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Development of a Smart Surveillance System With Remote Desktop Image Retrieval

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ABSTRACT : *Security and privacy protection have been a public policy concern for decades. The security system includes both the security hardware placed on a property and individuals' personal security practices. Security hardware includes doors, locks, alarm systems, lighting, motion detectors, and security camera systems. In this paper, a human face-detecting algorithm using OpenCV python was proposed and used which can recognize the face of a human. The hardware was then designed with PIR used as the human detection sensor, when there is a heat signature change the system will wake the Raspberry Pi camera from its sleep mode. The Pi camera will then scan for the face of a human. If it does not detect the face of any human, it then goes back to its sleep mode, but if a face is detected and there is a match with the stored images in the Raspberry Pi, the name of the person will be displayed on the LCD, the door is open for 20secs using solenoid lock and servo motor before the door is closed again. If there is no match (unknown face), the image of the unknown will be stored and retrieved later through remote desktop VNC, while notification will be sent to a registered email.*

KEYWORDS: *Surveillance, Raspberry Pi, PIR, Pi camera, OpenCV, Face Detection and Recognition*

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I. INTRODUCTION

Security and privacy protection have been a public policy concern for decades. The security system includes both the security hardware placed on a property and individuals' personal security practices. Security hardware includes doors, locks, alarm systems, lighting, motion detectors, and security camera systems. Traditionally, once some cameras are connected to displaying devices, a security guard is set to watch them and note any abnormal behaviour. This process unfortunately suffers from several drawbacks resulting in missing what these cameras are set for. For instance, when these cameras are set to monitor a burglary or border crossing events, while such events may take months to occur and such video feeds are often boring to watch, the person in charge of monitoring these camera feeds may easily miss the events that he is supposed to be waiting for, resulting in some serious damages. Furthermore, mounting video cameras is usually cheap, but finding available human resources to monitor the output is expensive. Moreover, in areas like banks, stores and parking lots, cameras are used for continuous recording and storing of video data, which are then replayed when needed to obtain desired information. This leads to the storing of large volumes of video information that are rarely used [1]. Therefore, there are immediate need for automated yet real-time security systems to save money and storage space, and still not miss what they must catch. This study presents a new real-time algorithm for detecting motions in selected areas, like windows and doors, or in the whole view when the camera is set. The algorithm may be used by a complete system to continuously monitor an area and take pictures of detected target objects - humans, in this case. The system is used to get the image(s) of an unknown guest or an intruder to the home of the installer.

A Raspberry Pi can be used to implement a security system with motion detection, image processing and an alert mechanism. The alert ought to contain a time-lapse photo or video and be transmitted over the internet. This thus will enable the users to monitor their homes from anywhere in the world. Several criteria have been used to select a security system required to safeguard a facility. The chief among all these has been the cost of implementation of such a system. The Raspberry Pi is also a very versatile device whose functionality is not limited. It can be extended from being merely a security device to a proxy server [7]. The following reasons explain the need to use Raspberry Pi:

i. Arduino microcontroller-based security system can be relatively cheaper to implement as compared to Raspberry Pi-based system but its memory capacity renders it more ineffective especially when trying to interface with other modules e.g. camera, monitors, motion sensors, mouse and keyboard. Raspberry Pi has an extendable SD card storage and can be expanded to suit the needs of an individual. Moreover, the Arduino microcontroller requires a GSM modem to enable it to transfer information through the internet. The Raspberry Pi has a port to connect it to the internet.

ii, A CCTV surveillance system is expensive to purchase and install compared to the system in question. It requires a Digital Video Recorder (DVR) system to connect it to the data networks through TCP/IP. A DVR on its own is very expensive. Hence such a system may not be afforded by low-income homeowners.

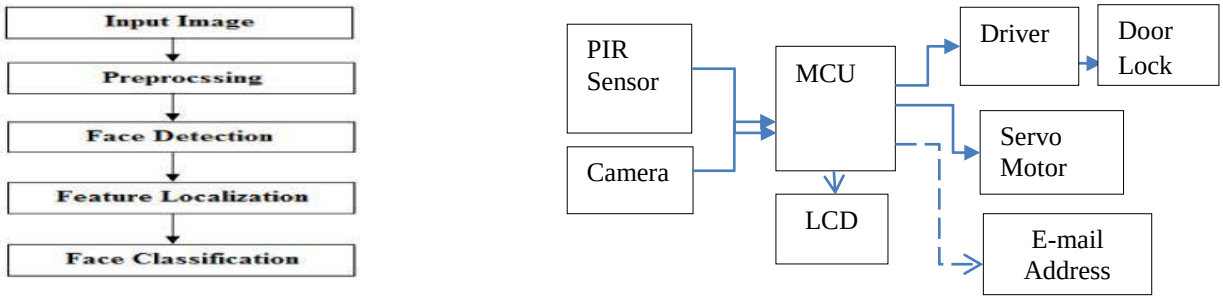
Several related studies have been carried out in the past which presented the following drawbacks:

i. Continuous image capture or recording, leading to wastage of storage space, and therefore higher cost.
ii. Focusing mostly on cyber security and privacy protection within cyberspace.
iii. Not incorporating human detection with image processing and matching.
iv. Where sensing devices (PIR sensors etc.) were used to detect human presence, images were not captured after such detection. GSM systems were used instead, to send messages to alert occupants of such presence. Moreover, PIR sensors only sense heat signatures and are not able to differentiate between a human and another animal.

In this study, these drawbacks were addressed by using Raspberry Pi to detect the presence of objects before pictures are taken. The capturing of images was achieved using a camera controlled by a microcontroller. The captured images were compared to pre-trained images in a database, and an access point opened when there was a match. This system will be useful for home security or restricted access areas of an industrial plant and warehouses.

II. MATERIALS AND METHODS

The block diagram of the smart surveillance system is shown in Figure 1 which is divided into two sections: proposed algorithm and hardware design. The proposed algorithm comprises the human capturing unit, image processing and detection unit shown in Figure 1(a) while Figure 1(b) shows the hardware implementation of the device.



(a): Flow Chart of Proposed Algorithm (b): Block Diagram of a Smart Security System

Figure 1: Generic representation of a face recognition system

Figure 2 shows the circuit diagram of the system using the face recognition algorithm. The system consists of the following: PIR sensor, pi camera, LCD, servo motor, solenoid lock and raspberry pi, The PIR sensor detects the heat change caused by the presence of life that is the slight heat difference caused by the radiation of heat generally caused by humans and animals from the environment [9]. Once a heat difference is observed a signal is sent to the Raspberry Pi [10] which is constantly monitoring the PIR sensor pin connected. When the Raspberry Pi receives the signal from the PIR sensor, the Raspberry Pi wakes the camera [11] connected to it. The Raspberry Pi uses the algorithm written inside it to detect the face of the human present. If there is no face of a human the raspberry pi goes back to its idle state. But if there is face of a human is detected, the Raspberry Pi takes the picture and compares it with the stored image in its dataset and if there is a match, the system opens the solenoid lock [12] and slides the door open via servo motor [13] for the 20sec and locks the door. But if there is no match of the human image, the system saves the image or sends the image of the human to a registered email(s) in the program. The LCD is connected to display results or aid in information when needed.

Figure 3 below presents the basic flowchart of the entire system. The flow chart commences with the start button, and the system continuously scans for heat signature, if there is no heat signature it continues to scan. If there is a heat signature, the camera is to check if the heat signature created is that of a human by scanning for the face of the human and it takes a picture after detecting the face and compares the image with the stored images in the image dataset or database and if there is no match the system saves and sends the image to a registered email, but if there is a match the door is opened for 20secs and then closed and the process continues all over again.

