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# Voice Assistance Based Remote Surveillance System

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**Abstract -** *In this project, a live video streaming system is designed. With the fast-growing world trend toward video surveillance systems, by means of which one can monitor the entire system remotely, this becomes interesting and easy. In other words, systems present the idea where one can monitor a remote area from a particular place. This project deals with the design approach of an embedded based real-time surveillance system using ESP32 Cam module for intrusion detection with face detection and recognition, fire detection, voice alerts, live video streaming, and portability as the supreme features of the system. The proposed solution offers a cost-effective, voice-assistance-based, ubiquitous surveillance solution that is efficient and easy to implement.*

***Key Words***: Remote, Surveillance, ESP32 Cam Module, Camera, PIR Sensor, Voice Alert, Python, Executable File.

## 1.INTRODUCTION

Digitalization can be considered as a revolution of digital technologies. Now a day's people and things are inter-connected for every possible need. Today everyone wants his home to be safe in every way, from thieves, fire, strangers, etc., and one of the things that people will want to know about their monitoring/surveillance system is whether or not they have the ability to connect to it over the cloud for remote viewing. In the past, security systems had to be monitored by guards. He was continuously watching the monitors to make sure that nothing would happen. Because of their incredible features, video surveillance systems are becoming increasingly popular.

We are back with a product which is very interesting because of its unique features, and it's a voice assistance based. Here, we used image processing to improve the project's concepts. Image processing indicates the processing of an image or video frame that is taken as an input, and the result set of the processing may be a set of related parameters of the image. The purpose of image processing by which we can analyse how is the person's movement? Who's the person, whether it's known or unknown? What is the object found? and so many other things. And after analysing all this, our system will tell us with a voice alert that the person is identified or unknown, the object, activity and movement. One of the feature of the system is the requirement of less storage space because of the system responds on only when any motion is detects in front of camera.

For the image processing and software development purpose here, we used high level general-purpose programming language i.e. Python. For ESP32 cam module setup Arduino IDE and embedded c language is used. It's a low-cost development board with a small camera module attached. It is a versatile & affordable platform for developing image-based IoT applications.

Let's talk about the already proposed system. When we started looking for some sample research papers on security surveillance systems, and after studying them, we discovered some common things and a few concepts as follows:

Ruiguan Ge, Zhenfang Shan and Hao Kou,proposed a system An Intelligent Surveillance System, that the system has the characteristics of a timely alarm with high compression and good usability, motion detection algorithm and quantitative media compression technology. The outcome of the simulation experiment confirms that the improved motion detection algorithm is reliable. Personal device can effectively decode and play surveillance video [1].

Saroja Kanta Panda and Sushanta Kumar Sahu, proposed a systemwhere, they create a fully functional, real-time monitoring system. In the future, plan to use OpenCV as a better way to improve the detection algorithm, because it mainly depends on the threshold value. Its mean algorithm was developed to perform absolute conditions and to determine whether a person is authenticated or not [2].

Qinsheng Du, and Jiling Tang, "Design of the ARM Based Remote Surveillance System,", They created a system where video has been compressed by the MJPEG algorithm and then directly sent to owner, It's about Image Compression [3].

Rohan Namdeo, Sahil Sharma, Varun Anand and Chanchal Lohi in July 2020 proposed a system "Smart Automated Surveillance System using Raspberry Pi", where the system will send an alert notification immediately to the owner whenever there is a movement detected, the system will take images at desired time and start recording video [5].

Sruthy. S, S. Yamuna, and Sudhish N. George, in 2017 proposed a system where person detection with face recognition feature and fire detection are the prime features of this system in "An IoT based Active Building Surveillance System using Raspberry Pi". And the source is IEEE [6].

Singoee Sylvestre Sheshaiin May 2016 proposed a system as "Raspberry pi Based Security System", In the system, using a PIR sensor motion will detect, using a Pi Camera video capturing will initiate and sending out an alert via e-mail [8].

