

Border Security using IoT and Embedded systems

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in Electronics and Communication Engineering

by

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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION
ENGINEERING**

**Sathyabama Institute of Science and Technology
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade “A” by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Shaik Althaf (Reg. No. 38130201) & Koripalli Yaswanth (Reg. No. 38130111)** who carried out the project entitled "**Border Security using IoT and Embedded systems**" under our supervision from December 2021 to March 2022.

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Embedded systems” done by me under the guidance of **Dr. M. Subramoniam**

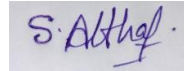
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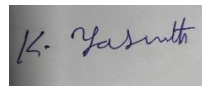
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ABSTRACT:

It is the prime duty of every government to give more priority for border security and protection. It is very difficult to monitor miles of extended international borders with limited sources. So border security force divides the soldiers into team which protect the border in certain time interval but it is again difficult to monitor border 24*7. As technology increases new threats and risks arise towards national security. If there is some mechanism to secure and protect borders from illegal activities like illegal immigration of people from neighbouring countries like Pakistan, China and Bangladesh, smuggling of drugs and illegal trafficking then it can provide aid to the national security.. Our borders extend thousands of miles and therefore our soldiers will not be able to provide complete security. The ordinary border patrol system suffers from intensive human involvement. Recently unmanned border patrol systems consist of high tech devices, like unmanned aerial vehicles, unattended ground sensors, and surveillance towers equipped with wireless cameras. Border patrol systems have recently achieved interest to address the concerns about national security. The major problem in protecting long stretches of borders is the need for large human involvement in patrolling the premises. Our border patrol system consists of security checkpoints and border troops. All vehicle traffic is needed to stop at security checkpoints which are set up on the international roads to detect and apprehend illegal aliens, drugs, and other illegal activity. The border troop watches and maintains control in a specific section of the border. The troops patrol the border according to predetermined route and time interval. Under the conventional border patrol system, even modest-sized areas require large human resources if manual patrolling is considered alone. However, any single technique encounters inextricable problems, such as high false alarm rate and line of sight constraints. They require a coherent system that coordinates various technologies to improve the system accuracy. At present border surveillance is often accomplished through separated stovepiped systems. Data

that might be of interest for not only one but many surveillance units can't be shared and thus the capabilities to secure the border are limited. To overcome these limitations, interoperable transnational surveillance systems, capable of including all relevant data sources and sharing them among border related law enforcement bodies are needed. To improve the border security, sensor technology and computer processing power can be used. For detecting trespassers automatically in border areas, an autonomous and intelligent Border Security Robot can be used to monitor every single movement with accuracy and without any failure by using Wifi. In this project the general idea of border security and border surveillance robot, wireless sensor network architecture for border patrol systems, is introduced via the internet by using Node Mcu. Border security robot uses a sensor for human intruder detection, a metal detector to detect the presence of explosives weapons and a wireless pi camera for monitoring the scenario continuously at the remote station. Mechanical control of robotic vehicles along with robotic arms can be done using joystick(Servo Motors from remote and hazardous places. Border surveillance makes use of a number of systems that detect threats and conspicuous behavior. Within an integrated surveillance system, disparate technologies that complement one another are installed, the interaction of the data output is essential. An integrated surveillance system consists of sensors, exploitation systems (that might also be deployed as situational awareness displays) and external information systems. A border is monitored by a range of different sensor types. Those sensors deliver data to a border surveillance unit (BSU). However, the areas that are monitored intersect and data that is of interest for one surveillance unit may also be of interest for adjacent units. Our architecture allows the necessary data sharing and accommodation of additional information from external systems resulting in enhanced situation awareness. In our project an autonomous intelligent robot is used which is enhanced with a video surveillance camera for detecting the trespasser, informing nearby control units and to check whether an intruder is detected and fired if necessary. PIR motion sensor is used for detecting the trespassers. If an intruder is detected a laser gun is provided for further purposes. The movement of the laser can be controlled as per the directions given by the control room. If necessary, a laser gun can be used for shooting or firing the intruder. To monitor the border in real-time with accuracy and minimize the need for human support, multiple surveillance technologies, which complement each other are required. To address the challenges still facing by the existing surveillance techniques, we introduce Border security robots, a new border patrol system framework based on hybrid wireless sensor networks, which can accurately detect the border intrusion with minimum human involvement. Border security robot utilizes the PIR sensor for human detection and a metal detector for