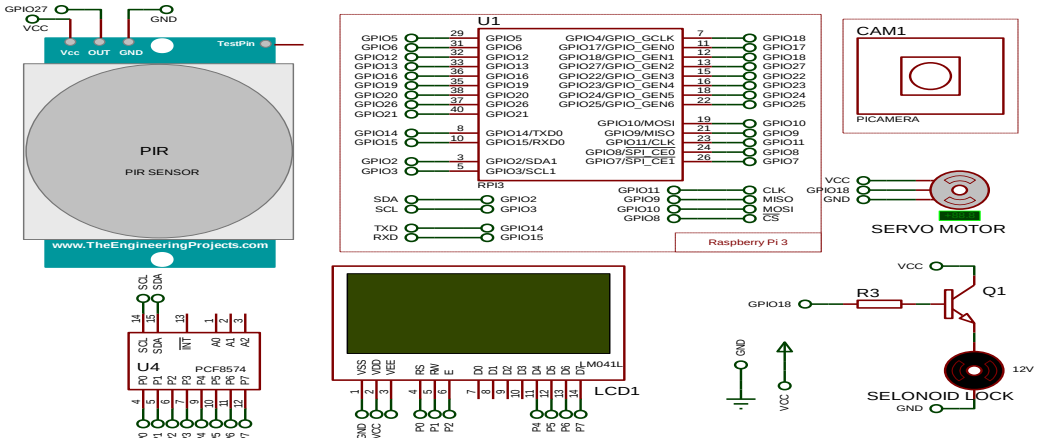


Figure 2: Smart Surveillance System using Face Recognition

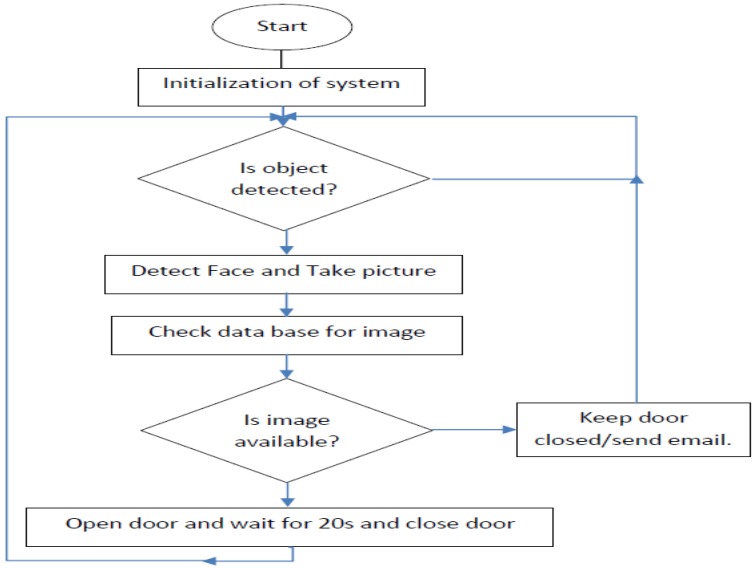


Figure 3: Flowchart Implementation of the Security System

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III. RESULTS

Figures 4 to 8 show the design results of the smart surveillance system using Raspberry Pi to implement.

