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Embedded Linux based smart security system using IoT and raspberry pi processor

C.Sunil[1], Prof. K. Prahlada Rao[2]

[1]*Department Of Mechanical Engineering &JNTUA,*
[2]*Department Of Mechanical Engineering &JNTUA,*

Abstract–The project aims at designing an intelligent access control system based on finger print technology. the propose system make use of finger print module for authentication process and an electromechanical relay switch to control door locking system for door accessing. The system also supports with camera based image capturing technique when any wrong finger print was detected and alerts through email from wireless Wi-Fi connectivity.

The raspberry pi processor is a low cost, credit -card sized computer that can be used in electronics projects. It is capable device that enables people of all ages to explore computing, and to learn how to program in languages like scratch and python. It is capable of doing everything you would expect a desktop computer to do, from browsing internet and playing high-definition video, to making spreadsheets, word-processing and playing games.

In this project we make use of a finger print module, Wi-Fi module, and raspberry pi processor. The processor reads the input from the finger print module and when the authentication details are correct then the system automatically opens the door lock and closed after predefined time using relay switch. The database of the operation of the door along with timings gets stored in pc application using Wi-Fi wireless communication. The system also captures the image of the user who provides wrong authentication of finger print and sends alerting message with image to the predefined email using Wi-Fi wireless communication to pc application.

Keywords–raspberry pi processor, dc motor, finger print module, web camera, relay switch.

I. INTRODUCTION

The Smart home is a system which makes the home appliances available to the user via remote access. In any Smart home system while using the system, the user will get the facilities like convenient, remote access, comfort. The fundamental of IoT is to connect the devices to the user anytime, anywhere with the aid of network connectivity. The physical world and computer based systems are governed using IoT. IoT employed with home devices is categorized into one-way and two-way devices. In one-way, the devices that are interfaced to the system are exclusively used to notify the administrator about their present conditions. In two-way, the devices that are interfaced with the system can both notify and respond to the Administrator instructions.

With the transformations made in embedded computing systems every device got the ability to be uniquely identified. Internet of Things offers advanced connectivity of device, services and covers a variety of protocols, applications. In the concept of IoT, the devices collect useful data with the help of numerous technologies and then flow the data between the devices. IoT had its impact on our lifestyle and it has lead a new dimension in the field of internet. Security and interoperability are the two significant aspects in the IoT. IoT has already brought revolution over the existing technologies and it is favourably advancing in the domains of education, science, Government, Communication. In the later transformation of Internet, IoT affirms to make a huge step in its ability to obtain, process, distribute data and that process can be transformed into information, knowledge and eventually intelligence. Some of the smart applications in the IoT are smart homes, smart industries, smart health care, smart transportation system. IoT consolidates assorted computing devices and sensor networks to keep track of the Home environments. The devices are connected in a seamless fashion, so that user utilizes their services conveniently. The smart home security system objective is to restrain the house safe from intruders or trespassers, fire accidents. The smart home security system reduces human effort by sensing and responds to the data in Real time without any delay. In the recent years, the urge for remote control and security for the home environments is being rapidly increasing. Though many systems are available, but they are not capable of coping up with the market standards. The Home environment which is not having a security system is easily proved to be insecure. The advancements of home network infrastructures leading rise to new applications in the fields of home security and also as well as for home automation. Security has become a major concern for years to organizations, home, companies. There are many advancements made in the home security system. The access control system mechanism is a significant part of an organization. The door access system limits access to the home to specific people

and hence enhances security. The implementation of the smart home security system can be facilitated with the support of biometric systems and sensors. The combination of biometrics and automation into a framework can enhance security. Biometric provides the ease of identifying people by their traits, these traits are distinct from person to person. Due to above specified quality biometrics gained prominent in the fields of systems ensuring privacy, identifying people, providing security, forensics. To ensure security to home environments, there exists numerous biometric identification elements like keystroke dynamics, speaker recognition, speech recognition, Iris recognition, Face recognition, Vein recognition, Fingerprint recognition. The biometric applications must follow the vital parameters like accuracy, robust, reliability. The general operation of biometric recognition elements is the data scanned is compared with the data available in the database of the system, if both the credentials are matched then the user will get verified and get access. Fingerprint recognition system combined with the webcam suits to be the efficient biometric recognition schemes. The traditional door lock system is built with Wi-Fi, Bluetooth but due to security considerations fingerprint module is employed. The fingerprint and webcam is advantageous over existing systems because it is low cost, works accurately, reliable, uniquely identifies individuals so that's why this approach is integrated into the smart home security system. An efficient smart home security system must work 24x7

II. Literature review

The smart home security system is a prime issue because it's not just about the monetary safety but much more than that. Everyone wants' the happiness and protection of their dear ones and no one wants to see their family members in danger. Significant reasons to utilize the smart home security system are protecting the family and home from trespassers, fire can be detected and safety measures can be taken. The challenges that smart home security system encounters are the developed system must be low cost because it must be available to all the classes of people, the system must be upgraded with the assured development team so that the system can function properly, the system's operating procedure must be known properly, the system must be flexible, it must not consume more power, the smart home security system must not intrude into the users personal life, finally the smart home security system must function accordingly to the instructions given by the administrator. Some of the challenges faced by biometric recognition systems are the data from the users must be sensed accurately.

