

Intelligent Home Surveillance System for Facial Recognition Using Raspberry Pi

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Abstract

In this project we are going to deal with the surveillance and security system using raspberry pi. We are using VGG face algorithm to process and extract the features in the image that help for facial recognition. We also make use of different type of sensors for creating a security system that will send alerts to the email.

Keywords: Internet Of Things (IOT), Raspberry Pi-4, VGG Face, PIR Sensor.

Introduction

Internet Of things is one of the concepts which got people attention all over the world. It is the one which connects the things to the Internet. In today's world we are living in a society where every device has become so smart. There are so many smart devices that are providing home security. Most of the devices lacks the accuracy and efficiency. They are much expensive that makes them unavailable for most of the people.

In this project we are going to develop the system which provides security to our home using Raspberry Pi, Pi Camera, PIR Sensor, Ultrasonic Sensor, Temperature Sensor.

This project works in two modes. In mode-1, If any person is present Infront of the camera it will capture the image and process the image using VGG algorithm and matches the image with the stored image in the database. If the image is present in the database the door will be opened else an alert will be sent to the owner of the house.

In mode-2, the PIR Sensor detects the motion of the Person. If any suspicious movement is detected then the image of the person will be sent to the owner through email.

We are making use of Raspberry Pi-4 which can perform millions of operations per second and has all the components integrated instead of buying them and integrating them separately which will increase the production cost. It also has the support to Latest Wi-Fi and Bluetooth Modules which is compatible with most of the devices.

Literature Survey

Ahmad [1] in 2020 propose a surveillance system using Raspberry Pi based on the user needs.

Ashwin Pawar [2] in 2019 proposed a home security system using Raspberry Pi-3 and some sensors such as Flame and PIR Sensor.

Shakthi Murugan [3] in 2018 proposed a security system using Raspberry Pi-3 and Open CV.

Rani [4] 2018 proposed a system that captures an image and send it through Gmail.

Dhanalakshmi [11] 2017 They have created a system that identifies any mismatch in the data sets for training the models using datamining.

In [12] They have designed a disease prediction system by using Random forest algorithm.

In [13] They have designed a system that analyses a spike and evaluates them based on the spike signals.

In [14] They have designed a system that extracts the useful features of a given image.

In [15] They have design a prediction analysis system using association rule.

In [1] they have a designed a system that particularly focuses on capturing and detecting the motion of the object Infront of the camera. They have not taken care of other aspects of home security.

In [2] they are using a Raspberry Pi-3 that lack efficiency compared to new model. They are not detecting the motion of object.

All the above projects have been focused on either the surveillance or security of the system. This project focuses on both the security and surveillance of the home. It makes use of Raspberry Pi-4 and VGG algorithm that is trained on different facial expressions to improve the accuracy of the system. The cost of the system design will be affordable to all classes of people.

System Architecture

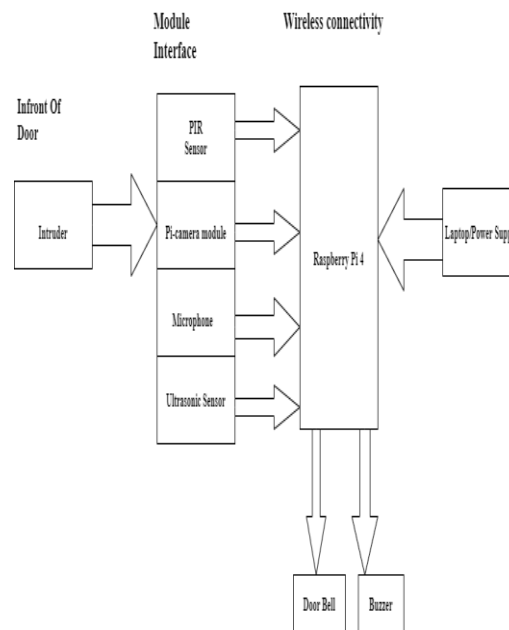


Fig-1: Architecture diagram of the proposed system

In this system architecture diagram, we are displaying a system that is implemented in this project. All the modules are connected to the Raspberry Pi through the GPIO pins. Here The architecture diagram includes, PIR sensor, Ultrasonic Sensor, Microphone to capture the noise, Pi-Camera to capture the image and Raspberry Pi that process the image captured using VGG face algorithm. It sends alerts to the owner through the Wi-Fi and Bluetooth modules that are inbuilt in the Raspberry Pi.