explosive detection. Also a wireless camera is used to continuously monitor the border. We introduce an Autonomous intelligent robot for border security. A cost effective autonomous solution is used to overcome the limitations of the existing physical solutions. The number of soldiers who are recruited in the borders can be reduced. To monitor the border in real-time with accuracy and minimize the need for human support, multiple surveillance technologies, which complement each other are required. Security Bot can be controlled on WLAN and LAN by using the live stream footage from Pi camera which is fitted in the intelligent robot system.

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CHAPTER 1

INTRODUCTION

The military is undeniably the primary customer of new advances and improvements in strategy, and is also often the sponsor of new improvements when it comes to envisioning new innovations in military settings. Numerous basic military technologies deployed out of the blue are now advanced to the piece of industrial robots. In any case, the importance of military autonomy and modern mechanical autonomy is still quite different. The military has special, robotic equipment while, in modern terms, the robot is a larger amount of a smart, adaptable, large-scale manufacturing machine. Later, the use of modern robots for military applications will always be imaginable. Cost and development of the specialized capacity of the innovative robot will build the enthusiasm of the military customers. We will demonstrate that the inspiration for the utilization of robots, inside the military and inside industry, is the substitution of people. The explanations behind this substitution are, as per the following: quality, cost and acculturation; be that as it may, utilizing an alternate methodology in each field, obviously Presently, the monitoring of International fringe zones is exceptionally overwhelming errand. The security forces observe the outskirts under antagonistic conditions. You get support from reconnaissance cameras officially assembled, but they cover exceptionally restricted zones. The cameras mounted viably at a settled position isn't of incredible use, as we can't change the camera look dynamic. Moreover, it is inconceivable to mount the cameras in the timberland regions as the trees discourage the camera's point of view This project presents a modern approach for surveillance at remote and border areas using multifunctional robots based on current IOT used in defense and military applications. This robotic vehicle has the ability to substitute the soldiers at the border area to provide surveillance. This class of robots can be utilized for tasks in hazardous environments where humans are not capable of doing it. The robotic vehicle works both as an autonomous and manually controlled vehicle using internet communication medium. Emphasizes on the skill of mobility which deals with the motion of mobile robots in unstructured, unsupervised and real-world environments in order to reach its goals. Here the focus is on locomotion and choice of particular locomotion mechanism which is best when compared to its substitutes. This versatile robot is used to detect the presence of an enemy and capture it in the camera and give the live streaming to the authorized person. Our report presents a smart surveillance robot for military application by using Raspberry Pi, Node

MCU, Servo Motors, Mounted Gun, Pi Camera and DC Motors. One Node MCU is used to control the bot and the other to control the gun (fixing the angle and shooting the target). Raspberry Pi is used to stream the live footage and make the entire bot on WAN. Basically, Border patrol systems have recently achieved interest to address the concerns about national security. The major problem in protecting long stretches of borders is the need for large human involvement in patrolling the premises. Our border patrol system consists of security checkpoints and border troops. The border troop watches and maintains control in a specific section of the border. The troops patrol the border according to predetermined route and time interval. In Fact even modest-sized areas require large human resources if manual patrolling is considered alone. The skill of a robot can be utilized where a human is not capable of doing it. For monitoring remote areas an intelligent robot can be designed with reliable economic communication. We introduce an Autonomous intelligent robot for border security. A cost effective autonomous solution is used to overcome the limitations of the existing physical solutions. The number of soldiers who are recruited in the borders can be reduced. To monitor the border in real-time with accuracy and minimize the need for human support, multiple surveillance technologies, which complement each other are required. Here the robot can identify trespassers using video surveillance, which provides a 24-hour surveillance. Intruder detection is performed with a Camera sensor module attached to the robot. There are mainly three sections, namely software section, hardware section and Robotic action. To address the challenges still facing by the existing surveillance techniques, we introduce Border security robot, a new border patrol system framework based on hybrid wireless sensor networks, which can accurately detect the border intrusion with minimum human involvement. Wireless cameras will send video signals to the user side. The Camera is wired to raspberry pi and the signal travels between the camera and the receiver. The camera picture is sent by the transmitter(camera) and the receiver (Script Running on pi) collects this signal and outputs it to our Computer or laptop. Pi camera sends real time video inputs which can be seen on a remote monitor in the base station from where the robot is being controlled by the user in user mode. This camera has quite a good range of providing full motion, real time, color video with no delay. It can easily conceal in a box made by us and the built-in microphone provides great sound quality. We used VNC Server for watching the live footage signals on our laptop thus the Gun will shoot the target . A wifi controlled car has been used which can be controlled on WAN & LAN, a human controller can see the live movement of any intrusion with the help of camera embedded which will live stream the entire footage on remote system thus, the gun