Some recognition elements need direct contact with the user, while some recognition element Multimodal Home Security System using IoT and Raspberry Pi 145 International Journal of Control Theory and Applications doesn't need any contact depending on the application need a specific recognition element must be chosen. Biometrics operate in both stand-alone or fused mode, So issues like noise captured data, man in the middle attacks must be taken care while developing the system. Based on the application the operating scope of the recognition system is chosen. Some of the available biometric recognition systems for smart home security are discussed below. Keystroke dynamics, specifically identify a person based on the periodicity of typing and the sequence of the words. The two parameters that keystroke dynamics follow are dwell time and flight time. The Dwell time is when the certain key is pressed and flight time is when the pressed key is released and another key is pressed. If the typing period is mismatched then the user must again repeat his actions.

The Speaker recognition is the automated approach of uniquely identifying a person based on the voice. The Four steps involved in speaker recognition method are voice recording, feature extraction, pattern matching, decisions.

The major disadvantage of this Speaker recognition system is anyone can imitate the voice and break the security. The speech recognition is the process of recognizing what is being said. An Unauthorized user can get access to the system by imitating the voice of the speaker.

The IRIS recognition is the method of identifying a person by the analysis of the pattern of IRIS. IRIS recognition system analyzes on the coloured pattern which is unique for each individual. The IRIS recognition system cost is high, very low range is required to capture the data between the IRIS and the system.

The IRIS recognition system damages the eye due to the variable light intensity and produces fault results. The fingerprint recognition system is considerably known for its applications in the field of authentication on computer systems.

The fingerprint is distinct from person to person, no two person's impressions will match. The basic patterns fingerprint has arch, loop, and whorl. Certain care must be taken while choosing a fingerprint reader because it must overcome the Type I and Type II error.

The optical reader sensor is more preferred over various readers available in the market because of its low cost, accuracy. The optical reader sensor resembles a digital camera that use visual images of the fingerprint. The Fingerprint recognition system supports the following criteria like universality, uniqueness, collectability, Acceptability, performance, Circumvention. The fingerprint trait doesn't transit unless there is physical riot due to cause of accidents which damages fingerprints

III. Hardware description

Introduction

The main blocks of this project are:

1. Raspberry pi
2. Power supply
3. Crystal Oscillator

4. Wi-Fi
5. Fingerprint scanner
6. USB Camera
7. DC motor
8. LCD with driver
9. Hard disk(SD card)

the block diagram of the project and design aspect of independent modules are considered. Block diagram is shown in fig below

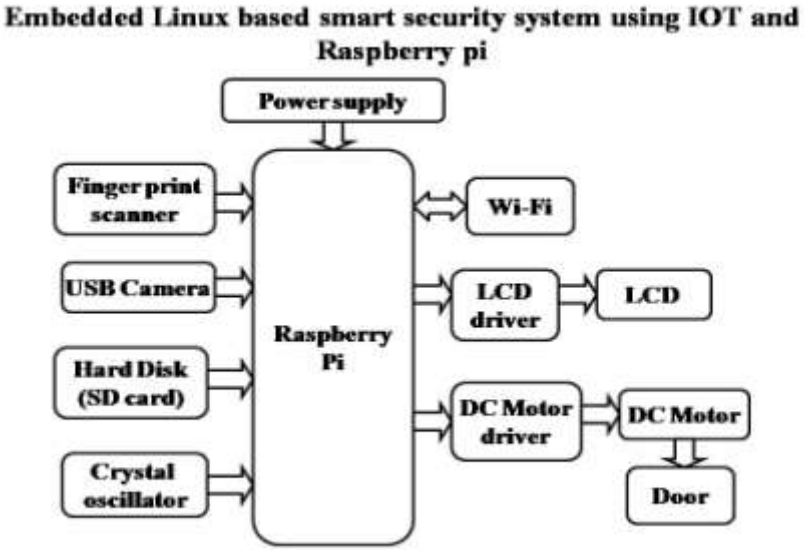

Fig.1.Block diagram of embedded Linux based smart security system using IoT

Biometric fingerprint O**ptical reader:** The fundamental role of fingerprint scanner is to scan the image of finger and examine with the earlier scanned images, if the image data matches then authentication will be provided. Among various readers available the optical fingerprint reader suits to be more beneficial because of its unique advantages. The optical reader can log up to 256 images. The optical fingerprint module is interfaced the Raspberry Pi 3. This module is identical to that of a digital camera.