In this project we are using the latest version of Raspberry Pi which is Raspberry Pi-4 model-B which performs millions of operations per second. It also improves the performance. It has support to the latest Wi-Fi and Bluetooth technologies which will be helpful in connecting to all types of devices. The advantage of using this model is that it can connect to Two 4k monitors at a time and it is power efficient too.

Existing system

In the previous projects they are focusing only on one of the aspects of home security. They are using devices that cannot process large number of operations. The capabilities of the camera have been drastically changed in the past two years. The cameras and the algorithms that are utilized in the previous projects are not compatible with the modern-day devices.

The existing system does not have latest inbuilt Wi-Fi module or Bluetooth module. They will not be able to cope up the capacity of the devices. They are not focusing on accuracy of the face recognition. They simply send an email to the owner every time a person stands Infront of the camera. This results in wastage of storage and processing capacity of the device.

With the advancement in AI and ML, the technologies used in the existing system lags behind the current technologies. They have not focused on the movement of the people standing Infront of door.

Proposed System

In this project we are developing a system that is affordable and accurate with the results. In this project we are developing a security system using the latest version of Raspberry Pi [Raspberry Pi-4] model-B. The reason to choose Raspberry Pi is that in Arduino you do not have all the components integrated with each other. It also processes the request faster than every other available device. It also has got the support to the latest Wi-Fi and Bluetooth modems.

The model used in our project is trained on thousands of images stored in the database to improve the accuracy. If a known person is Infront of the door the door will automatically open for the person as soon as the image of the person matches with the image stored in the database.

The model will be trained on different facial expressions and moods of a person so as to improve the accuracy of the system. Here face recognition is done by extracting the important features of the face so as to reduce the time and improve the accuracy of the system.

Here we are creating a security system that provides the complete home security.

Different types of sensors are used to trigger movements control temperature and alert the person if any suspicious activity happens in the home.

Implementation

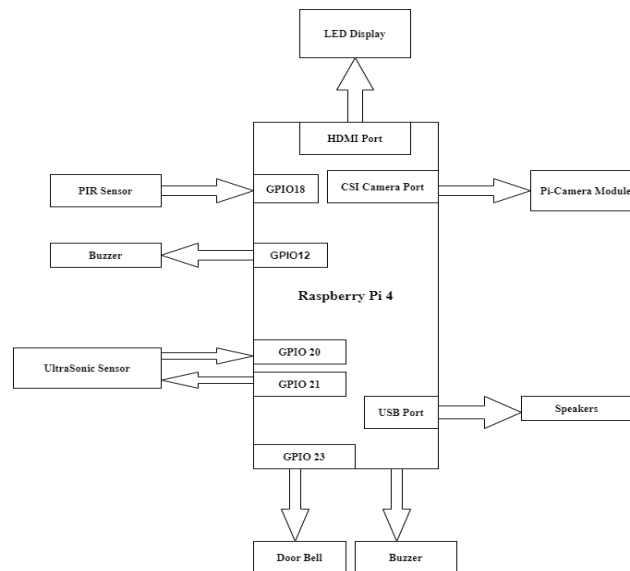


Fig-2: Block Diagram

The sensors are connected to the Raspberry Pi through the general-purpose input output pins as shown in the above figure.

The camera module is connected to the CSI module of the Raspberry Pi. The display is connected to the Raspberry Pi through the HDMI port.

In this project we are developing a security system that captures the image of a person and process it using the VGG Face algorithm and match it with the required image in the database.

The Camera captures the image of the person Infront of the door and the sends it to the Raspberry Pi which process the image using VGG face algorithm. It first gets the face alignment and then extract the required features and performs the matching with the images in the database if it is matched then the door will be opened for the person and Vice-Versa.

This project not only focus on Image recognition but also other parts of security system such as motion detection and fire detection using PIR sensor, temperature sensor respectively.

