

HOME SECURITY SYSTEM WITH INTRUDER ALERT

Submitted in Partial fulfillment of the Requirements for the award of

**Bachelor of Engineering in
Electronics and Communication Engineering**

BY

G.N. SAI VARUN (38130191)

A. ANUDEEP (38130007)



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION
ENGINEERING**

SCHOOL OF ELECTRICAL AND ELECTRONICS

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that Project Report is the bonafide work of **G.N. SAIVARUN (38130191)** and **A. ANUDEEP (38130007)** who carried out the Project entitled **"HOME SECURITY SYSTEM WITH INTRUDER ALERT"**. Under the guidance of **Dr.R.M. JOANY, M.E., Ph.D.**, during the period OCT 2021 to APR 2022.

Internal Guide

Dr.R.M. JOANY, M.E., Ph.D.,

Head of the Department

Dr. T. RAVI, M.E., Ph.D.,

Submitted for Viva Voce held on

Internal Examiner

External Examiner

DECLARATION

We **AKKIREDDY ANUDEEP (38130007)** and **G.N.SAIVARUN (38130191)** hereby declare that the Project report entitled “**HOME SECURITY SYSTEM WITH INTRUDER ALERT**” is done under the guidance of **Dr.R.M. JOANY, M.E., Ph.D.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

DATE:

1)

PLACE: CHENNAI

2)

SIGNATURE OF CANDIDATES

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We are pleased to acknowledge my sincere thanks to board management of **SATHYABAMA** for their kind encouragement in doing this internship and for completing it successfully. I am grateful to them.

We convey my thanks to **Dr. N.M. NANDHITHA, M.E., Ph.D.**, Dean, School of Electrical and Electronics Engineering and **Dr. T. RAVI, M.E., Ph.D.**, Head of the Department, Electronics and Communication Engineering for providing me necessary support and details at the right time during the progressive reviews.

We would like to express my sincere and deep sense of gratitude to my Project Guide **Dr.R.M. JOANY, M.E., Ph.D.**, for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of my Project.

We wish to express my thanks to all Teaching and Non-teaching staff members of the **Department of Electronics and Communication Engineering** who were helpful in many ways for the completion of the project.

ABSTRACT

Security has become one of the main concerns nowadays. It is very important for all the offices; banks etc. to have a well-defined security system which would allow only authorized people to enter these places.

We have designed an IoT and RFID based security system in which only a person with valid RFID would be allowed to enter the premise. IOT and RFID based security system use RFID as access control. A person carrying the RFID tag needs to swipe it at the RFID reader.

The RFID reader reads the unique RFID number from the RFID tag. The RFID reader then sends the ID details over to the Raspberry Pi. The Raspberry Pi is programmed to compare the ID number from the swiped card with that of the authorized IDs.

If the card number is invalid, the Raspberry Pi sends the signal to camera. If the card number is valid, the Raspberry Pi sends the signal to open the gate and let the person in.

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO
	ABSTRACT	v
	LIST OF TABLES	x
	LIST OF FIGURES	xi
	LIST OF ABBREVIATIONS	xii
1	INTRODUCTION	1
	1.1 PURPOSE	2
	1.2 EXISTING SYSTEM	3
	1.3 BENEFIT OF PROPOSED SYSTEM	4
	1.4 RELATED WORKS	4
2	LITERATURE SURVEY	6
	2.1 SYSTEM ARCHITECTURE	8
	2.2 PROPOSED WORK	9
	2.3 INTRODUCTION	11
	2.4 SYSTEM OVERVIEW	12
	2.5 CONCLUSION	13
3	ARTIFICIAL INTELLIGENCE	14
	3.1 TYPES OF MACHINE LEARNING	15
	3.2 TYPES OF PROBLEMS SOLVED USING ARTIFICIAL INTELLIGENCE ALGORITHMS	17
	3.2.1 Artificial Intelligence Algorithms	18
	3.2.2 Classification Algorithms	18
	3.2.3 Naive Bayes	19
	3.2.4 Decision Tree	20
	3.2.5 Random Forest	21
	3.2.6 Logistic Regression	22
	3.2.7 Support Vector Machine	23

CHAPTER NO	TITLE	PAGE NO
	3.2.8 K Nearest Neighbors	24
	3.2.9 Regression Algorithms	25
	3.2.10 Linear Regression	25
	3.2.11 Clustering Algorithms	26
	3.2.12 K-Means Clustering	26
	3.2.13 Ensemble Learning Algorithms	27
	3.2.14 Gradient Boosting	29
	3.2.15 XGBoost	29
3.3	IOT	30
	3.3.1 How does IoT work?	30
	3.3.2 Why is IoT important?	31
	3.3.3 What are the benefits of IoT to organizations?	32
3.4	PROS AND CONS OF IoT	33
3.5	IoT STANDARDS AND FRAMEWORKS	34
3.6	CONSUMER AND ENTERPRISE IoT APPLICATIONS	36
3.7	IoT SECURITY AND PRIVACY ISSUES	37
3.8	WHAT IS THE HISTORY OF IoT?	38
4	HARDWARE DESCRIPTION	40
	4.1 INTRODUCTION	40
	4.2 OVERVIEW	41
	4.3 EXPLORING THE RASPBERRY PI BOARD	41
	4.3.1 SD Card Slot	42
	4.3.2 Micro USB Power	42
	4.3.3 HDMI Out	42
	4.3.4 Ethernet and USB port	42

CHAPTER NO	TITLE	PAGE NO
	4.2.5 RCA Video Out and Audio Out	42
	4.2.6 GPIO Headers (Pins)	43
	4.2.7 Chips (Broadcom)	43
4.4	RASPBERRY PI 2 MODEL B	43
4.5	HARDWARE REQUIRED FOR RASPBERRY PI	43
	4.5.1 Power Supply	44
	4.5.2 Storage	44
	4.5.3 Input	44
	4.5.4 Monitor	44
	4.5.5 Network	44
4.6	POWER SUPPLY UNIT	45
	4.6.1 Simple 5V power supply for digital circuits	46
4.7	WEBCAM	47
	4.7.1 Lens	47
	4.7.2 Portability	48
	4.7.3 Features (LOGITECH WEBCAM C100)	48
4.8	IMAGE PROCESSING ON RASPBERRY PI	49
4.9	INTRODUCTION	49
4.10	BASIC CONCEPT OF IMAGE PROCESSING	50
4.11	SYSTEM HARDWARE DESIGN	51
5	SOFTWARE DESCRIPTION	54
5.1	START UP WITH RASPBERRY PI	54
	5.1.1 Installation of operating system on Raspberry Pi	54
	5.1.2 Use of laptop screen,	54

CHAPTER NO	TITLE	PAGE NO
	keyboard and mouse for Raspberry Pi	
5.2	PUTTY	55
5.3	INSTALLATION OF REQUIRED APPLICATIONS ON RASPBERRY PI	56
6	RESULTS AND DISCUSSION	66
6.1	OUTPUT	66
6.2	CONCLUSIONS	67
	REFERENCES	68

LIST OF TABLES

TABLE NO	TITLE	PAGE NO
3.1	Type of Problems Solved Using AI – Artificial Intelligence Algorithms	17

LIST OF FIGURES

FIGURE NO	TITLE	PAGE NO
3.1	Machine Learning	15
3.2	Decision Trees	20
3.3	Random Forest	21
3.4	Logistic Regression	22
3.5	Support Vector Machine	23
3.6	Linear Regression	25
3.7	K-means	27
3.8	Ensemble Learning	28
3.9	Example of IOT system	31
4.1	Raspberry Pi	40
4.2	Block diagram of power supply	45
4.3	Processing of power supply	45
4.4	Webcam	49
4.5	Block diagram of image processing	50
4.6	System Block Diagram	51
5.1	Putty login windows	55
5.2	Putty success windows	56
5.3	Raspberry Pi Desktop on your Laptop Display	56

LIST OF ABBREVIATIONS

AI	-	Artificial intelligence
GPIO	-	General purpose input output
HDMI	-	High definition multimedia interface
IoT	-	Internet of Things
KNN	-	K nearest neighbors
ML	-	Machine learning
OPENCV	-	Open source computer vision
OS	-	Operating System
PIR	-	Passive infrared sensor
RFID	-	Radio Frequency Identification Device
UI	-	User interface
USB	-	Universal serial bus

CHAPTER 1

INTRODUCTION

Raspberry Pi is connected to the USB camera with the help of USB port .In the PC, Raspbian operating system is installed. Raspberry-pi works only on Raspbian operating system, Linux. Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. An operating system is the set of basic programs and utilities that make your Raspberry RFIDun. However, Raspbian provides more than a pure OS: it comes with over 35,000 packages, pre-compiled software bundled in a nice format for easy installation on your Raspberry Pi.

Putty configuration and VNC viewer are needed to install Raspbian OS. Putty configuration is SSH and Telnet client .It is a open source software that is available with source code.

Internet of things (IOT) platform based smart device/system has entered into a golden era of rapid growing technology in the field of home security. The Internet of Things is a concept to make every device/system such as Internet TV's, smart phones and sensors connected with the Internet can be controlled and monitored from anywhere and anytime. There are various existing systems that are used for home security purposes such as Microcontrollers- based wired and wireless security systems, CCTV system etc., but they are much expensive and having limitation in range and accessibility to the user. In this research work, cost effective Raspberry Pi based home security system using RFID and Pi-Camera is designed and build.[1,2,10]. In this paper, a IoT platform based home security system is developed. Whenever human intrusion is detected in front of home door then system send security alert to user/owner of the home and registered members through email on his/her smartphone . This email alert will contain image of the Intruder which is captured by Pi-camera and also video and audio clip of the

Intruder. Raspberry Pi-3 is used to control the whole home security system with Python programming. This system can be installed at the main door of user home or office, then user can get the email alert on his/her smartphone from system anywhere in the world over internet.

The present situation ensures that the safety and security has become more essential. There is a regressive progress in the security system as the influence of modern technology is reaching its maximum limits. When there is a modern home with minimum human needs, it is said as modern house. Wireless and digital technologies, all together it produces a automated intelligent security system to our home. The automated house security system can be implemented with the surveillance camera and multiple sensors, and the use of these sensors will be defining the characteristics of these sensors. Speed data transmission takes place while using the Wi-Fi to security systems which helps the user to control and monitor the system. The need of video surveillance systems are rapidly increasing in the present day. The things people want to know about their security surveillance system is whether or not they have the ability to connect to it over the internet for remote monitoring. In the past, security surveillance systems had to be viewed by a person who was locked away in a room all day monitoring the systems to make sure that nothing bad happen. The other way was to come back and review the footage but there is chance of damage to the footage.

It can be happened by using Raspberry Pi and switch sensors to detect the presence of an individual in the absence of the owner. When the motion of the person had been detected the sensor will give an alert message or call to the owner, So that the owner can monitor the footage of the house to detect the individual who entered the house. Advantage of using piezoelectric sensor. It can withstand high temperature (500°C) comparing to PIR sensor. Sensor that is used was small in size and has a rugged construction

1.1 PURPOSE

- This paper deals with the design and implementation of Smart surveillance monitoring system using Raspberry pi and RFID for mobile devices.

- It increases the usage of mobile technology to provide essential security to our homes and for other control applications. The proposed security system captures information and transmits it to the respective mail using the internet.
- Raspberry pi operates and controls motion detectors and video cameras for remote sensing and surveillance, streams live video and records it for future playback. For example, when RFID, The cameras automatically initiate recording and the Raspberry pi device alerts the owner of the possible intrusion having a smart phone. Raspberry- Pi has two main components interacting with each other.
- We can able to detect, recognize, Tracking system using webcam, we can able to send it to the email automatically. We can able to alert the people using IOT technology.

1.2 EXISTING SYSTEM

- Existing is sensor less capturing system based on raspberry pi based controllers.
- Thus we have designed a smart surveillance system capable of recording/capturing video/image and transmitting to any system
- It is advantageous as it offers reliability and privacy on both sides. It is authenticated and encrypted on the receiver side, hence it offers only the person concerned to view the details.
- Future work is to locate the number of persons located exactly on that area and their position so that accurate information can be obtained on the receiver side.

1.3 BENEFIT OF PROPOSED SYSTEM

- Remote control is possible
- Can share data between others
- Can monitor wherever from the world
- It is Effective.
- It is Low cost.
- We can monitor the blind people with location by receiving the messages.
- Automatic character recognition.

1.4 RELATED WORKS

In the IoT platform based home security system, the main emphasis on protecting our loved ones and our belongings at home. Today numbers of IoT based home security systems are available in market. According to the literature and market survey, the common parameters of IoT enabled home security system are 24 hours monitoring and detection of the intruder, real time, cost effective and precise notification system suggested by various researchers. Following are the contributions of various researcher done in IoT domain.

Rani et al. (2018) explains the IoT based home security using Raspberry Pi which give SMS alert to authorize person through WAY2SMS and image of the unauthorized person via g-mail. Dinakar et al. (2018) proposed IoT based automated home security system using Raspberry Pi which gives intruder detection alarm and notification to the owner. Ghodke et al. (2017) explains in their paper how the IoT network based system send the information of any person image coming close to the door for home security to the owner. Anwar et al. (2016) explains the IoT based door accessibility and voice alerting through smart phone for home security system. Tanaya and Kishore (2016) explains the up-gradation of home security system with face detection technique using haar algorithm in open

CV for the detection of authorized or design and build unauthorized person. Chowdhury et al. (2013) describes IoT based remote access control system for authorized person at door using raspberry Pi. The internet connectivity, raspberry pi, pi-camera and PIR sensor, these are common components are used in the above references system. PIR sensor is used for detection of movement at the door and pi-camera is used to capture the image according to movement in all system. Few system gives the remote access for authorized person at the door step. Comparatively very less work is done on the human face and object detection.