From above literature we found some common things like most of the system developed using raspberry pi module which is very costly due to its high demand and unavailability in the market. Some of them are cost-effective system by the use of low-cost controller and camera, also face recognition and identification, alert generation via mail and text. However, the voice assistance feature was not proposed in above schemes. Then we thought that apart from these common things, we can incorporate a voice assistance feature. The benefit of voice assistance is quite imperative as the instant access to information. This instant alert issued by surveillance system may help to get immediate action against an intrusion or suspicious activity happening. Voice assistance can be given in multiple local languages also so as to ease the understanding of warning to a layman also. It can be used anywhere and anytime and is handy due to the alert available on a smart mobile handset.

## 2. PROPOSED METHODOLOGY

The main components of these systems are the ESP32 Camera module and an executable file (.exe), which is built for video processing and monitoring. ESP32 Cam module is one of the single Arduino controller board developed in the Interaction Design Institute Ivrea in Ivrea, Italy. This system is an intelligent system based on IoT. When there is a person or any other object and motion of an object detected and captured in camera, this system calls the voice command from the database also sends an alert notification on email to the owner immediately, and the system will take images at the desired time quantum, and video recording will begin.

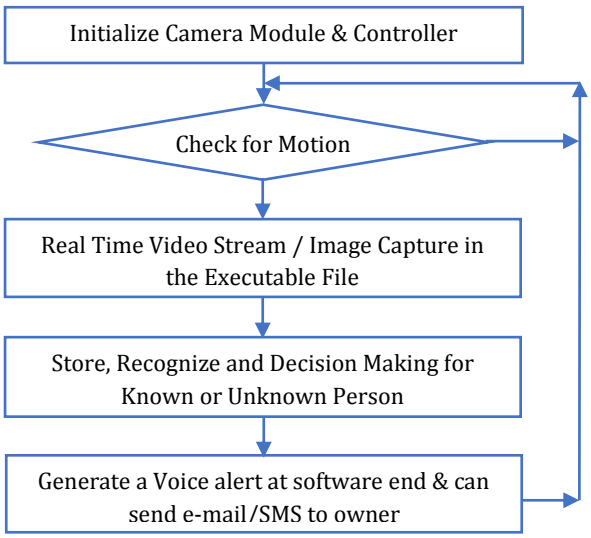


**Fig -1:** Flow Chart

From the above flowchart we can imagine how the system works from the motion sensing, image acquisition upto the end of the process. Here we discussed the process and steps to actually implement the project. Also requirement of hardware components and software sources for physical implementation. Python has various software libraries, from few of them we used for developing an executable file with Graphical User Interface.

### 2.1 Hardware Implementation

The ESP32 CAM Wi-Fi Module Bluetooth comes with OV2640 Camera Module 2MP For Face Recognization has a very competitive small-size camera module that can operate independently as a minimum system with 40 x 27 mm of footprint only, and is widely used in various IoT applications. It is suitable for wireless monitoring, smart home devices, industrial wireless control and other IoT applications. It provides highly-reliable connection mode to customers conveniently for application in various IoT hardware terminals.

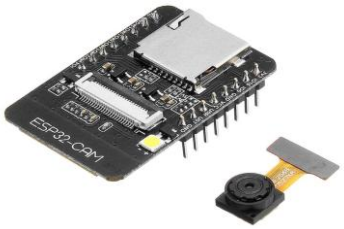


**Fig -2:** ESP32 Cam Module

At the heart of Microcontroller ESP32-S chip with dual-core 32-bit LX6 microprocessors, ESP integrates Wi-Fi 802.11 b/g/n Wi-Fi (2.4 GHz) with WPA/WPA2 PSK and 802.1X authentication, Bluetooth v4.2 BR/EDR and BLE, OV2640 2 MP camera module with 1600x1200 resolution, 4 MB flash memory and 520 KB SRAM, MicroSD card slot with support for up to 4 GB, Interfaces like UART, SPI, I2C, I2S, PWM, ADC, DAC, and GPIO. It requires Power supply of 5 V DC via USB or 5 V DC input pin. It has on-chip sensor, temperature sensor, Hall sensor, etc. and frequency adjustment range of 80MHz to 240MHz.

ESP32 has no USB port so we cannot directly upload programs to it. In order to upload code from Arduino software to this ESP32 module, we required a FTDI driver. For TTL serial communication the FTDI USB to TTL serial converter module known as UART board is used.