The Image recognition algorithm requires a trained model for which we require a large dataset. Here we are using Transfer learning and Finetuning process to train the model. If we train a model using VGG face algorithm it will take a lot of time for training. Transfer learning is a process where the machine learns by it's previous experiences.

Finetuning is a process where the last layer of a network is removed and our network is added based on the problem.

The model is trained on datasets by using the Transfer learning and Finetuning techniques and employed in our system. This model is trained of thousands of expressions of a person so as to improve the accuracy of the

system. The performance of the system will be lightening quick as we are using the latest version of Raspberry Pi.

Result

```
import os
os.environ['TF_CPP_MIN_LOG_LEVEL'] = '3'

from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, ZeroPadding2D, MaxPooling2D, \
Dropout, Flatten, Activation

def get_model():
    model = Sequential()
    model.add(ZeroPadding2D((1,1), input_shape=(224,224, 3)))
    model.add(Conv2D(64, (3, 3), activation='relu'))
    model.add(ZeroPadding2D((1,1)))
    model.add(Conv2D(64, (3, 3), activation='relu'))
    model.add(MaxPooling2D((2,2), strides=(2,2)))

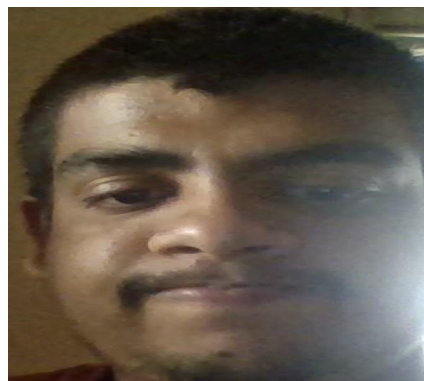
    model.add(ZeroPadding2D((1,1)))
    model.add(Conv2D(128, (3, 3), activation='relu'))
    model.add(ZeroPadding2D((1,1)))
    model.add(Conv2D(128, (3, 3), activation='relu'))
    model.add(MaxPooling2D((2,2), strides=(2,2)))

    model.add(ZeroPadding2D((1,1)))
    model.add(Conv2D(256, (3, 3), activation='relu'))
    model.add(ZeroPadding2D((1,1)))
    model.add(Conv2D(256, (3, 3), activation='relu'))
    model.add(ZeroPadding2D((1,1)))
    model.add(Conv2D(256, (3, 3), activation='relu'))
    model.add(MaxPooling2D((2,2), strides=(2,2)))

    model.add(ZeroPadding2D((1,1)))
    model.add(Conv2D(512, (3, 3), activation='relu'))
    model.add(ZeroPadding2D((1,1)))
    model.add(Conv2D(512, (3, 3), activation='relu'))
    model.add(ZeroPadding2D((1,1)))
    model.add(Conv2D(512, (3, 3), activation='relu'))
    model.add(MaxPooling2D((2,2), strides=(2,2)))

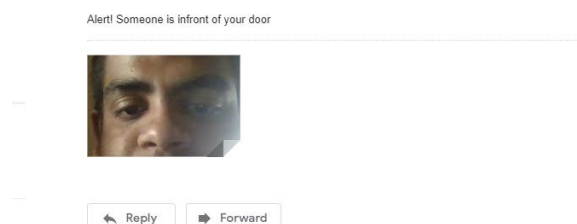
    model.add(ZeroPadding2D((1,1)))
```

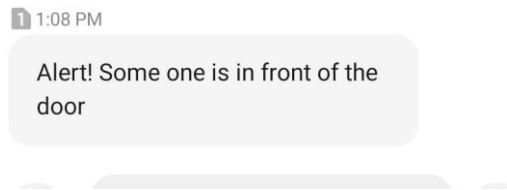
The image of the person:



It will process the image and performs the necessary things.

As the image is not in the database the user will get the notification through mail and text as shown below.





Conclusion

In this project we have achieved an utmost accuracy and performance of the system. The main aim of our project is to bring a security system which will be accurate at making decisions with an affordable price tag. The goal is achieved.

In Future work, as the technology develops there will be more advancement in the security system. The camera capabilities of the system will be developed as AI develops.

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