CHAPTER 2

LITERATURE SURVEY

There are multiple solutions proposed for the security system provided with IoT facilities that have been proposed and invented in the literatures which helps the solid security system improve the quality of service delivery. Researches in [1] Deepak.S.Kumbhar, H.C.Chaudhari, Shubhangi M.Taur, Shubhangi S.Bhatambrekar make use of the Linux environment – Raspbian OS for implementing the python code. From [2] the feature based Haar cascade face detection classifier algorithm is used for detecting faces, edges and lines. R Gurunath , Mohit Agarwal, Abhrajeet Nandi, Debabrata Samanta from [3] made use of BOT NET to function the controlled IoT devices. In [4] the transactions on pattern analysis is focussed. Researchers from [5] make use of RFID to sense the signal inputs. Thinagaran Perumal, Chui Y.L, Mohd Anuaruddin Bin Ahmadon, Shingo Yamaguchi from [6] install Naïve Bayes machine learning package for activity recognition purpose. From [7] Piezoelectric RF Resonance voltage is used as amplifier for the IoT devices for reducing power consumption. In [8] Dr. M.L. Ravi Chandra, B. Varun Kumar, B. Sureshbabu propose a smart home system to monitor the surrounding parameters such as temperatures smoke and intensity. Researchers in [9] use PIR sensors for the motion detection purpose. In [10] Dr. M.L. Ravi Chandra, B. Varun Kumar, B. Sureshbabu provides confidentiality by converting the information collected from sensors into cipher text.

Title: Home Security System

Author: Ashwini Pawar

Description:

In the Home Security System (HSS) by Ashwini Pawar used raspberry Pi to get the security alerts after every event. The HSS provides security such as

fire protection gas leakage detection and also protection from intruders. Enhancing HSS using IoT by Alanah Singh, in this the HSS that can be managed by a user through android phone. This is related to an Android platform. Automatic service request system for security in smart home using IoT by Pranav Kumar. This discuss about implementation of raspberry Pi associated with web server or cloud via internet. The sensor data is processed by raspberry pi and if any problems found in protection then it will automatically send service request to the owner of the home regarding the security issue. All the above system's purpose is to solve the security issues. In this project, we collect data from different sensors for monitoring the present status through IoT. This can be useful for intruder detection, fire accidents and any other abnormalities occur.

Title: Internet of things (IOT) platform based smart device/system

Author: R Gurunath, Mohit Agarwal, Abhrajeev Nandi, Debabrata Samanta

Description:

This entered into a golden era of rapid growing technology in the field of home security. The Internet of Things is a concept to make every device/system such as Internet TV's, smart phones and sensors connected with the Internet can be controlled and monitored from anywhere and anytime. There are various existing systems that are used for home security purposes such as Microcontrollers- based wired and wireless security systems, CCTV system etc., but they are much expensive and having limitation in range and accessibility to the user. In this research work, cost effective Raspberry Pi based home security system using PIR and Pi-Camera is designed and build.[1,2,10]. In this paper, a IoT platform based home security system is developed. Whenever human intrusion is detected in front of home door then system send security alert to user/owner of the home and registered members through email on his/her smartphone . This email alert will contain image of the Intruder which is captured by Pi-camera and also video and audio clip of the Intruder. Raspberry Pi-3 is used to control the whole home security system with Python programming. This system can be installed at the main door of user home or office, then user can get the

email alert on his/her smartphone from system anywhere in the world over internet..

2.1 SYSTEM ARCHITECTURE

The home security system based on Internet of Things (IoT) with additional capability to detect and recognize intruder using YOLO algorithm. The system is implemented on Raspberry Pi-3, because it can process captured image with low power and high processing speed. Raspberry Pi-3 equipped with all necessary electronics components (PIR sensor, Ultrasonic sensor, Pi-Camera, Buzzer, Speaker and Microphone) required for home security.

In this section we discuss architecture of the home security system approach as shown in figure 1. In the architecture of home security, a PIR sensor is used to detect the presence of any intruder person and it also work in darkness. A Pi Camera is used to capture the image of intruder when the presence it detected [3,4,5]. It works into two mode. In the first mode, whenever any person motion is detected and that person presses doorbell button, then system will capture an image and save it into database on 16GB Micro SD-card. Raspberry Pi processes the image to find out the intruders using YOLO algorithm with help of Python and OpenCV , then it is decided that the intruder is familiar or unfamiliar with the help of stored database. If the person is not familiar then system will alert through e-mail notification to the user and registered members by sending captured image, video and audio clip of that person as attachment. If the person is familiar then system will capture an image of that person and stored in the system.

The IoT based home security system has been designed and developed with RaspberryPi-3, Pi-camera and PIR sensor. The user can get alerts anytime and anywhere through e-mail on smartphones or Laptop. Whenever any unknown or suspicious movement is detected, its gives loud alarm. Hence, the designed system successfully prevent access to any unknown person entering the home.

Title: IoT based Security System using Raspberry Pi

Author: R Gurunath, Mohit Agarwal, Abhrajeev Nandi, Debabrata Samanta1

Description:

There are multiple solutions proposed for the security system provided with IoT facilities that have been proposed and invented in the literatures which helps the solid security system improve the quality of service delivery. Researches make use of the Linux environment – Raspbian OS for implementing the python code. From [2] the feature based Haar cascade face detection classifier algorithm is used for detecting faces, edges and lines. R Gurunath, Mohit Agarwal, Abhrajee Nandi, Debabrata Samanta from [3] made use of BOT NET to function the controlled IoT devices. In [4] the transactions on pattern analysis is focussed. Researchers from [5] make use of RFID to sense the signal inputs. Thinagaran Perumal, Chui Y.L, Mohd Anuaruddin Bin Ahmadon, Shingo Yamaguchi from [6] install Naïve Bayes machine learning package for activity recognition purpose. From [7] Piezoelectric RF Resonance voltage is used as amplifier for the IoT devices for reducing power consumption. In [8] Dr. M.L. Ravi Chandra, B. Varun Kumar, B. Sureshbabu propose a smart home system to monitor the surrounding parameters such as temperatures smoke and intensity. Researchers in [9] use PIR sensors for the motion detection purpose. In [10] Dr. M.L. Ravi Chandra, B. Varun Kumar, B. Sureshbabu provides confidentiality by converting the information collected from sensors into cipher text. Raspberry pi 3 was the latest version of the raspberry pi computer. The pi wasn't like a typical computer. The size of the raspberry pi is almost equal to the size of the creditcard. One thing to keep in mind is that the Pi by itself was just a bare board. One must also require a power supply, a monitor or TV, leads to connect to the monitor-typically HDMI, and a mouse and keyboard.

2.2 PROPOSED WORK

The IoT based Security System using Raspberry Pi system views the entire floor for movement. Once its detects the movement an alert over IoT will be generated. This system is secure which is connected with IoT when we go out of home, the system is to be turned on, then only whoever try to enter inside the house information will be passed over the IoT. This system is powered by Raspberry pi which is included in the security system, Whenever someone enters in the house, and their movement will be immediately sensed by the sensor which

passes on the signal to raspberry pi controller. The controller processes the request if it is a valid request and then it turn on the camera which is linked to the controller to the area where motion was detected and then sends it over the Internet for the user to check the footage. Sensors are implemented in the home such a way that they are not visible. These sensors will be linked to the raspberry pi processing unit. When the motion is detected by the sensor it will generate an input signal. Once input signal is generated it will be transmitted to raspberry pi unit and validates the request. Based on the input signal, camera linked to the raspberry pi will capture the video. Video frames is collected from the camera and transmitted to the owner over the internet by using Wi-Fi module. Collecting input signal from the sensor to Raspberry pi Controller. Generating rotation in the servo motor based on the signal received from the raspberry Pi Once the System receives the signals, the alert about an intruder is sent to the owner's device. Here, the camera will be recording till the full time interval has been set and it will minimize some video part where there is no motion is available and the remaining contents will save in the memory.

Internet of things used in the light of wire application helps to see the action and distinguished development. Computer Vision provides the face detection and is used for recognition of people which is a most fascinating kind of application for the Internet of Things. Computer Vision combinations exhibits greater level of security system in the IoT platform especially for intelligent homes as they have capacities which perceive a person in the incorrect places since the human might be a bad human for environment.

Title: IoT-Based Home Security Using Raspberry Pi

Author: Dr. M.L. Ravi Chandra, B. Varun Kumar, B. Sureshababu

Description:

Internet of Things (IoT) is a network of all devices that can be accessed through the Internet. This device can be used for home security in an effective way. Home security has been a major issue in the world, where crime is increasing every day and everybody wants to take proper measures to prevent it. This system was invented to keep home safe from intruder. The system is portable and

constructed in such a way that is easy to install, configure, run and maintain. Therefore the purpose of this system is to provide a security which gives immediate notification to the owner mobile phone in order to ensure that the owner can get the information about the dangerous situations and the security notifications will be through the email. In this paper, we developed IoT enabled system to send security alert to owner of the home through email whenever human is present in front of home door. IoT enable home security system using raspberry pi-3 model which take a very less power. In this paper our approach is to provide security against intruder using IoT platform.

2.3 INTRODUCTION

Security System plays an important role in the protection of lives. This security system is defined as to detect intrusion, unauthorized entry into a building or a protected area and deny such unauthorized access to protect personnel and property from damage or harm. It is necessary to secure home as the possibilities of intruders are increasing intentionally or unintentionally to gain access inside premises for harming and to become potentially threat to life, property which may cost to loss of unauthorized materials and information. If we look at different home security systems over time, they have always tried to provide efficient, convenient and safe ways for home inhabitants to access their homes.

Every system from the past has been found to be very much vulnerable. Home is a place where security is must, to keep all the valuables safe. The owner should have the confidence to step out of the house with the feel that nothing can happen to the home. This feel can only arise when the home is equipped with the reliable security system. Classifying the comforting zone traditional locks were used to guard the home. Somewhere there are chances for key loss. Due to this short come full system break down .The main aim of the system is to make our home security more efficient and more reliable. You might live in a reliable and sound neighborhood, but crime happen sever where. Criminals might try to break into your home but having a predefined plan in place will protect your family members and personal property. Such plan is very essential to your security. It is essential to make sure that everyone in your family knows the correct safety

measures and also knows how to enable and disable any safety features or alarms in your home. Thus putting together a safety plan at home will keep each one on the same page. Although user's expectations have changed and technology is advanced but the role of a home security system has remained the same. And if your family members are safe and secure, you can live in tranquility. But is this really happening in current scenario where the crime rates are ever rising? Most of us often overlook and ignore the importance of home security. Proper timely precautions can save you with all such consequences. And installing a smart security system and turning your home into smart home can be the solution to all these problems; providing such security system is hassle-free and user friendly.

2.4 SYSTEM OVERVIEW

The system is made up of basic components like Raspberry pi 3 and peripheral sensors like vibration sensor, gas detector, fire detector, magnetic sensor, PI camera, relay, buzzer, exhaust fan, PIR sensor. The system is implemented on Raspberry Pi-3, because it can process captured image with low power and high processing speed. In the architecture of home security, PIR sensor is used to detect the presence of any intruder. Pi Camera is used to capture the image of intruder when the presence it is detected. It works whenever any person motion is detected, then system will capture an image and save it into database on 16GB Micro SD-card. Raspberry Pi 3 processes the image to find out the intruders, then it is decided that the intruder is familiar or un familiar with the help of stored database. If the person is not familiar then system will send the alert message through e-mail to the owner by sending captured image, video and audio clip of that person as attachment. If the person is familiar then system will capture the image of that person and store in the system.

Raspberry Pi is a credit card sized single board computer and designed to run an operating system called GNU/Linux Raspbian. Raspberry pi 3 Model B has a faster 64-bit 1.4GHz quad core processor, 1GB of RAM, faster dual-band 802.11 b/g/n/ac, Bluetooth 4.2, and significantly faster 300Mbit/s Ethernet. The device performs signal fetching through sensors and processing the signal, and sending email after processing. It fetches the signal from PIR sensor, Pi-camera

and send capture images to the owner through email services. USB ports and GPIO pins are required as connectors for connecting the sensors and devices as shown in Figure 3 with various component present on the Raspberry Pi-3 module.

2.5 CONCLUSION

Home security system using Raspberry pi helps people feel safe about their home whether they are away from home. This system is easily adjustable at any home. Here it has provided utmost security so it is quite impossible to any burglar to enter the home without the concern of owner. If any intruder is detected, the buzzer will turn on and the owner is notified via email. This security system help and assistance especially to disabled and elderly. It is a friendly user interface system. This system is easily operable, low power consumption and low cost and since it being the latest technology it provides more compatibility with the latest devices and sensors. Security factor is most important when it comes to proper implementation and development of home security system. Such systems will definitely provide a sense of security to every person at home and will effectively provide a peace of mind.

CHAPTER 3

ARTIFICIAL INTELLIGENCE

We can all agree that Artificial Intelligence has created a huge impact on the world's economy and will continue to do so since we're aiding its growth by producing an immeasurable amount of data. Thanks to the advancement in Artificial Intelligence Algorithms we can deal with such humungous data. In this blog post, you will understand the different Artificial Intelligence Algorithms and how they can be used to solve real-world problems.

To get in-depth knowledge of Artificial Intelligence and Machine Learning, you can enroll for live **Machine Learning Engineer Master Program** by Edureka with 24/7 support and lifetime access.

What Is Artificial Intelligence ?

To simply put it, Artificial Intelligence is the science of getting machines to think and make decisions like human beings do.

Since the development of complex Artificial Intelligence Algorithms, it has been able to accomplish this by creating machines and robots that are applied in a wide range of fields including agriculture, healthcare, robotics, marketing, business analytics and many more.

Before we move any further let's try to understand what Machine Learning is and how does it is related to AI.

What Is Machine Learning?