Fig.2 Finger print optical reader

Webcam: In the Raspberry Pi 3, there is certain zone available for interfacing Webcam. It can produce 5 MP resolution image. The webcam is interfaced to the USB ports provided on the Raspberry pi. The Raspberry Pi 3 integrated with the webcam serves efficiently in the field of security applications.

Fig 3 Web camera

DC motor: The DC motor is utilized in the process of opening and closing the door. The DC motor directly cannot interface to the Raspberry pi 3, because Raspberry Pi 3 provides 5 V where as DC motor requires 12 V to operate. So the L293D driver is employed to drive the voltage from 5 V to 12 V to the DC motor. With one L293D driver two DC motors can be interfaced.

Fig.4 Dc motor

Raspberry Pi 3: The Raspberry Pi 3 is a low cost, efficient processor. It works on the operating voltage of 5 V. It can facilitate the user with all the features that are provided in the personal computer. The Raspberry Pi 3 acts as a central server controlling all the data. The Raspberry Pi3 is programmed using Python programming language. All the information from sensors attached to the body are interfaced to the Raspberry Pi to achieve high computations and efficient data communication.

Fig.5 Raspberry pi processor

LCD: Liquid crystal displays are used in digital watches and many embedded systems projects. The LCD is used to display the measured data. A 16 x 2 Alphanumeric Display it can display two lines with a maximum of 16 characters in one line.

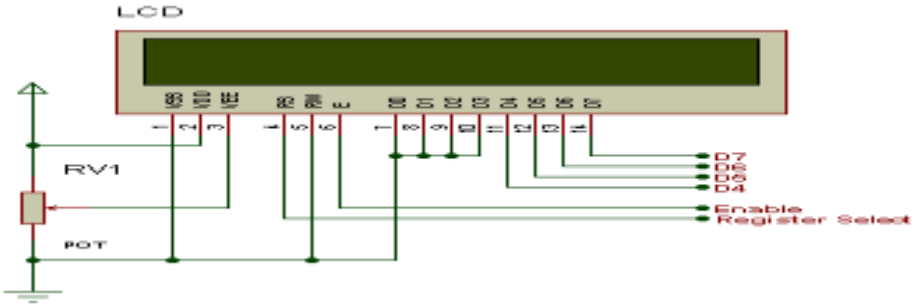

Fig.6 LCD Pin diagram

IV. Project description

The implementation of the smart home security system is significant because in the recent days investigators proposed that the rate of increase in robberies is not being controlled.

In this system shown in above Figure represents the hardware of the home security system, the developed model resembles an efficient smart home security scheme. Here two buttons **E** and **S** are provided. 'E' button is used to register new user, 'S' button provided is utilized to get the optical finger print module ready for the user to verify the credentials.

On the LCD display the message place the finger is displayed, then the user must place the finger on the area provided on the optical fingerprint module.

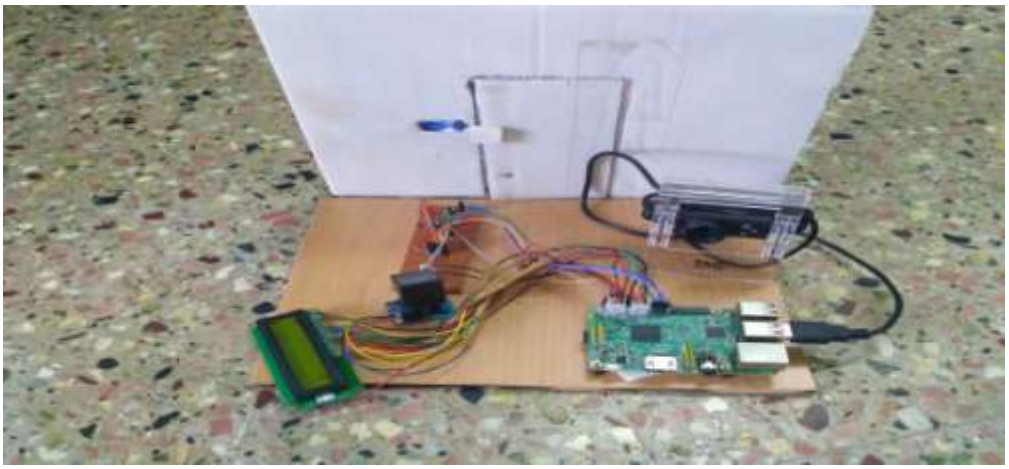

Fig.7 Implemented Hardware of the security system

With the Optical fingerprint reader provided, the user must first enroll with the administrator for remote door access. If the user is an authorized person, the person can directly access the door by placing the finger. The optical fingerprint reader is to scan the fingerprint of the user and the webcam is used to snap the unauthorised person photo. The data from the fingerprint and the camera is uploaded to the database which is in the hard disc. In the database the scanned fingerprint will be compared with fingerprints already stored, if the data matches, then the access to the door is automatically provided. Display will show message of "access granted". If unauthorised person placed the finger display will shows message of "access denied". then immediately web camera capture the photo and send it to the predefined email which is provided by the user.