**Fig -3:** ESP32 Cam Module

It uses 3.3 V or 5 V DC. It is a breakout board for the FTDI FT232R chip with a USB interface and also has Tx/Rx and other breakout points. These modules are used for general serial applications. Few boards in microcontrollers which do not have USB interfaces like ESP and Arduino micros so in that case these types of converters are popularly used for communication to and from microcontroller development boards.

**Fig -4:** Pan/Tilt Bracket

Figure 4 shows Pan and Tilt bracket for setting up and controlling two servo motors and interfacing it with an ESP32 to access the camera's video stream from another device.

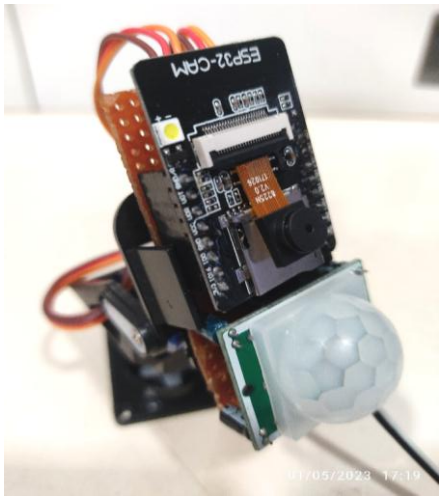


**Fig -5:** ESP32 Cam with PIR Sensor Assembled Module

Figure 5 shows the complete hardware controller section, in this mode, the power adapter should be connected so that the system captures videos continuously and sends the video towards the software / monitor system for further image processing.

Since there is no USB port in this ESP32 module, one cannot directly upload programs to it. So, in order to upload code from Arduino software to this ESP32 module, we required a FTDI USB to TTL serial converter.

## 2.2 Software Implementation

- **Arduino**

It is an open-source hardware and software company. And user community that designs and manufactures onboard microcontrollers and kits for building digital devices. Its software is licenced under the GNU General Public Licence (GPL) or the GNU Lesser General Public Licence (LGPL). Arduino board designs use a variety of controllers and microprocessors. A board with a set of digital and analog I/O pins that can be interfaced with various expansion boards or controllers for prototyping and other circuits like sensors or modules. The board has serial communication interfaces, most of model comes with Universal Serial Bus, which are used to download the programmes into the controller. The microcontrollers can be programmed using the embedded C languages using a standard API, inspired by the Processing language and used with a modified version of the Processing IDE, also known as the Arduino Programming Language [10].

- **Python**

Python is a popular programming language. It can be used for web development (server-side), software development, mathematics and system scripting. In this system we used Python for GUI design, image processing and executable file formation for Windows OS, which means the software development. For GUI design we used Tkinter library, OpenCV and TensorFlow for face detection and recognition. The tkinter package (Tk interface) is the standard Python interface GUI toolkit. Both tkinter and Tk are available on most Unix platforms, including Windows, as well as on MacOS systems. OpenCV means Open Source Computer Vision Library. These are the free and open source software library for machine learning and artificial intelligence. OpenCV was created to provide a common infrastructure for accelerate the use of machine perception in commercial products and computer vision applications.

For connecting to the camera node from our executable file we required IP address of the camera module so either we can give a static IP address from our Arduino code or to find the allotted IP from the network we can use Arduino serial monitor. We used this IP in our python code but for accessing the live streaming we used “urllib” library. The voice alert which we call according to image recognition which are the messages already stored in the program, here we used pyttsx library for conversion of text to speech. For sending the mail to the owners’ personal device we used python mail server, “smtplib” library is available to used for sending the mail. Also we attached the camera image with this mail if intruder is detected.

TensorFlow was developed by the google brain team for the purpose of research and production. It can be used in Medical for increase the speed and accuracy of MRIs in

identifying specific body parts, in social media for suggest custom filters for photos, in search engine, in education for virtual learning platform and to filter out chat messages, in retail to provide personalized recommendations for customers and etc [11].