Generally, an algorithm takes some input and uses mathematics and logic to produce the output. In stark contrast, an Artificial Intelligence Algorithm

takes a combination of both – inputs and outputs simultaneously in order to “learn” the data and produce outputs when given new inputs.

This process of making machines learn from data is what we call Machine Learning.

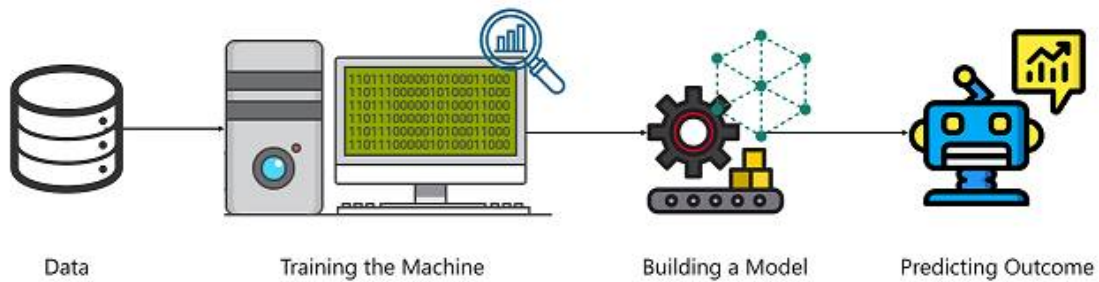


Fig. 3.1: Machine Learning

Machine Learning is a sub-field of Artificial Intelligence, where we try to bring AI into the equation by learning the input data.

If you're curious to learn more about Machine Learning, give the following blogs a read:

Introduction To Machine Learning: All You Need To Know About Machine Learning

Machine Learning Tutorial for Beginners

Machine Learning Algorithms

Machines can follow different approaches to learn depending on the data set and the problem that is being solved. In the below section we'll understand the different ways in which machines can learn.

3.1 TYPES OF MACHINE LEARNING

Machine Learning can be done in the following ways:

- Supervised Learning
- Unsupervised Learning

- Reinforcement Learning
- Ensemble Learning

Let's briefly understand the idea behind each type of Machine Learning.

What Is Supervised Learning?

In **Supervised Learning**, as the name rightly suggests, it involves making the algorithm learn the data while providing the correct answers or the labels to the data. This essentially means that the classes or the values to be predicted are known and well defined for the algorithm from the very beginning.

What Is Unsupervised Learning?

The other class falls under **Unsupervised Learning**, where, unlike supervised methods the algorithm doesn't have correct answers or any answers at all, it is up to the algorithms discretion to bring together similar data and understand it.

What Is Reinforcement Learning?

Along with these two prominent classes, we also have a third class, called **Reinforcement Learning**. Just as children are generally "reinforced" certain ideas, principles by either rewarding them when doing the right thing or punishing upon doing something wrong, in Reinforcement Learning, there are rewards given to the algorithm upon every correct prediction thus driving the accuracy higher up.

Here's a short video recorded by our Machine Learning experts. This will help you understand the difference between Supervised, Unsupervised and Reinforcement learning.

What Is Ensemble Learning?

While the above three classes cover most fields comprehensively, we sometimes still land into the issue of having to bump up the performance of our

model. In such cases it might make sense, to use **ensemble methods** (explained later) to get the accuracy higher up.

Now let's understand how Artificial Intelligence algorithms can be used to solve different types of problems.

Also, enroll in AI and ML courses to become proficient in this Artificial Intelligence and ML.

3.2 TYPES OF PROBLEMS SOLVED USING ARTIFICIAL INTELLIGENCE ALGORITHMS

Algorithms in each category, in essence, perform the same task of predicting outputs given unknown inputs, however, here data is the key driver when it comes to picking the right algorithm.

What follows is an outline of categories of Machine Learning problems with a brief overview of the same:

- Classification
- Regression
- Clustering

Here's a table that effectively differentiates each of these categories of problems.

Table 3.1: Type of Problems Solved Using AI – Artificial Intelligence Algorithms

Regression	Classification	Clustering
• Supervised Learning • Output is a continuous quantity • Main aim is to forecast or predict • Eg: Predict stock market price • Algorithm: Linear Regression	• Supervised Learning • Output is a categorical quantity • Main aim is to compute the category of the data • Eg: Classify emails as spam or non-spam • Algorithm: Logistic Regression	• Unsupervised Learning • Assigns data points into clusters • Main aim is to group similar items clusters • Eg: Find all transactions which are fraudulent in nature • Algorithm: K-means

For each category of tasks, we can use specific algorithms. In the below section you'll understand how a category of algorithms can be used as a solution to complex problems.

3.2.1 *Artificial Intelligence Algorithms*

As mentioned above, different Artificial Intelligence algorithms can be used to solve a category of problems. In the below section we'll see the different types of algorithms that fall under Classification, Regression and Clustering problems.

Also, enroll in AI ML Courses to become proficient in Artificial Intelligence and Machine Learning.

3.2.2 *Classification Algorithms*

Classification, as the name suggests is the act of dividing the dependent variable (the one we try to predict) into classes and then predict a class for a given input. It falls into the category of Supervised Machine Learning, where the data set needs to have the classes, to begin with. Thus, classification comes into play at any place where we need to predict an outcome, from a set number of fixed, predefined outcomes.

Classification uses an array of algorithms, a few of them listed below

1. Naive Bayes
2. Decision Tree
3. Random Forest
4. Logistic Regression
5. Support Vector Machines
6. K Nearest Neighbours

Let us break them down and see where they fit in when it comes to application.

3.2.3 **Naive Bayes**

Naive Bayes algorithm follows the Bayes theorem, which unlike all the other algorithms in this list, follows a probabilistic approach. This essentially means, that instead of jumping straight into the data, the algorithm has a set of prior probabilities set for each of the classes for your target.

Once you feed in the data, the algorithm updates these prior probabilities to form something known as the posterior probability. Hence this can be extremely useful in cases where you need to predict whether your input belongs to either a given list of n classes or does it not belong to any of them. This can be possible using a probabilistic approach mainly because the probabilities thrown for all the n classes will be quite low.

Let us try to understand this with an example, of a person playing golf, depending on factors like the weather outside.

- We first try to generate the frequencies with which certain events occur, in this case, we try to find frequencies of the person playing golf if it's sunny, rainy, etc outside.
- Using these frequencies we generate our apriori or initial probabilities (eg, the probability of overcast is 0.29 while the general probability of playing is 0.64)
- Next up, we generate the posterior probabilities, where we try to answer questions like "what would be the probability of it being sunny outside and the person would play golf?"

We use the Bayesian formula here,

$$P(\text{Yes} \mid \text{Sunny}) = P(\text{Sunny} \mid \text{Yes}) * P(\text{Yes}) / P(\text{Sunny})$$

Here we have $P(\text{Sunny} \mid \text{Yes}) = 3/9 = 0.33$, $P(\text{Sunny}) = 5/14 = 0.36$, $P(\text{Yes}) = 9/14 = 0.64$

You can go through this [A Comprehensive Guide To Naive Bayes](#) blog to help you understand the math behind Naive Bayes.

3.2.4 *Decision Tree*

The Decision Tree can essentially be summarized as a flowchart-like tree structure where each external node denotes a test on an attribute and each branch represents the outcome of that test. The leaf nodes contain the actual predicted labels. We start from the root of the tree and keep comparing attribute values until we reach a leaf node.

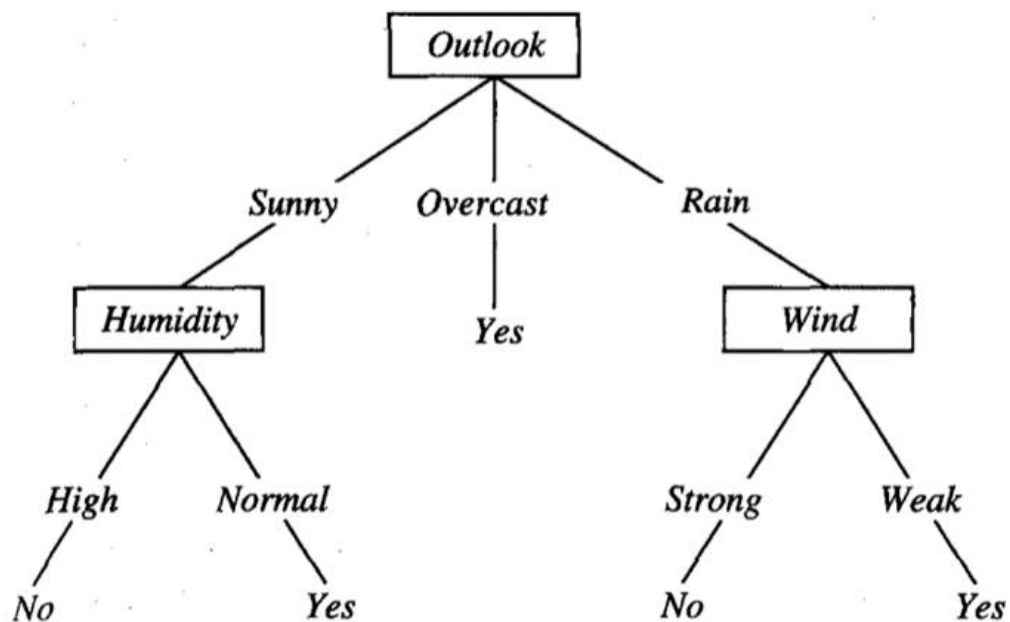


Fig. 3.2: Decision Trees

We use this classifier when handling high dimensional data and when little time has been spent behind data preparation. However, a word of caution – they tend to overfit and are prone to change drastically even with slight nuances in the training data.

You can through these blogs to learn more about Decision Trees:

- [A Complete Guide On Decision Tree Algorithm](#)
- [Decision Tree: How To Create A Perfect Decision Tree?](#)

3.2.5 *Random Forest*

Think of this as a committee of Decision Trees, where each decision tree has been fed a subset of the attributes of data and predicts on the basis of that subset. The average of the votes of all decision trees are taken into account and the answer is given.

An advantage of using Random Forest is that it alleviates the problem of overfitting which was present in a standalone decision tree, leading to a much more robust and accurate classifier.

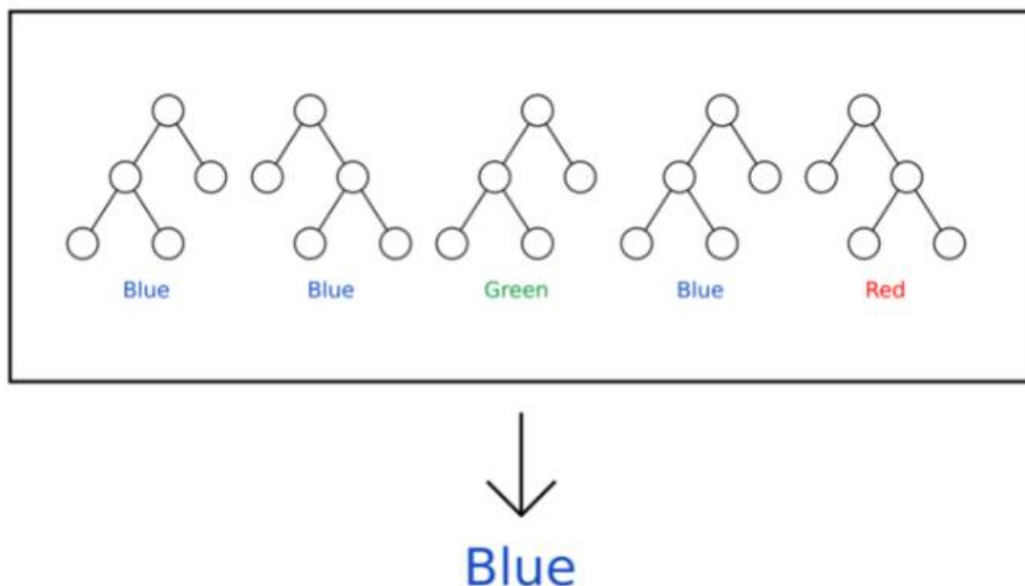


Fig. 3.3: Random Forest

As we can see in the above image, we have 5 decision trees trying to classify a color. Here 3 of these 5 decision trees predict blue and two have different outputs, namely green and red. In this case, we take the average of all the outputs, which gives blue as the highest weightage.

Here's a blog on Random Forest Classifier that will help you understand the working of Random forest algorithm and how it can be used to solve real-world problems.

3.2.6 *Logistic Regression*

It's a go-to method mainly for binary classification tasks. The term 'logistic' comes from the legit function that is used in this method of classification. The logistic function, also called as the sigmoid function is an S-shaped curve that can take any real-valued number and map it between 0 and 1 but never exactly at those limits.

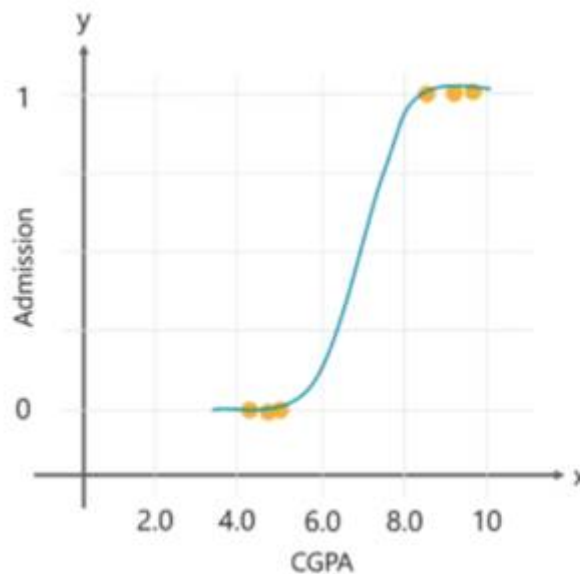


Fig. 3.4: Logistic Regression

Let's assume that your little brother is trying to get into grad school, and you want to predict whether he'll get admitted in his dream establishment. So, based on his CGPA and the past data, you can use Logistic Regression to foresee the outcome.