User need to press and hold the enrol button E for enrol, Then display shows place the finger. After lacing of finger on the optical finger print reader it stores the details of the user and generates a template of the finger print. Finger print will get enrolled.

If user wants to access the door he has to press and hold the selection button S and place finger on the finger optical finger print reader. Processor compare with the stored template. If the data is matched, processor gives input to the motor to open the door. LCD will display the message access granted. If data was not matched with the template data LCD will display message access denied and web cam capture the photo of unauthorised person then send it to predefined email of the user.

V. ADVANTAGES AND DISADVANTAGES

Advantages:

1. Highly efficient and user friendly design.
2. Easy to operate.
3. Low power consumption.
4. Wi-Fi based communication.
5. Provides security to homes, industries and educational institutions.

Disadvantages:

1. Interfacing fingerprint scanner to ARM-11 processor is highly sensitive

Applications:

1. Used at homes.
2. Industrial Security Applications.
3. Educational Applications.
4. Used at lockers.

VI. RESULTS

The project "**Embedded Linux based Smart Security System using IoT and Raspberry Pi"** was designed to provide security through fingerprint technology and keep track of intruder images whenever wrong fingerprint is placed.

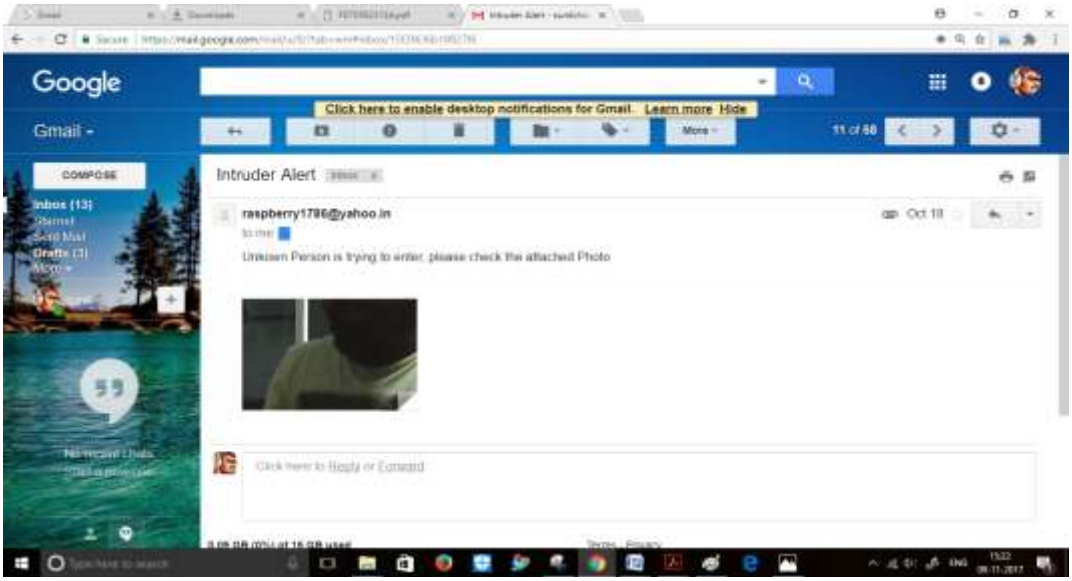

Fig. 8 Screenshot of Email alert on Internet Browser

VII. Conclusion

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested.

VIII. Future Scope:

Our project "**Embedded Linux based Smart Security System using IoT and Raspberry Pi**" is mainly intended to provide security through fingerprint technology and keep track of intruder images whenever wrong fingerprint is placed.

The controlling device of the whole system is a Raspberry Pi processor. Fingerprint scanner, USB Camera, DC motor and LCD are interfaced to the ARM1176JZF-S 1.2 GHz processor Raspberry Pi. The data received by the fingerprint scanner is fed to the ARM1176JZF-S 1.2 GHz processor. The processor acts accordingly and either opens or does not open the door. In achieving the task the controller is loaded with a program written using Embedded Linux programming language.

This project can be extended using high efficiency GSM module using which we can send the user about the unauthorized access. The GSM module gives the SMS messages of the authentication through SMS. Whenever wrong fingerprint is placed the user gets message in the form of SMS through GSM modem and he can check the email to see the intruder image.

IX. REFERENCES

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