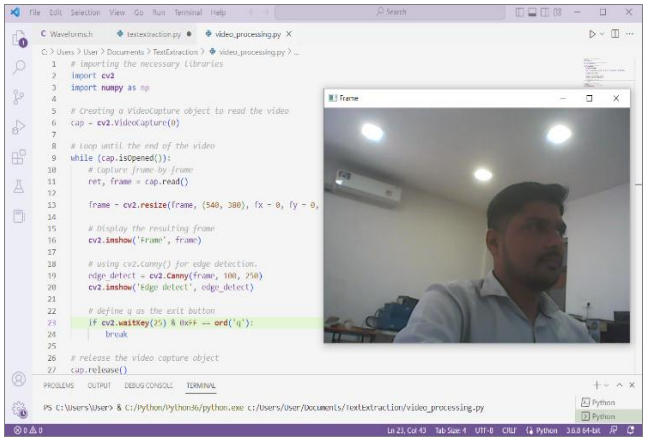

**Fig -6:** Desktop of VS Code for Python Coding

At the end of the developed executable file, we are accessing images continuously from the ESP32 camera module, when the system responds to motion detected in the input detected data. Below figures 7 show the desktop of Graphical User Interface designed for monitoring.

- **Executable File for Windows OS**

With auto-py-to-exe we can easily create our own executable python application and it's not only for Windows OS we can also built for Mac and Linux.

We designed a GUI based Python application using Tkinter and few other libraries and then used auto-py-to-exe to create single standalone executable file that executable file is able to install and run on any Microsoft Windows OS. We used this application without Python installed. For creating the app for Mac and Linux users there are different PyInstaller command line tools. Using single line instruction, a simple app can be created. By adding more arguments, we can include packaged libraries, icon etc. Below figure shows the basic face identification algorithms.

Following figure shows a GUI window designed in Tkinter library and camera access with face recognition. Also, this window calls and play a particular voice instruction or alert from its database.

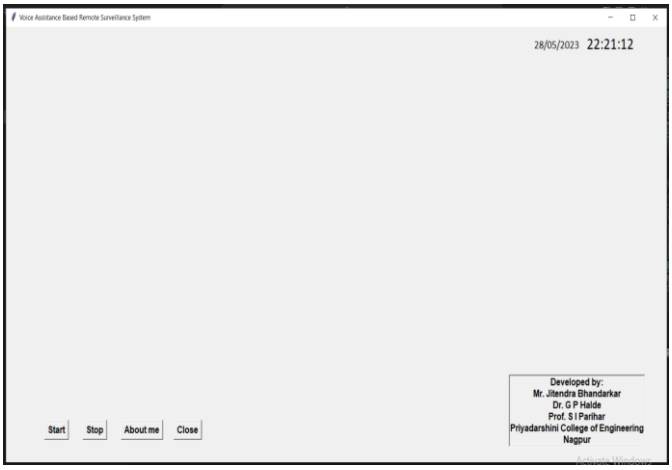


**Fig -7:** GUI/Executable file for Windows OS

## 3. SYSTEM ARCHITECTURE

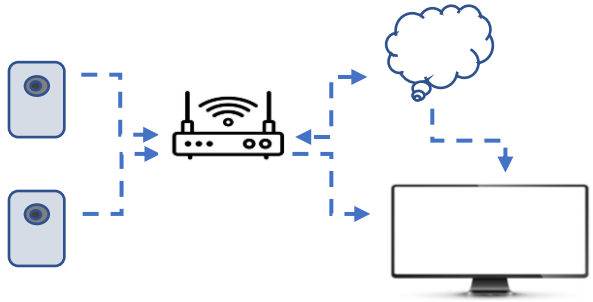

**Fig -8:** Basic Architecture of Project

Surveillance system provides an adequate way for monitoring suspicious activities. Traditional systems have low maintenance cost and are efficient. However, energy consumption is greater when the system is continuously powered on. connectivity which allows real time data transfer. Also, the problem of data transfer at the long range is overcome by using internet connectivity through GPRS. Thus, the system is stable, reliable and can be used in most critical conditions. System senses the movement and depending on the detected motion, system turns on the camera, capture the image of intruder, recognize it and send a notification on owner's monitor screen with the generation of voice alert if the person is not recognized by the system.