Logistic Regression allows you to analyze a set of variables and predict a categorical outcome. Since here we need to predict whether he will get into the school or not, which is a classification problem, logistic regression would be ideal.

Logistic Regression is used to predict house values, customer lifetime value in the insurance sector, etc.

3.2.7 Support Vector Machine

An SVM is unique, in the sense that it tries to sort the data with the margins between two classes as far apart as possible. This is called maximum margin separation.

Another thing to take note of here is the fact that SVM's take into account only the support vectors while plotting the hyper plane, unlike linear regression which uses the entire dataset for that purpose. This makes SVM's quite useful in situations when data is in high dimensions.

Let's try to understand this with an example. In the below figure we have to classify data points into two different classes (squares and triangles).

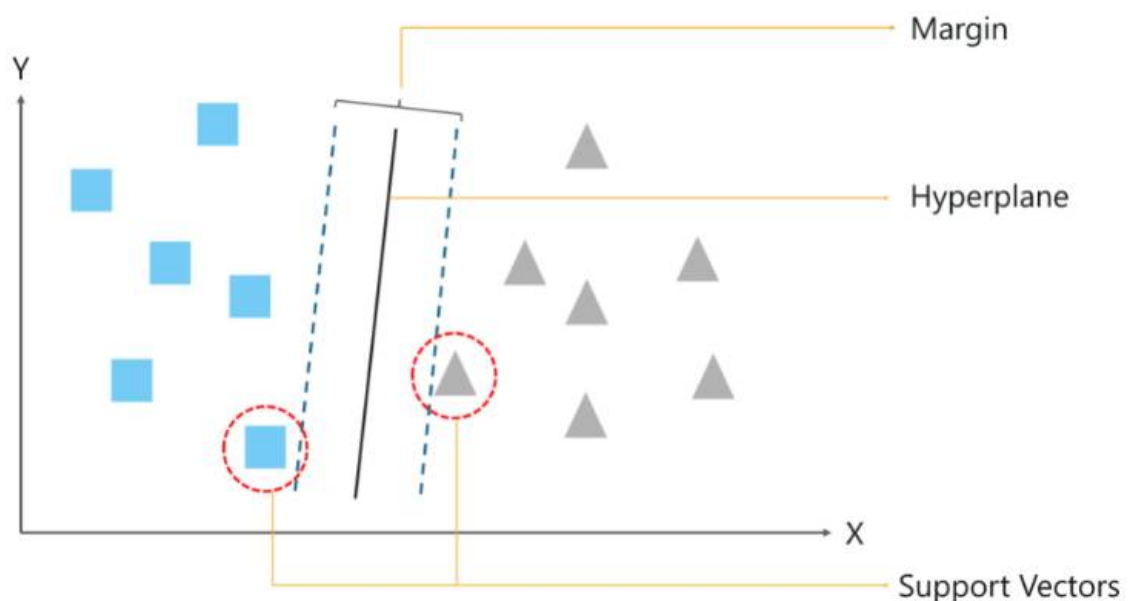


Fig. 3.5: Support Vector Machine

So, you start off by drawing a random hyperplane and then you check the distance between the hyperplane and the closest data points from each class. These closest data points to the hyperplane are known as **Support vectors**. And that's where the name comes from, Support Vector Machine.

The hyper plane is drawn based on these support vectors and *an optimum hyper plane will have a maximum distance from each of the support*

vectors. And this distance between the hyper plane and the support vectors is known as the **margin**.

To sum it up, SVM is used to classify data by using a hyper plane, such that the distance between the hyper plane and the support vectors is maximum.

To learn more about SVM, you can go through this, [Using SVM To Predict Heart Diseases](#) blog.

3.2.8 *K Nearest Neighbors*

KNN is a non-parametric (here non-parametric is just a fancy term which essentially means that KNN does not make any assumptions on the underlying data distribution), lazy learning algorithm (here lazy means that the “training” phase is fairly short).

Its purpose is to use a whole bunch of data points separated into several classes to predict the classification of a new sample point.

The following points serve as an overview of the general working of the algorithm:

- A positive integer N is specified, along with a new sample
- We select the N entries in our database which are closest to the new sample
- We find the most common classification of these entries
- This is the classification we give to the new sample

However, there are some downsides to using KNN. These downsides mainly revolve around the fact that KNN works on storing the entire dataset and comparing new points to existing ones. This means that the storage space increases as our training set increases. This also means that the estimation time increases in proportion to the number of training points.

The following blogs will help you understand how the KNN algorithm works in depth:

- A Practical Implementation Of KNN Algorithm In R
- K-Nearest Neighbors Algorithm Using Python

Now let's understand how regression problems can be solved by using regression algorithms.

3.2.9 **Regression Algorithms**

In the case of regression problems, the output is a *continuous quantity*. Meaning that we can use regression algorithms in cases where the target variable is a continuous variable. It falls into the category of Supervised Machine Learning, where the data set needs to have the labels, to begin with.

3.2.10 **Linear Regression**

Linear Regression is the most simple and effective regression algorithm. It is utilized to gauge genuine qualities (cost of houses, number of calls, all out deals and so forth.) in view of the consistent variable(s). Here, we build up a connection between free and ward factors by fitting the best line. This best fit line is known as regression line and spoken to by a direct condition $Y = a * X + b$.

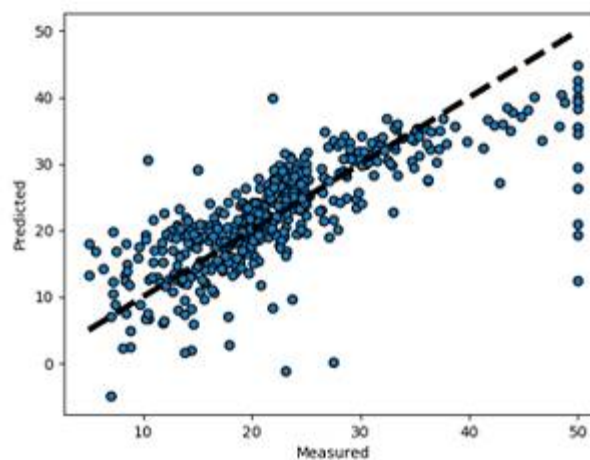


Fig. 3.6: Linear Regression

Let us take a simple example here to understand linear regression.

Consider that you are given the challenge to estimate an unknown person's weight by just looking at them. With no other values in hand, this might look like a fairly difficult task, however using your past experience you know that generally speaking the taller someone is, the heavier they are compared to a shorter person of the same build. This is linear regression, in actuality!

However, linear regression is best used in approaches involving a low number of dimensions. Also, not every problem is linearly separable.

Some of the most popular applications of Linear regression are in financial portfolio prediction, salary forecasting, real estate predictions and in traffic in arriving at ETAs

Now let's discuss how clustering problems can be solved by using the K-means algorithm. Before that, let's understand what clustering is.

3.2.11 *Clustering Algorithms*

The basic idea behind clustering is to assign the input into two or more clusters based on feature similarity. It falls into the category of Unsupervised Machine Learning, where the algorithm learns the patterns and useful insights from data without any guidance (labeled data set).

For example, clustering viewers into similar groups based on their interests, age, geography, etc can be done by using Unsupervised Learning algorithms like K-Means Clustering.

3.2.12 *K-Means Clustering*

K-means is probably the simplest unsupervised learning approach. The idea here is to gather similar data points together and bind them together in the form of a cluster. It does this by calculating the centroid of the group of data points.

To carry out effective clustering, k-means evaluates the distance between each point from the centroid of the cluster. Depending on the distance between the data point and the centroid, the data is assigned to the closest cluster. The goal of clustering is to determine the intrinsic grouping in a set of unlabelled data.

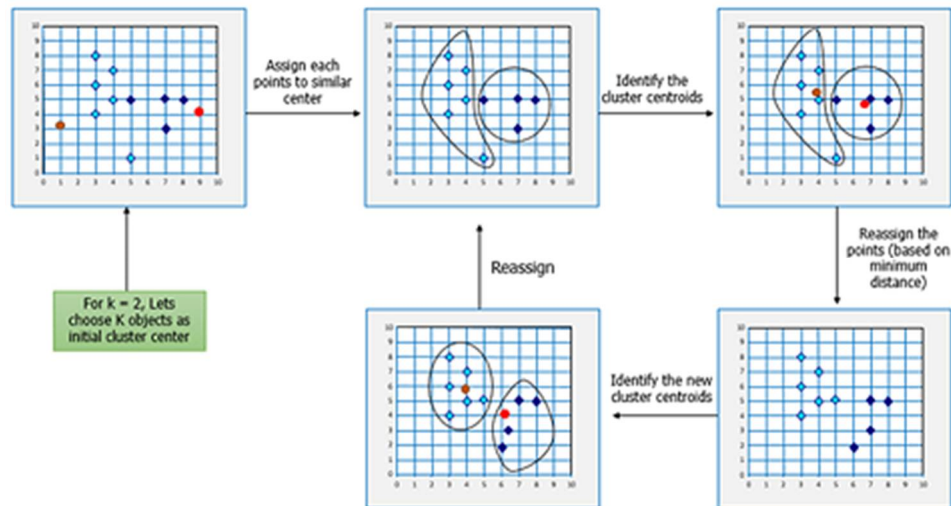


Fig. 3.7: K-means

The 'K' in K-means stands for the number of clusters formed. The number of clusters (basically the number of classes in which your new instances of data can fall into) is determined by the user.

K-means is used majorly in cases where the data set has points which are distinct and well separated from each other, otherwise, the clusters won't be far apart, rendering them inaccurate. Also, K-means should be avoided in cases where the data set contains a high amount of outliers or the data set is non-linear.

So that was a brief about K-means algorithm, to learn more you can go through this content recorded by our Machine Learning experts.

3.2.13 Ensemble Learning Algorithms

In cases where data is of abundance and prediction precision is of high value, boosting algorithms come into the picture.

Consider the scenario, you have a decision tree trained on a data set along with a whole bunch of hyperparameter tuning already performed, however, the final accuracy is still slightly off than you'd like. In this case, while it might seem that you have run out of possible things to try, ensemble learning comes to the rescue.

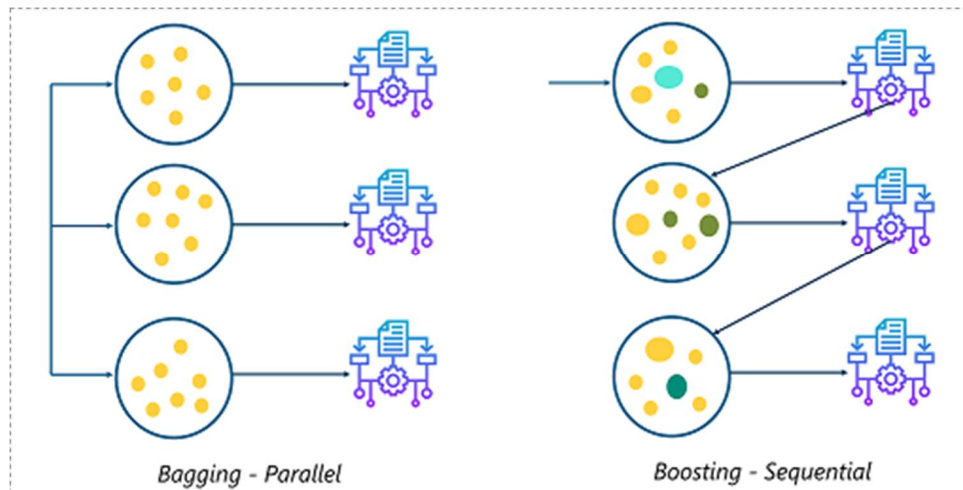


Fig. 3.8: Ensemble Learning

You have two different ways in which you can use ensemble learning, in this case, to bump up your accuracy. Let us say your decision tree was failing on a set of input test values, what you do now is, to train a new decision tree model and give a higher weighting to those input test values that your previous model struggled with. This is also called as Boosting, where our initial tree can be formally stated as a weak learner, and the mistakes caused by that model pave way for a better and stronger model.

Another way to approach this is by simply training a whole bunch of trees at once (this can be done fairly quickly and in a parallel fashion) and then taking outputs from each tree and averaging them out. So this way, if after training 10 trees, let's say 6 trees reply positive to input and 4 trees reply negative, the output you consider is positive. This is formally known as Bagging.

They are used to reduce the bias and variance in supervised learning techniques. There are a host of boosting algorithms available, a few of them discussed below:

3.2.14 *Gradient Boosting*

Gradient Boosting is a boosting algorithm used when we deal with plenty of data to make a prediction with high prediction power. It combines multiple weak or average predictors to build strong predictor. These boosting algorithms are heavily used to refine the models in data science competitions.

Here, we consider an “optimal” or best model, so essentially our model is at some distance from that “optimal” model. What we now do is, use gradient mathematics and try to get our model closer to the optimal space.

3.2.15 *XGBoost*

Pertaining to its extremely high predictive power, XGBoost is one of the go-to algorithms when it comes to increasing accuracy as it contains both linear & tree learning algorithms making it 10 times faster than most boosting techniques.

It is the holy grail algorithm when it comes to hackathons, it is no wonder CERN used it in the model for classification of signals from the Large Hadron Collider.

If you want to learn more about Boosting Machine Learning, you can go through this, [Comprehensive Guide To Boosting Machine Learning Algorithms](#) blog.

