toolkit and surveillance system with raspberry pi3 including library OpenCV
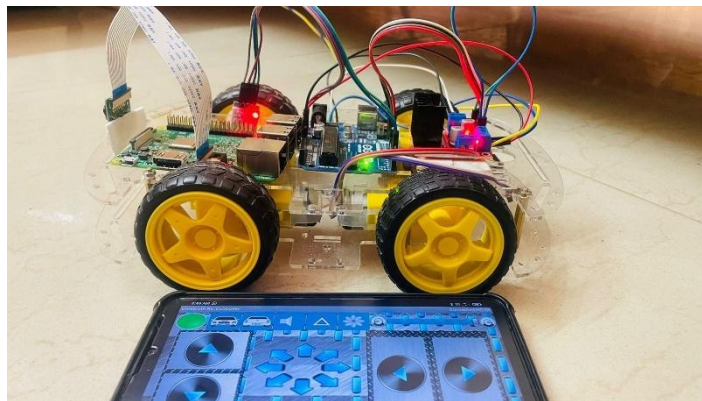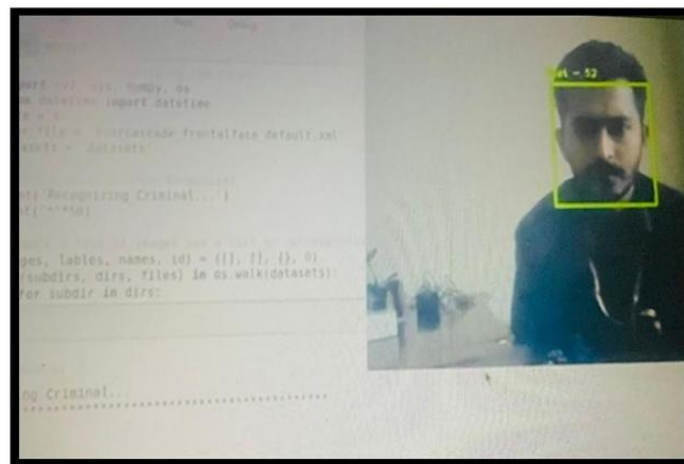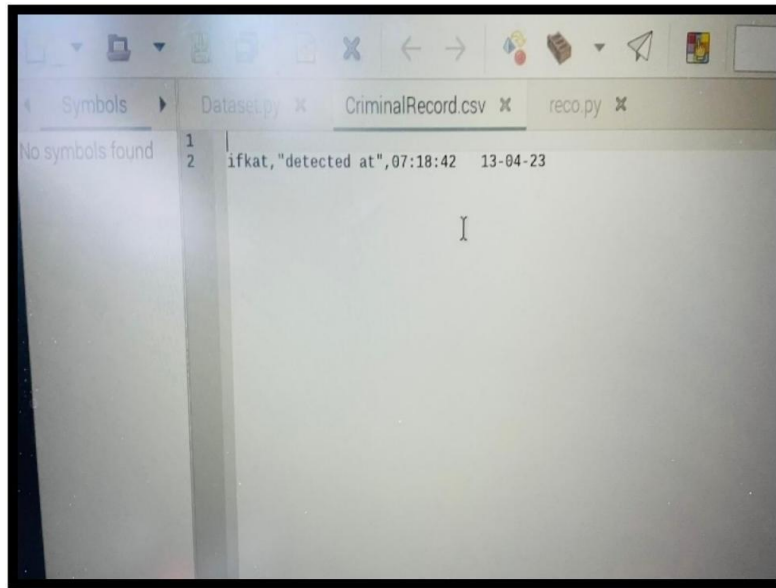

Figure15: implementation of the project 1st part

Figure16: implementation of the project 2nd part

Programming with the Arduino IDE:

In order to run our car, first of all we need to setup Arduino IDE accordingly.

- Go to board manager and upload json file as according to your board.

- Go to sketch and download the library Arduino uno.

- Then go to tools, select the board Arduino uno.

- Select the baud rate, frequency.

- Paste the code to the Arduino IDE and compile the code.

Working Principle:

The following steps make up the face recognition technique on which our suggested system is built.

- We will first power up and set up the Raspberry pi board.

- After that, it will determine whether it is linked to a power source. If it is attached, it will begingathering information by employing face recognition technology to capture images of the nearby surroundings.

- Then, it will extract the image and match the person's image to the database that already exists in to the system.

- If a match is made with a related database, it will immediately send an alert to the appropriateauthority, including the name and time, by using sheets.

- Thus, same process will be going continuing until face will be matched with database.

6. Results

We have implemented the proposed system and we get the desired result. As we cansee face recognition has been done and its result will be shown in the sheets.

Figure 17: Final result

6.1Conclusion

So, it can be demonstrated that face recognition-based human or criminal detection systems aresafe and effective. utilizing a specific methodology and configuration with a range of hardwareand software, such as OpenCV, for face detection and identification. In a similar manner, the Raspberry Pi 3 board is effectively employed to extract the image from its surroundings and tomatch the image from the next stored database. With a lower false rate, it provides a higher recognition rate.

The system can be utilized as a security surveillance system and its recognition rate can be increased by using Raspberry Pi Infra-Red camera module further.

6.2. Future Scope

In near future, if the demands of the face recognition's technique will increase and will valuable for everyone. Then, the proposed system will not only work for criminal detection. It will work efficiently with project like attendance monitoring, home security, business, shop, car parking and many more. If it will get approved and work efficiently, more functions like location with IP address tracking system can be added as well to know the exact place where criminal was detected or even send the alert to the nearest crime investigation department who is searching for criminals.

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