We have used two different camera nodes in this project and the real-time videos of both camera nodes accessing in Python programming with the help of the OpenCV library and urllib via IP, we can get access directly from the internet also. We can interface multiple camera units or sensor nodes, either wired or wirelessly.

## 4. OBSERVATIONS AND RESULTS

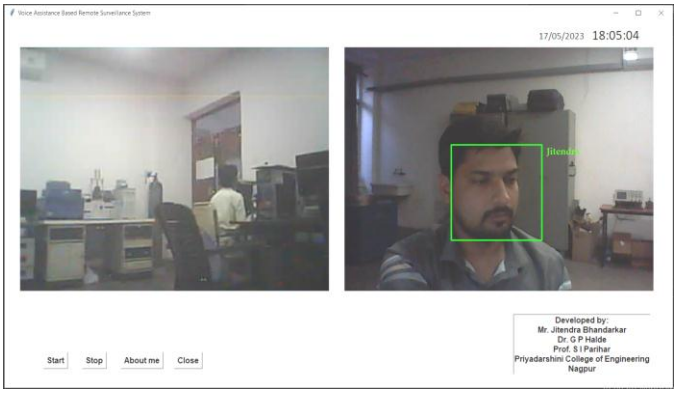


**Fig -9:** GUI/Executable file for Windows OS

To use an email address for sending mail from the Python IDE, we are using the smtp module. And we cannot directly use the email address and Password directly as a sender in Python programming, some email providers may require additional configurations or app-specific passwords. Make sure you have the necessary permissions and configurations to send emails via SMTP. Hence, we were required to generate the app password from the Gmail security settings. We have provided an executable file (.exe) in a portable storage device along with the thesis. First, we installed it on our Windows operating system and run the file. A welcome message is played by the software and informs the user of the connectivity of the internet with the Windows system. Figure 11 shows the received mail.

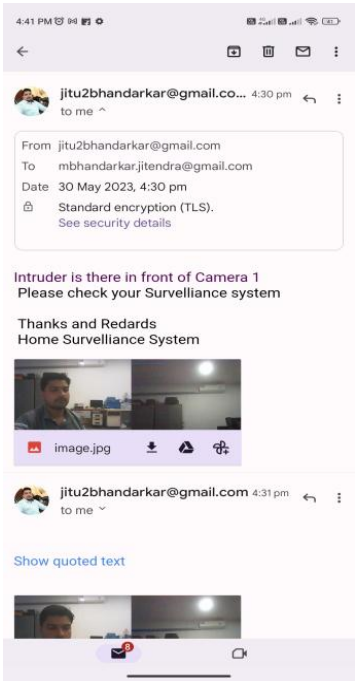


**Fig -10:** Email Alert from Sender Side

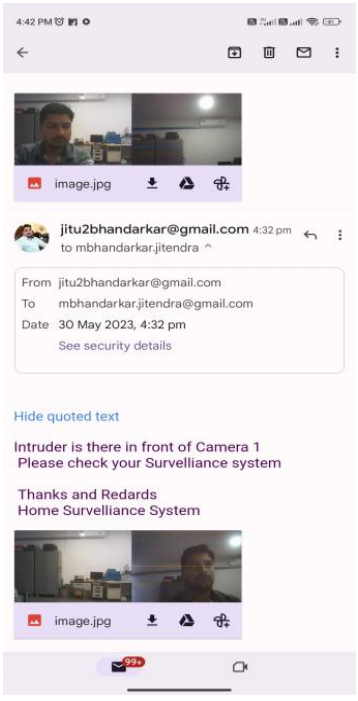


**Fig -11:** Email Alert at Receiver Side

Similarly, when a mail is sent to the receiver's ID, at the same time, a voice alert is also generated according to image recognition and plays in the background of the software.

## CONCLUSION

Under this project, we had created a voice assistant which is capable of running and playing all commands from its database according the image recognition. We are getting intruder images at our mail ID properly. Here we are accessing two streaming's from different two independent camera modules. We are even trying it to make it highly user friendly by implementing the GUI for our particular VA so that it helps them more to understand it in a better manner and finally it runs and working properly.

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