So with this, we come to an end of this Artificial Intelligence Algorithms blog. If you wish to learn more about Artificial Intelligence, you can give these blogs a read:

- [Artificial Intelligence – What It Is And How Is It Useful?](#)
- [A Comprehensive Guide To Artificial Intelligence With Python](#)
- [Artificial Intelligence Tutorial: All you need to know about AI](#)
- [AI vs Machine Learning vs Deep Learning](#)
- [AI Applications: Top 10 Real World Artificial Intelligence Applications](#)

If you wish to enroll for a complete course on Artificial Intelligence and Machine Learning, Edureka has a specially curated Machine Learning Engineer Master Program that will make you proficient in techniques like Supervised Learning, Unsupervised Learning, and Natural Language Processing. It includes training on the latest advancements and technical approaches in Artificial Intelligence & Machine Learning such as Deep Learning, Graphical Models and Reinforcement Learning

3.3 IOT

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and is able to transfer data over a network.

Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business.

3.3.1 *How does IoT work?*

An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do

most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data.

The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed.

IoT can also make use of artificial intelligence (AI) and machine learning to aid in making data collecting processes easier and more dynamic.

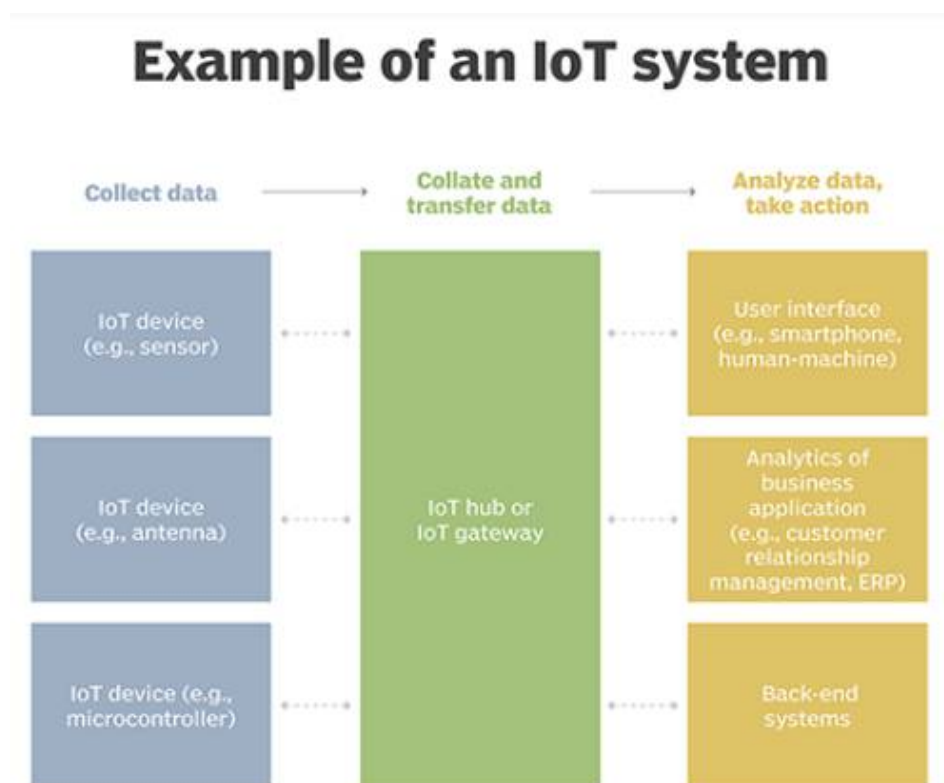


Fig. 3.9: Example of IOT system

3.3.2 Why is IoT important?

The internet of things helps people live and work smarter, as well as gain complete control over their lives. In addition to offering smart devices to automate homes, IoT is essential to business. IoT provides businesses with a real-time look into how their systems really work, delivering insights into everything from the performance of machines to supply chain and logistics operations.

IoT enables companies to automate processes and reduce labor costs. It also cuts down on waste and improves service delivery, making it less expensive to manufacture and deliver goods, as well as offering transparency into customer transactions.

As such, IoT is one of the most important technologies of everyday life, and it will continue to pick up steam as more businesses realize the potential of connected devices to keep them competitive.

3.3.3 *What are the benefits of IoT to organizations?*

The internet of things offers several benefits to organizations. Some benefits are industry-specific, and some are applicable across multiple industries. Some of the common benefits of IoT enable businesses to:

- monitor their overall business processes;
- improve the customer experience (CX);
- save time and money;
- enhance employee productivity;
- integrate and adapt business models;
- make better business decisions; and
- generate more revenue.

IoT encourages companies to rethink the ways they approach their businesses and gives them the tools to improve their business strategies.

Generally, IoT is most abundant in manufacturing, transportation and utility organizations, making use of sensors and other IoT devices; however, it has also found use cases for organizations within the agriculture, infrastructure and home automation industries, leading some organizations toward digital transformation.

IoT can benefit farmers in agriculture by making their job easier. Sensors can collect data on rainfall, humidity, temperature and soil content, as well as other factors, that would help automate farming techniques.

The ability to monitor operations surrounding infrastructure is also a factor that IoT can help with. Sensors, for example, could be used to monitor events or changes within structural buildings, bridges and other infrastructure. This brings benefits with it, such as cost saving, saved time, quality-of-life workflow changes and paperless workflow.

A home automation business can utilize IoT to monitor and manipulate mechanical and electrical systems in a building. On a broader scale, smart cities can help citizens reduce waste and energy consumption.

IoT touches every industry, including businesses within healthcare, finance, retail and manufacturing.

3.4 PROS AND CONS OF IoT

Some of the advantages of IoT include the following:

- ability to access information from anywhere at any time on any device;
- improved communication between connected electronic devices;
- transferring data packets over a connected network saving time and money; and
- automating tasks helping to improve the quality of a business's services and reducing the need for human intervention.

Some disadvantages of IoT include the following:

- As the number of connected devices increases and more information is shared between devices, the potential that a hacker could steal confidential information also increases.

- Enterprises may eventually have to deal with massive numbers -- maybe even millions -- of IoT devices, and collecting and managing the data from all those devices will be challenging.
- If there's a bug in the system, it's likely that every connected device will become corrupted.
- Since there's no international standard of compatibility for IoT, it's difficult for devices from different manufacturers to communicate with each other.

3.5 IoT STANDARDS AND FRAMEWORKS

There are several emerging IoT standards, including the following:

- IPv6 over Low-Power Wireless Personal Area Networks (*6LoWPAN*) is an open standard defined by the Internet Engineering Task Force (IETF). The 6LoWPAN standard enables any low-power radio to communicate to the internet, including 804.15.4, Bluetooth Low Energy (BLE) and Z-Wave (for home automation).
- ZigBee is a low-power, low-data rate wireless network used mainly in industrial settings. ZigBee is based on the Institute of Electrical and Electronics Engineers (IEEE) 802.15.4 standard. The ZigBee Alliance created Dotdot, the universal language for IoT that enables smart objects to work securely on any network and understand each other.
- LiteOS is a Unix-like operating system (OS) for wireless sensor networks. LiteOS supports smartphones, wearables, intelligent manufacturing applications, smart homes and the internet of vehicles (IoV). The OS also serves as a smart device development
- OneM2M is a machine-to-machine service layer that can be embedded in software and hardware to connect devices. The global standardization body, OneM2M, was created to develop reusable

standards to enable IoT applications across different verticals to communicate.

- Data Distribution Service (DDS) was developed by the Object Management Group (OMG) and is an IoT standard for real-time, scalable and high-performance M2M communication.
- Advanced Message Queuing Protocol (AMQP) is an open source published standard for asynchronous messaging by wire. AMQP enables encrypted and interoperable messaging between organizations and applications. The protocol is used in client-server messaging and in IoT device management.
- Constrained Application Protocol (CoAP) is a protocol designed by the IETF that specifies how low-power, compute-constrained devices can operate in the internet of things.
- Long Range Wide Area Network (LoRaWAN) is a protocol for WANs designed to support huge networks, such as smart cities, with millions of low-power devices.

IoT frameworks include the following:

- Amazon Web Services (AWS) IoT is a cloud computing platform for IoT released by Amazon. This framework is designed to enable smart devices to easily connect and securely interact with the AWS cloud and other connected devices.
- Arm Mbed IoT is a platform to develop apps for IoT based on Arm microcontrollers. The goal of the Arm Mbed IoT platform is to provide a scalable, connected and secure environment for IoT devices by integrating Mbed tools and services.
- Microsoft's Azure IoT Suite is a platform that consists of a set of services that enables users to interact with and receive data from their IoT devices, as well as perform various operations over data,

such as multidimensional analysis, transformation and aggregation, and visualize those operations in a way that's suitable for business.

- Google's Brillo/Weave is a platform for the rapid implementation of IoT applications. The platform consists of two main backbones: Brillo, an Android-based OS for the development of embedded low-power devices, and Weave, an IoT-oriented communication protocol that serves as the communication language between the device and the cloud.
- Calvin is an open source IoT platform released by Ericsson designed for building and managing distributed applications that enable devices to talk to each other. Calvin includes a development framework for application developers, as well as a runtime environment for handling the running application.

3.6 CONSUMER AND ENTERPRISE IoT APPLICATIONS

There are numerous real-world applications of the internet of things, ranging from consumer IoT and enterprise IoT to manufacturing and industrial IoT (IIoT). IoT applications span numerous verticals, including automotive, telecom and energy.

In the consumer segment, for example, smart homes that are equipped with smart thermostats, smart appliances and connected heating, lighting and electronic devices can be controlled remotely via computers and smartphones.

Wearable devices with sensors and software can collect and analyze user data, sending messages to other technologies about the users with the aim of making users' lives easier and more comfortable. Wearable devices are also used for public safety -- for example, improving first responders' response times during emergencies by providing optimized routes to a location or by tracking construction workers' or firefighters' vital signs at life-threatening sites.

In healthcare, IoT offers many benefits, including the ability to monitor patients more closely using an analysis of the data that's generated. Hospitals

often use IoT systems to complete tasks such as inventory management for both pharmaceuticals and medical instruments.

Smart buildings can, for instance, reduce energy costs using sensors that detect how many occupants are in a room. The temperature can adjust automatically -- for example, turning the air conditioner on if sensors detect a conference room is full or turning the heat down if everyone in the office has gone home.

In agriculture, IoT-based smart farming systems can help monitor, for instance, light, temperature, humidity and soil moisture of crop fields using connected sensors. IoT is also instrumental in automating irrigation systems.

In a smart city, IoT sensors and deployments, such as smart streetlights and smart meters, can help alleviate traffic, conserve energy, monitor and address environmental concerns, and improve sanitation.

3.7 IoT SECURITY AND PRIVACY ISSUES

The internet of things connects billions of devices to the internet and involves the use of billions of data points, all of which need to be secured. Due to its expanded attack surface, IoT security and IoT privacy are cited as major concerns.

In 2016, one of the most notorious recent IoT attacks was Mirai, a botnet that infiltrated domain name server provider Dyn and took down many websites for an extended period of time in one of the biggest distributed denial-of-service (DDoS) attacks ever seen. Attackers gained access to the network by exploiting poorly secured IoT devices.

Because IoT devices are closely connected, all a hacker has to do is exploit one vulnerability to manipulate all the data, rendering it unusable. Manufacturers that don't update their devices regularly -- or at all -- leave them vulnerable to cybercriminals.

Additionally, connected devices often ask users to input their personal information, including names, ages, addresses, phone numbers and even social media accounts -- information that's invaluable to hackers.

Hackers aren't the only threat to the internet of things; privacy is another major concern for IoT users. For instance, companies that make and distribute consumer IoT devices could use those devices to obtain and sell users' personal data.

Beyond leaking personal data, IoT poses a risk to critical infrastructure, including electricity, transportation and financial services.

3.8 WHAT IS THE HISTORY OF IoT?

Kevin Ashton, co-founder of the Auto-ID Center at the Massachusetts Institute of Technology (MIT), first mentioned the internet of things in a presentation he made to Procter & Gamble (P&G) in 1999. Wanting to bring radio frequency ID (RFID) to the attention of P&G's senior management, Ashton called his presentation "Internet of Things" to incorporate the cool new trend of 1999: the internet. MIT professor Neil Gershenfeld's book, *When Things Start to Think*, also appeared in 1999. It didn't use the exact term but provided a clear vision of where IoT was headed.

IoT has evolved from the convergence of wireless technologies, microelectromechanical systems (MEMSes), microservices and the internet. The convergence has helped tear down the silos between operational technology (OT) and information technology (IT), enabling unstructured machine-generated data to be analyzed for insights to drive improvements.

Although Ashton's was the first mention of the internet of things, the idea of connected devices has been around since the 1970s, under the monikers *embedded internet* and *pervasive computing*.

The first internet appliance, for example, was a Coke machine at Carnegie Mellon University in the early 1980s. Using the web, programmers could

check the status of the machine and determine whether there would be a cold drink awaiting them, should they decide to make the trip to the machine.

IoT evolved from M2M communication, i.e., machines connecting to each other via a network without human interaction. M2M refers to connecting a device to the cloud, managing it and collecting data.

Taking M2M to the next level, IoT is a sensor network of billions of smart devices that connect people, systems and other applications to collect and share data. As its foundation, M2M offers the connectivity that enables IoT.

The internet of things is also a natural extension of supervisory control and data acquisition (SCADA), a category of software application programs for process control, the gathering of data in real time from remote locations to control equipment and conditions. SCADA systems include hardware and software components. The hardware gathers and feeds data into a computer that has SCADA software installed, where it is then processed and presented in a timely manner. The evolution of SCADA is such that late-generation SCADA systems developed into first-generation IoT systems.

The concept of the IoT ecosystem, however, didn't really come into its own until the middle of 2010 when, in part, the government of China said it would make IoT a strategic priority in its five-year plan.