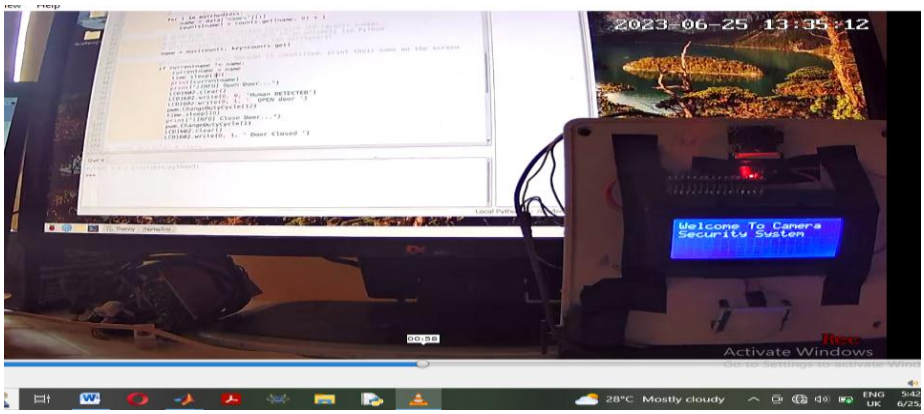

Figure 4: Initialization of the System

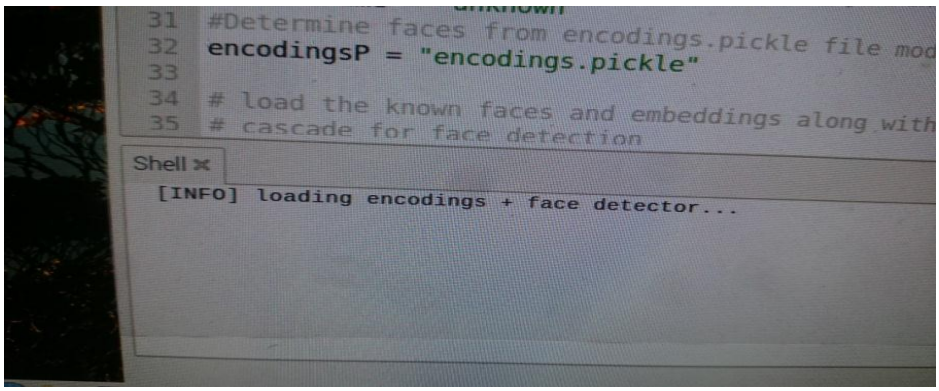

Figure 5: Detecting and Loading of Captured Face Features

Figure 6: Detecting Known Face

Figure 7: Granting Access to Door

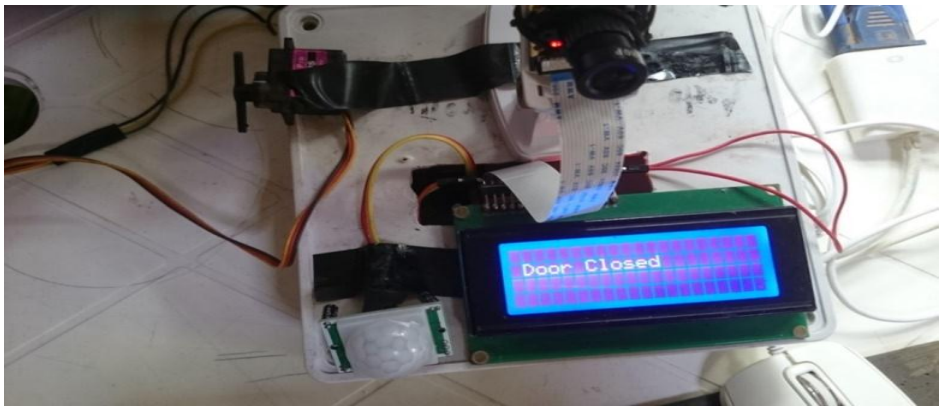

Figure 8: Closing of Door After Access Granted

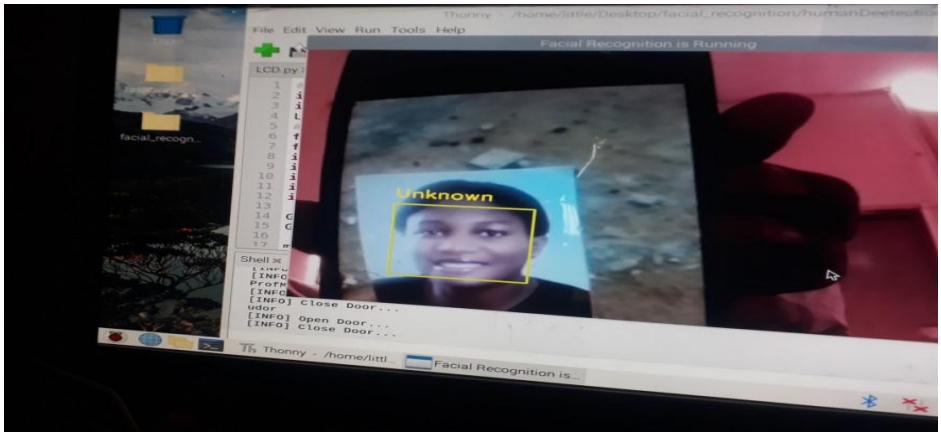

Figure 9: Detecting Unknown Face

IV. DISCUSSION

Figure 4 shows the status when the system initializes. The peripheral devices: camera, PIR sensor and LCD initialize the LCD a message: "Welcome To Camera Security System". Figure 5 presents when the PIR sensor scans for changes in temperature from motion. When temperature change and motion are sensed at the same time, a message:" Motion Detected" is displayed on the LCD and the camera starts to capture an image which the system used in the detection of the face by loading the features of the captured images. After the features of the captured images are extracted, the extracted features are used to detect if there is or are face(s) in the captured images. The detected face is then compared with the trained image stored in the dataset. The camera images and database images are compared for a match, if there is a match, as shown in Figure 6 the name of the matching face is displayed e.g. "Joseph", followed by the message "Door Opened" and then the door will open for 20seconds using a servo motor to slide the door before turning ON the solenoid lock and the door will close with the LCD "Door Close" as shown in Figure 7 and 8 respectively. But if there is no match, a message "Unknown" is displayed followed by "Door Closed" as shown in Figure 9.

V. CONCLUSION

The project, designed and implemented a security system based on the Raspberry Pi as a stand-alone device that can be installed on any building for surveillance purposes. The designed system was able to detect motion detection, video using a Pi camera and send out an alert through e-mail when an unknown person came close to the entrance where it was installed. This project system can be successfully used to monitor the places to prevent any intruders' access by some alert mechanism, image processing, emailing to the person who installs the device and keeping an eye on people that enter and leave the premises using the pi camera. The significance of this project can be applied in the restricted sections of places such as power transmission companies, homes, schools, institutions, government warehouses, hospitals, and some other places where critical security concern is highly demanded.

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