CHAPTER 4

HARDWARE DESCRIPTION

4.1 INTRODUCTION

- This paper deals with the design and implementation of system using Raspberry pi and RFID for mobile devices.
- It increases the usage of mobile technology to provide essential security to our homes and for other control applications . The proposed security system captures information and transmits it to the respective mail using the internet.
- For example, when RFID and the Raspberry pi device alerts the owner of the possible intrusion having a smart phone. Raspberry- Pi has two main components interacting with each other.
- We can able to detect, recognize, Tracking system using webcam, we can able to send it to the email automatically. We can able to alert the people using IOT technology.

Block Diagram

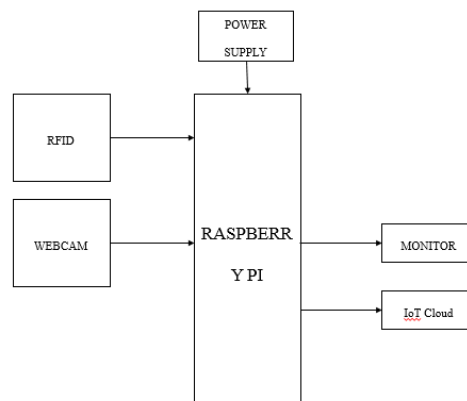


Fig. 4.1: Raspberry Pi

Hardware

- Raspberry Pi
- Web Camera
- RFID

Software

- Raspian OS
- Python
- Open CV

RASPBERRY PI

4.2 OVERVIEW

Raspberry Pi seems to be new in the world and many people really don't know what the Raspberry Pi is. Raspberry Pi can be defined as a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you would expect a desktop computer to do, from browsing the internet and playing high definition video, to making spreadsheets, word-processing, and playing games. It is great bonding with Arduino and can do a lot with Arduino.

4.3 EXPLORING THE RASPBERRY PI BOARD

There are two models of Raspberry Pi, model A and model B. These two are bit similar with few advance features on model B compared to model A. Model B has 512 MB RAM, two USB port where as Model A has 256 MB RAM and just a USB port. Besides, Model B has Ethernet port while Model A does not.

Different components of the Pi are named in the Figure 5-1 and brief description on each component is given in following sections.

4.3.1 *SD Card Slot*

Raspberry Pi doesn't have the real hard drive as in laptop and computer, SD card is taken as solid state drive (SSD) which is used to install operating system and all others software and store everything. This card is needed to insert into the slot for using the Raspberry Pi.

SD card may be 2GB, 4GB or 16GB.

4.3.2 *Micro USB Power*

The power port is a 5V micro-USB input and supply should be exactly 5v as it doesn't have onboard power regulator. So, power supply shouldn't exceed than 5V.

4.3.3 *HDMI Out*

This output port is used to connect the Raspberry Pi with a monitor via HDMI (High Definition Multimedia Interface). Hence, any screen or TV can be connected to it which consists of HDMI port.

4.3.4 *Ethernet and USB port*

Both the Ethernet port and USB port on Model B are supplied via the onboard LAN9512 chip. It is a high-speed USB 2.0 hub with a 10/100 Ethernet controller (Donat, 2014). USB ports are used to connect the inputs (keyboard, mouse). Almost everything that can connect to computer via USB also can connect with Raspberry Pi.

4.3.5 *RCA Video Out and Audio Out*

Audio and RCA video jacks are present on the board for audio and video out.

The Raspberry Pi does support sound over its HDMI output, but there is a standard 3.5-mm audio jack to plug in headphones but USM mikes may work or not.

For video, the RCA jack sends video to any connected RCA video device.

4.3.6 *GPIO Headers (Pins)*

GPIO pins stands for general purpose of input output pins. These pins are used to connect any number of physical extensions with the Raspberry Pi. Raspberry Pi has pre-installed libraries that allow us to access the pins using programming languages like C, C++ or python.

4.3.7 *Chips (Broadcom)*

The most important component in a Raspberry Pi is chip that is Broadcom which is placed at the middle of the board. The chip consists of ARM11 processor running at 700 MHz and a Videocore4 GPU and can be over clocked to at least 800 MHz without a problem.

4.4 RASPBERRY PI 2 MODEL B

Recently, Raspberry Pi 2 Model B has been launched recently which Broadcom BCM2836 ARM Cortex-A7 Quad Core Processor has powered Single Board Computer running at 900MHz, 1GB RAM and 4 Quad USB ports. It is the advanced version of Model B and is 6 times faster than Model B Raspberry Pi. In addition, it has combined 4-pole jack for connecting your stereo audio out and composite video out and advanced power management. Figure 5-2 shows the top view of the board with labels of some important components (raspberrypi.org, 2015a).

4.5 HARDWARE REQUIRED FOR RASPBERRY PI

Raspberry Pi can't start alone, it needs many others peripherals (hardware). There is brief description of the hardware requirements in the following section (Bates, 2014).

4.5.1 *Power Supply*

As mentioned already in above theory portion, Raspberry Pi needs 5V power supply. If supply exceeds 5V then it can't guaranteed to work properly. And the power supply also need to supply at least 500 milliamps (mA), and preferably more like 1 amp (A). If the supply is 500 mA or less, it is likely to have the malfunction of keyboard and mouse. It is not good idea to power the Raspberry Pi from USB port of computer and hub as they mostly provide current less than required. Hence, the Raspberry Pi requires a Micro-USB connection which is capable of supplying at least 700 mA (or 0.7 A) at 5V.

4.5.2 *Storage*

A separate hardware is required for the storage purpose in Raspberry Pi. For this, SD card is used, mostly 4 GB and 8 GB if needed. The operating system and all files are stored in the card. We can buy blank SD card and install operating system or buy a pre-installed one.

4.5.3 *Input*

External keyboard and mouse are required to provide input to the Raspberry Pi. No any additional software is needed to use the keyboard and mouse.

4.5.4 *Monitor*

We can use monitor or TV with HDMI port or DVI inputs as the screen for the Raspberry Pi. For DVI inputs, HDMI-to-DVI converters are required which can be finding easily in a market. Monitor is most important for the Raspberry Pi as it is the only way to see what we have done on it.

4.5.5 *Network*

As in laptop or computer, we can access to internet and network in Raspberry Pi as well. For that, we can use wired Ethernet connection which is easier option or Wi-Fi module to access Wi-Fi in the Raspberry Pi.

4.6 POWER SUPPLY UNIT

A power supply (sometimes known as a power supply unit or PSU) is a device or system that supplies electrical or other types of energy to an output load or group of loads. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

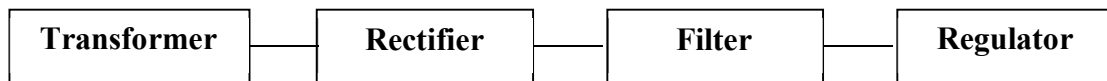


Fig. 4.2: Block diagram of power supply

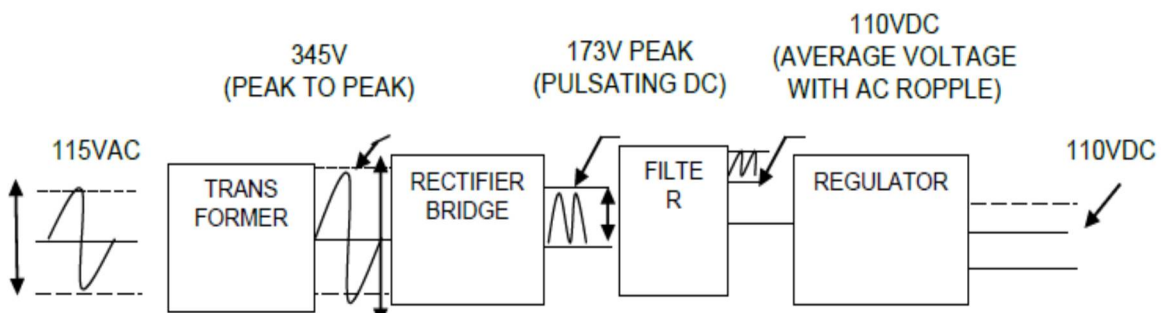


Fig. 4.3: Processing of power supply

The transformer steps up or steps down the input line voltage and isolates the power supply from the power line. The RECTIFIER section converts the alternating current input signal to a pulsating direct current. However, as you proceed in this chapter you will learn that pulsating dc is not desirable. For this reason a FILTER section is used to convert pulsating dc to a purer, more desirable form of dc voltage.

The final section, the REGULATOR, does just what the name implies. It maintains the output of the power supply at a constant level in spite of large changes in load current or input line voltages. Now that you know what each

section does, let's trace an ac signal through the power supply. At this point you need to see how this signal is altered within each section of the power supply. Later on in the chapter you will see how these changes take place. An input signal of 115 volts ac is applied to the primary of the transformer.

The transformer is a step-up transformer with a turns ratio of 1:3. You can calculate the output for this transformer by multiplying the input voltage by the ratio of turns in the primary to the ratio of turns in the secondary; therefore, 115 volts ac $\times 3 = 345$ volts ac (peak-to-peak) at the output. Because each diode in the rectifier section conducts for 180 degrees of the 360-degree input, the output of the rectifier will be one-half, or approximately 173 volts of pulsating dc. The filter section, a network of resistors, capacitors, or inductors, controls the rise and fall time of the varying signal; consequently, the signal remains at a more constant dc level. You will see the filter process more clearly in the discussion of the actual filter circuits. The output of the filter is a signal of 110 volts dc, with ac ripple riding on the dc. The reason for the lower voltage (average voltage) will be explained later in this chapter. The regulator maintains its output at a constant 110-volt dc level, which is used by the electronic equipment (more commonly called the load).

4.6.1 *Simple 5V power supply for digital circuits*

- Brief description of operation: Gives out well-regulated +5V output, output current capability of 100 mA
- Circuit protection: Built-in overheating protection shuts down output when regulator IC gets too hot
- Circuit complexity: Very simple and easy to build
- Circuit performance: Very stable +5V output voltage, reliable operation
- Availability of components: Easy to get, uses only very common basic components
- Design testing: Based on datasheet example circuit, I have used this circuit successfully as part of many electronics projects

- Applications: Part of electronics devices, small laboratory power supply
- Power supply voltage: Unregulated DC 8-18V power supply
- Power supply current: Needed output current + 5 mA
- Component costs: Few dollars for the electronics components + the input transformer cost

4.7 WEBCAM

A **webcam** is a video camera which feeds its images in real time to a computer or computer network, often via USB, Ethernet or Wi-Fi. Their most popular use is the establishment of video links, permitting computers to act as videophones or videoconference stations. This common use as a video camera for the World Wide Web gave the webcam its name. Other popular uses include security surveillance and computer vision. Webcams are known for their low manufacturing cost and flexibility, making them the lowest cost form of video telephony. They have also become a source of security and privacy issues, as some built-in webcams can be remotely activated via spyware.

4.7.1 Lens

Webcams typically include a lens, an image sensor, support electronics, and may also include a microphone for sound. Various lenses are available, the most common in consumer-grade webcams being a plastic lens that can be screwed in and out to focus the camera. Fixed focus lenses, which have no provision for adjustment, are also available. As a camera system's depth of field is greater for small image formats and is greater for lenses with a large f-number (small aperture), the systems used in webcams have a sufficiently large depth of field that the use of a fixed focus lens does not impact image sharpness to a great extent.

Image sensors can be CMOS or CCD, the former being dominant for low-cost cameras, but CCD cameras do not necessarily outperform CMOS-based

cameras in the low cost price range. Most consumer webcams are capable of providing VGA resolution video at a frame rate of 30 frames per second. Many newer devices can produce video in multi-megapixel resolutions, and a few can run at high frame rates such as the PlayStation Eye, which can produce 320×240 video at 120 frames per second.

Support electronics read the image from the sensor and transmit it to the host computer. The camera pictured to the right, for example, uses a Sonix SN9C101 to transmit its image over USB. Typically, each frame is transmitted uncompressed in RGB or YUV or compressed as JPEG. Some cameras, such as mobile phone cameras, use a CMOS sensor with supporting electronics "on die", i.e. the sensor and the support electronics are built on a single silicochip to save space and manufacturing costs.

4.7.2 *Portability*

Most webcams feature built-in microphones to make video calling and videoconferencing more convenient. The USB video device class (UVC) specification allows for interconnectivity of webcams to computers without the need for proprietary device drivers. Microsoft Windows XP SP2, Linux and Mac OS X (since October 2005) have UVC support built in and do not require extra device drivers, although they are often installed to add additional features.

4.7.3 *Features (LOGITECH WEBCAM C100)*

- Plug-and-play setup (UVC)
- Video capture: Up to 640 x 480 pixels
- Photos: Up to 1.3 megapixels (software enhanced)
- Frame rate: Up to 30 frames per second (with recommended system)
- Hi-Speed USB 2.0 certified
- Fixed focus

- Universal clip fits notebooks, LCD or CRT monitor



Fig. 4.4: Webcam

4.8 IMAGE PROCESSING ON RASPBERRY PI

Today image processing are used in various techniques, this paper presents the implementation of image processing operations on Raspberry Pi. The Raspberry Pi is a basic embedded system and being a low cost a single board computer used to reduce the complexity of systems in real time applications. This platform is mainly based on python. Raspberry pi consist of Camera slot Interface (CSI) to interface the raspberry pi camera. Here, the Dark and Low contrast images captured by using the Raspberry Pi camera module are enhanced in order to identify the particular region of image. This concept is used in the real time application of MAV, The MAVs are basically used to capture images and videos through the Raspberry pi camera module. Because of its credit card sized (small) and less weight in the design. However, the image captured by MAVs will consist of unwanted things due to atmospheric conditions; hence it is necessary to remove noise present in the MAVs images.

4.9 INTRODUCTION

The image processing is a form of signal processing where the input is an image, photograph or video frame, the output of an image processing may be either an image or a video frame or a set of characteristics or parameters related to the image. The acquisition of digital image usually suffers from undesirable

camera shakes and due to unstable random camera motions. Hence image enhancement algorithms are required to remove these unwanted camera shakes. This image processing concepts are implemented in Raspberry pi in the application of MAV. The Raspberry Pi is a basic embedded system having a credit card-sized single board computers developed in the UK by the Raspberry Pi Foundation. The Raspberry Pi is based on the Broadcom BCM2835 system on a chip (SOC) which includes an ARM1176JZF-S Core (ARM V6K)700 MHz CPU processor, Broadcom Video Core IV GPU having 17 pins, 3.5W of power, and 512 MB of RAM memory. The Raspberry Pi system has Secure SD card reader (models A and B) or Micro SD card reader (models A+ and B+) sockets for boot media and persistent storage. The system provides Debian Linux operating system Raspbian image for download. Python is used as main programming language for raspberry pi. A micro air vehicle (MAV) is a remote-controlled, Unmanned Aircraft Vehicle (UAV) significantly smaller than typical UAVs that have a size restriction. UAV is an aircraft without a human pilot. Its flight is controlled either autonomously on board computers or by the remote control of a pilot on the ground or in another vehicle. By having a Raspberry Pi camera module available on a MAV the efficiency of this air vehicle increases and new fields of applications are available. It is needed in military Operations, in which targets have to be identified. Such identification is often done by a human on ground, to reduce the probability of mistakes. But a Raspberry Pi camera module is also helpful if a MAV shall autonomously fly through an arch.

4.10 BASIC CONCEPT OF IMAGE PROCESSING

In general, any digital image processing algorithm consists of three stages: input, processor and output. In the input stage image is captured by a camera. It sent to a particular system to focus on a pixel of image that's gives, its output as a processed image.

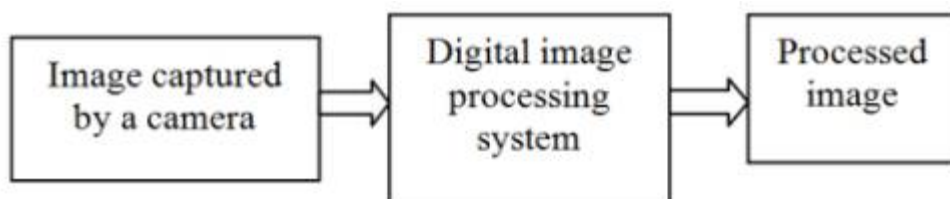


Fig. 4.5: Block diagram of image processing

4.11 SYSTEM HARDWARE DESIGN

The Raspberry Pi board is the central module of the whole embedded image capturing and processing system as given in fig. 2. Its main parts include: main processing chip unit, memory, power supply HDMI Out i.e VGA display, Ethernet port, and USB ports.

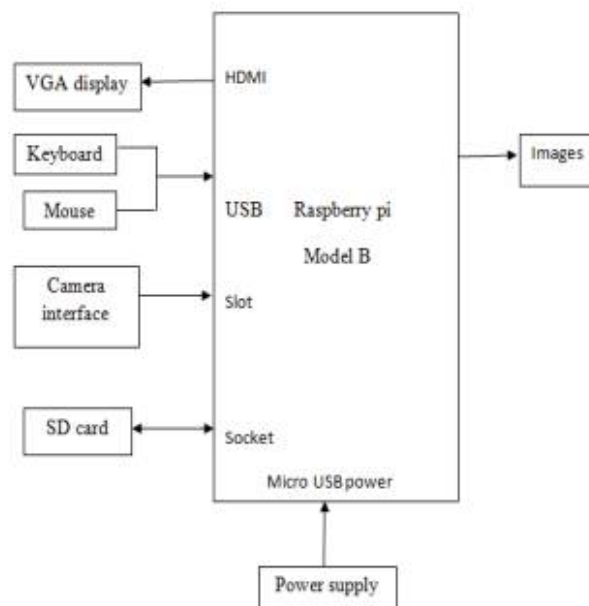


Fig. 4.6: System Block Diagram

RFID (radio-frequency identification)

Radio Frequency Identification (RFID) refers to a wireless system comprised of two components: tags and readers. ... Tags, which use radio waves to communicate their identity and other information to nearby readers, can be passive or active. Passive RFID tags are powered by the reader and do not have a battery.

Passive tags are powered by energy from the RFID reader's interrogating radio waves. Active tags are powered by a battery and thus can be read at a greater range from the RFID reader, up to hundreds of meters.

Unlike a barcode, the tag does not need to be within the line of sight of the reader, so it may be embedded in the tracked object. RFID is one method of automatic identification and data capture (AIDC).

RFID tags are used in many industries. For example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line, RFID-tagged pharmaceuticals can be tracked through warehouses, and implanting RFID microchips in livestock and pets enables positive identification of animals. Tags can also be used in shops to expedite checkout, and to prevent theft by customers and employees.

Since RFID tags can be attached to physical money, clothing, and possessions, or implanted in animals and people, the possibility of reading personally-linked information without consent has raised serious privacy concerns. These concerns resulted in standard specifications development addressing privacy and security issues.

Tags

RFID tags are made out of three pieces: a microchip (an integrated circuit which stores and processes information and modulates and demodulates radio-frequency (RF) signals), an antenna for receiving and transmitting the signal and a substrate. The tag information is stored in a non-volatile memory. The RFID tag includes either fixed or programmable logic for processing the transmission and sensor data, respectively.]

RFID tags can be either passive, active or battery-assisted passive. An active tag has an on-board battery and periodically transmits its ID signal. A battery-assisted passive tag has a small battery on board and is activated when in the presence of an RFID reader. A passive tag is cheaper and smaller because it has no battery; instead, the tag uses the radio energy transmitted by the reader.

However, to operate a passive tag, it must be illuminated with a power level roughly a thousand times stronger than an active tag for signal transmission. This makes a difference in interference and in exposure to radiation.

Tags may either be read-only, having a factory-assigned serial number that is used as a key into a database, or may be read/write, where object-specific data can be written into the tag by the system user. Field programmable tags may be write-once, read-multiple; "blank" tags may be written with an electronic product code by the user.

The RFID tag receives the message and then responds with its identification and other information. This may be only a unique tag serial number, or may be product-related information such as a stock number, lot or batch number, production date, or other specific information. Since tags have individual serial numbers, the RFID system design can discriminate among several tags that might be within the range of the RFID reader and read them simultaneously.

Readers

RFID systems can be classified by the type of tag and reader. There are 3 types:

A Passive Reader Active Tag (PRAT) system has a passive reader which only receives radio signals from active tags (battery operated, transmit only). The reception range of a PRAT system reader can be adjusted from 1–2,000 feet (0–600 m), allowing flexibility in applications such as asset protection and supervision.

An Active Reader Passive Tag (ARPT) system has an active reader, which transmits interrogator signals and also receives authentication replies from passive tags.

An Active Reader Active Tag (ARAT) system uses active tags activated with an interrogator signal from the active reader. A variation of this system could

also use a Battery-Assisted Passive (BAP) tag which acts like a passive tag but has a small battery to power the tag's return reporting signal.

Fixed readers are set up to create a specific interrogation zone which can be tightly controlled. This allows a highly defined reading area for when tags go in and out of the interrogation zone. Mobile readers may be handheld or mounted on carts or vehicles.

CHAPTER 5

SOFTWARE DESCRIPTION

5.1 START UP WITH RASPBERRY PI

5.1.1 *Installation of operating system on Raspberry Pi*

Raspberry Pi is a small computer; hence operating system (OS) should be installed. As the Raspberry doesn't have hard drive, OS is installed in the external memory. For that, memory card (SD card) is used for the installation of operating system and all the required software and supporting files are stored in the same SD card.

There are different types of operating system but we preferred to talk about NOOBS (New Out of the Box Software) as it is suitable for the beginners. We can either buy a preinstalled SD card or empty SD card. In pre-installed SD card, NOOBS is already copied and ready to boot. The detail description of installation of operating system in a blank SD card in step wise is given in Appendix B.

5.1.2 *Use of laptop screen, keyboard and mouse for Raspberry Pi*

If you don't have suitable screen for the Raspberry Pi, we can use the monitor of a laptop. Besides, we can use keyboard and mouse of laptop as well for Raspberry Pi. For that, two software are needed to install in a laptop which screen is going to use for Raspberry Pi. Installation and configuration of the software is discussed briefly in the following sections. Xming

This is the first software need to be installed which can be downloaded from the link, [Download_Xming](#) and install it in the laptop. After completion of installation, run the application called 'XLaunch' and verify that the settings are as shown in three following figures.

Finally, click "Next" button shown in Figure 12-3, it goes to last configuration dialogue box where "Finish" button is needed to click for the completion of the setting. After Completion of configuration, double click the application named as "Xming".

5.2 PUTTY

This is the primary software need to be installed. It can be downloaded in the provided link as follow, [Download_Putty](#). As, it is downloaded, it needs to be installed following some few normal steps of installation. For Configuration, double click the icon of Putty after the completion of installation and enter the IP address of Raspberry Pi as shown in Figure 5.1.

Finally, click on "open" button and as a result; window will be displayed as shown in Figure 5.1.

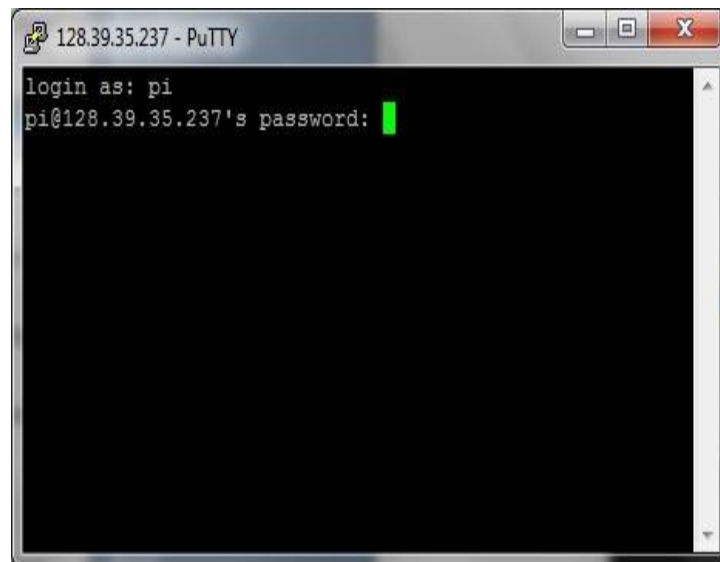


Fig. 5.1: Putty login windows

In this window, username and password of the Raspberry Pi should be entered. The default username for a Raspberry Pi is pi. Press enter after entering correct username and password and you will see the windows where you should enter the text "lesson" as shown in Figure.

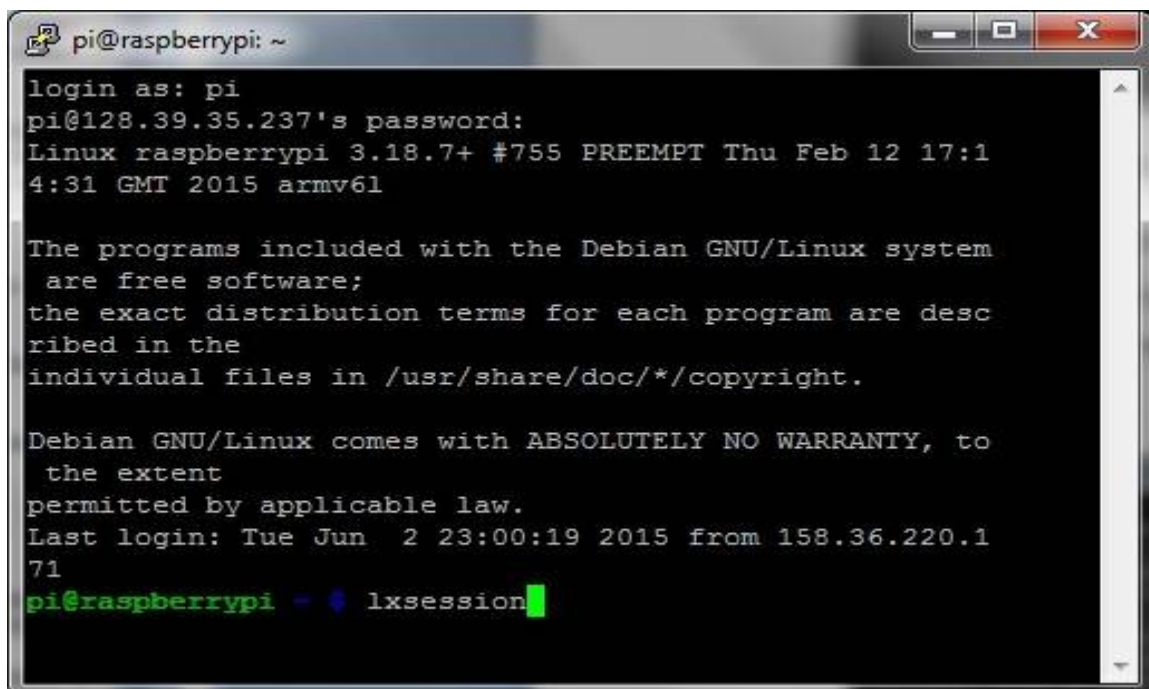


Fig. 5.2: Putty success windows

Then, you will be able to see the desktop of Raspberry Pi in the laptop as shown in Figure 5. and mouse and keyboard can be used for the Raspberry Pi.

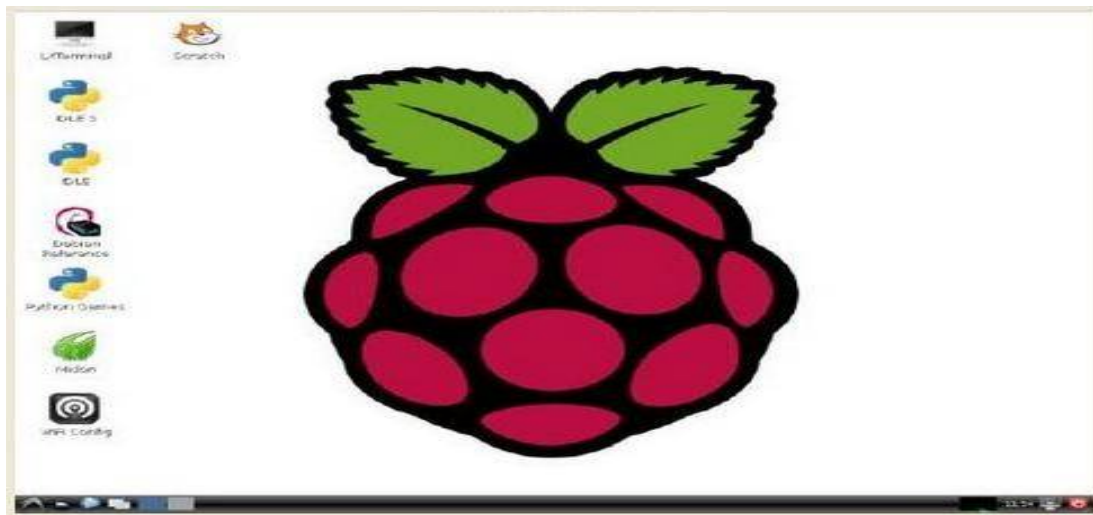


Fig. 5.3: Raspberry Pi Desktop on your Laptop Display

5.3 INSTALLATION OF REQUIRED APPLICATIONS ON RASPBERRY PI

There are many applications that are needed to install in the Raspberry Pi for the completion of the thesis. For data logging, MySQL apache5 and php my admin are needed to install whereas for the web-page development, PHP is needed to install. Web page is used for the monitoring and managing purpose

Raspbian OS

Raspberry Pi OS (formerly Raspbian) is a Debian-based operating system for Raspberry Pi. Since 2015, it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the Raspberry Pi family of compact single-board computers. The first version of Raspbian was created by Mike Thompson and Peter Green as an independent project The initial released build was completed on July 15, 2012'

Raspberry Pi OS is highly optimized for the Raspberry Pi line of compact single-board computers with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller. Raspberry Pi OS uses a modified LXDE as its desktop environment with the Openbox stacking window manager, along with a

unique theme. The distribution is shipped with a copy of the algebra program Wolfram Mathematica and a version of Minecraft called Minecraft: Pi Edition (note that Minecraft: Pi Edition is no longer installed as of the Debian bullseye update) as well as a lightweight version of the Chromium web browser.

User Interface

Raspberry Pi OS's desktop environment, PIXEL, looks similar to many common desktops, such as macOS, Microsoft Windows, and is based on LXDE. The menu bar is positioned at the top and contains an application menu and shortcuts to Terminal, Chromium, and File Manager. On the right is a Bluetooth menu, a Wi-Fi menu, volume control, and a digital clock.

Components

PCManFM is a file browser allowing quick access to all areas of the computer, and was redesigned in the first Raspberry Pi OS Buster release (2019-06-20).

Raspberry Pi OS originally used Epiphany as the web browser, but switched to Chromium with the launch of its redesigned desktop.

Raspberry Pi OS comes with many beginner IDEs, such as Thonny Python IDE, Mu Editor, and Greenfoot. It also ships with educational software like Scratch and Bookshelf.

Version Size

The Raspberry Pi documentation recommends at least a 4GB microSD card for Raspberry Pi OS Lite, an 8GB microSD card for Raspberry Pi OS, and a 16GB microSD card for Raspberry Pi OS Full.[19] The image files themselves are 1,875MB, 3,980MB, and 8,603MB respectively.

Python

What is Python?

Python: Dynamic programming language which supports several different programming paradigms:

- Procedural programming
- Object oriented programming
- Functional programming

Standard: Python byte code is executed in the Python interpreter (similar to Java) → platform independent code

Why Python?

Extremely versatile language Website development, data analysis, server maintenance, numerical analysis,

- Syntax is clear, easy to read and learn (almost pseudo code)
- Common language
- Intuitive object oriented programming
- Full modularity, hierarchical packages
- Comprehensive standard library for many tasks
- Big community Simply extendable via C/C++, wrapping of C/C++ libraries
- Focus: Programming speed

History

Start implementation in December 1989 by Guido van Rossum (CWI)

- 16.10.2000: Python 2.0
- Unicode support

- Garbage collector
- Development process more community oriented
- 3.12.2008: Python 3.0
- Not 100% backwards compatible 2007 & 2010 most popular programming language (TIOBE Index)
- Recommendation for scientific programming (Nature News, NPG, 2015)
- Current version: Python 3.9.2
- Python2 is out of support

Is Python fast enough?

- For user programs: Python is fast enough!
- Most parts of Python are written in C
- For compute intensive algorithms: Fortran, C, C++ might be better
- Performance-critical parts can be re-implemented in C/C++ if necessary
- First analyses, then optimize!

Conclusion

Python is a fully-fledged programming language. Any code you download from github, the Python Package Index, or anywhere else, can be malicious and would almost certainly go unnoticed by most people's firewalls.

OpenCV

OpenCV is a cross-platform library using which we can develop real-time computer vision applications. It mainly focuses on image processing, video capture and analysis including features like face detection and object detection. Let's start the chapter by defining the term "Computer Vision"

Computer Vision

Computer Vision can be defined as a discipline that explains how to reconstruct, interpret, and understand a 3D scene from its 2D images, in terms of the properties of the structure present in the scene. It deals with modeling and replicating human vision using computer software and hardware.

Computer Vision overlaps significantly with the following fields:

- Image Processing: It focuses on image manipulation.
- Pattern Recognition: It explains various techniques to classify patterns.
- Photogrammetry: It is concerned with obtaining accurate measurements from images.

Computer Vision Vs Image Processing

Image processing deals with image-to-image transformation. The input and output of image processing are both images.

Computer vision is the construction of explicit, meaningful descriptions of physical objects from their image. The output of computer vision is a description or an interpretation of structures in 3D scene.

Applications of Computer Vision

Here we have listed down some of major domains where Computer Vision is heavily used.

Robotics Application

- Localization — Determine robot location automatically
- Navigation
- Obstacles avoidance
- Assembly (peg-in-hole, welding, painting)
- Manipulation (e.g. PUMA robot manipulator)
- Human Robot Interaction (HRI): Intelligent robotics to interact with and serve people

Medicine Application

Classification and detection (e.g. lesion or cells classification and tumor detection)

- 2D/3D segmentation
- 3D human organ reconstruction (MRI or ultrasound)
- Vision-guided robotics surgery

Industrial Automation Application

- Industrial inspection (defect detection)
- Assembly
- Barcode and package label reading
- Object sorting
- Document understanding (e.g. OCR)

Security Application

- Biometrics (iris, finger print, face recognition)
 - Surveillance — Detecting certain suspicious activities or behaviors
- Transportation

Application

- Autonomous vehicle
- Safety, e.g., driver vigilance monitoring

Features of OpenCV Library

Using OpenCV library, you can –

- Read and write images
- Capture and save videos
- Process images (filter, transform)
- Perform feature detection
- Detect specific objects such as faces, eyes, cars, in the videos or images.
- Analyze the video, i.e., estimate the motion in it, subtract the background, and track objects in it. OpenCV was originally developed in C++. In addition to it, Python and Java bindings were provided. OpenCV runs on various Operating Systems such as windows, Linux, OSx, FreeBSD, Net BSD, Open BSD, etc.

This tutorial explains the concepts of OpenCV with examples using Java bindings.

OpenCV Library Modules

Following are the main library modules of the OpenCV library.

Core Functionality

This module covers the basic data structures such as Scalar, Point, Range, etc., that are used to build OpenCV applications. In addition to these, it also includes the multidimensional array Mat, which is used to store the images. In

the Java library of OpenCV, this module is included as a package with the name `org.opencv.core`.

Image Processing

This module covers various image processing operations such as image filtering, geometrical image transformations, color space conversion, histograms, etc. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.imgproc`.

Video

This module covers the video analysis concepts such as motion estimation, background subtraction, and object tracking. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.video`.

Video I/O

This module explains the video capturing and video codecs using OpenCV library. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.videoio`.

calib3d

This module includes algorithms regarding basic multiple-view geometry algorithms, single and stereo camera calibration, object pose estimation, stereo correspondence and elements of 3D reconstruction. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.calib3d`.

features2d

This module includes the concepts of feature detection and description. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.features2d`.

Objdetect

This module includes the detection of objects and instances of the predefined classes such as faces, eyes, mugs, people, cars, etc. In the Java library of OpenCV, this module is included as a package with the name `org.opencv.objdetect`.

Highgui

This is an easy-to-use interface with simple UI capabilities. In the Java library of OpenCV, the features of this module is included in two different packages namely, `org.opencv.imgcodecs` and `org.opencv.videoio`.

OpenCV — Storing Images

To capture an image, we use devices like cameras and scanners. These devices record numerical values of the image (Ex: pixel values). OpenCV is a library which processes the digital images, therefore we need to store these images for processing. The `Mat` class of OpenCV library is used to store the values of an image. It represents an n-dimensional array and is used to store image data of grayscale or color images, voxel volumes, vector fields, point clouds, tensors, histograms, etc. This class comprises of two data parts: the header and a pointer

- Header: Contains information like size, method used for storing, and the address of the matrix (constant in size).
- Pointer: Stores the pixel values of the image (Keeps on varying).

The Mat Class

The OpenCV Java library provides this class with the same name (`Mat`) within the package `org.opencv.core`.

Constructors

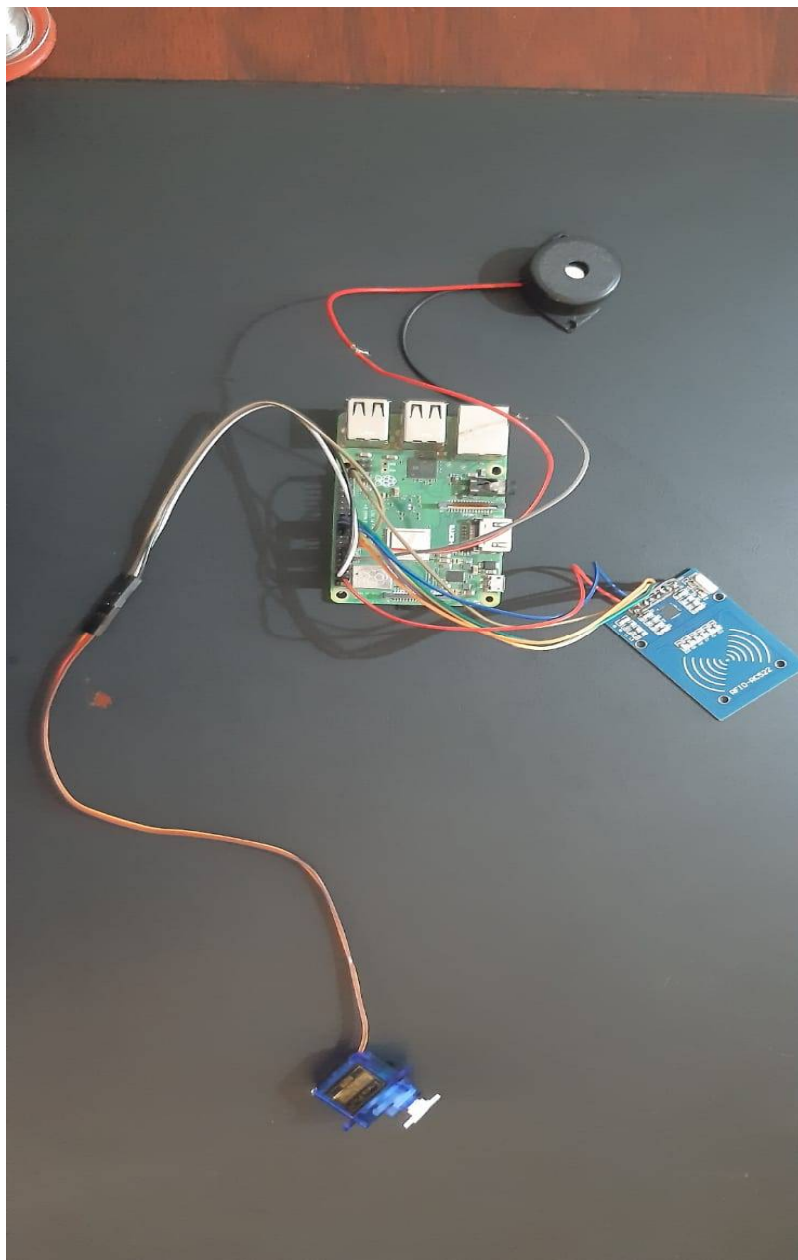
The Mat class of OpenCV Java library has various constructors, using which you can construct the Mat object.

1. This is the default constructor with no parameters in most cases. We use this to constructor to create an empty matrix and pass this to other OpenCV methods. 2. `Mat(int rows, int cols, int type)` This constructor accepts three parameters of integer type representing the number of rows and columns in a 2D array and the type of the array (that is to be used to store data). 3. `Mat(int rows, int cols, int type, Scalar s)` Including the parameters of the previous one, this constructor additionally accepts an object of the class Scalar as parameter. 4. `Mat(Size size, int type)` 3. OpenCV — Storing Images

CHAPTER 6

RESULTS AND DISCUSSION

6.1 OUTPUT



6.2 CONCLUSIONS

internet of things used in the light of wire application helps to see the action and distinguished development. Computer Vision provides the face detection and is used for recognition of people which is a most fascinating kind of application for the Internet of Things. Computer Vision combinations exhibits greater level of security system in the IoT platform especially for intelligent homes as they have capacities which perceive a person in the incorrect places since the human might be a bad human for environment.

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