mounted on the bot can be used to shoot the target, nevertheless the controller can fix various angle too as per as their requirement. The robot can save its power too as it can get completely off thus the ongoing battery consumption can be saved. The robot can go anywhere , where there is a network/internet connection. The proposed work presents designing and development of a multipurpose smart robot car using wireless camera detecting alive humans, fire, harmful gases, metals, obstacles at remote areas and send information to main location.

1.2 OBJECTIVE:

- An essential requirement of this situation is a robot which automatically detects trespasser in the border and report nearby board security control unit.
- to reach any corner of the security region without alarming the enemy
- It can employ for suspicious bomb detection & demolition, threat detection
- It can also be used for tactical communication, fast-deployed relay stations.

1.3 MOTIVATION

At present, human work is greatly reduced by machines in each doable method. Mostly, computers and robots play a serious role in our day to day life. In recent times, most the military organizations take the assistance of military robots to hold several risky jobs. In general, a mechanism could be a combination of mechanical and physics model designed by humans to perform a particular task. Robots have immense applications in military and industrial space, such as, for lifting significant weights and playing same task many times with efficiency with none committing any errors in contrast to humans. In recent years, the Indian border military forces face a large destruction because of the attacks of neighboring countries. In several things, our troopers got to venture into enemy's base that could be a risky job. Such dangerous jobs can be avoided by mistreatment robots. Robots with high resolution cameras will monitor over long distances. mechanism loaded with totally different sensors performs numerous tasks. they'll even find hidden chemical objects with the assistance of gas sensing element that cannot be done by humans. Generally, air is associate odorless one that consists of compounds made

from 2 main components - carbon and element referred to as hydrocarbons. If the harmful level exceeds the traditional level, the sensing element detects it. the most part used is Raspberry pi and like several alternative laptop, it also can settle for several programming languages as well as Python. It supports several in operation systems like Raspbian, Fedora, Debian, Windows IOT Core, Kali UNIX and Arch UNIX ARM and that we use Raspbian OS. We have created a borderline military mechanism that stops the large destruction of human lives. This mechanism also can be used for spying enemy territories throughout vital things within the border and it also can monitor the movements of enemies coming into our country. Since the mechanism is extremely tiny in size it will send to the enemy's camp to watch their movements.

1.4 DESCRIPTION

The Internet of things is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Earlier the robots were controlled through wired networks but now to make robot more users friendly, they are framed to make user commanded work. There is no distance limitation issues in this project. The robot is capable to work everywhere where there is a wireless connection. This project can be used for security purposes where we need to get information about some suspicious area/people. We can do this by sitting at a far secure place and safely devise a plan to tackle their activities. It acquires image from cameras through a web browser. As the internet of things is the concept, newly introduced in the field of electronics. The concept is about handling the things with the use of internet and the best model for these applications is raspberry pi. When the surveillance is considered, raspberry pi serve his purpose. On the other hand it can also be very helpful in explorers and animal psychologists need to observe closely the life style of various dangerous animals like lions, snakes and small insects so they use such kind of robots because human life is at risk or their presence can disturb animal patterns of livings. Similarly it can be used in laboratories where dangerous chemicals and gases are tested. It can go to places where chemists can't go, check the leakage and also can perform other tasks. Robots can be classified into different types based on their environment and mechanism of interaction such as mobile and fixed robot of which mobile robot can be further classified as aquatic, terrestrial and airborne. The terrestrial robots are much in use and their applications are vast in each and every field, they are of two types (i) wheeled and (ii) legged each having a different use. Robots are being

used in variety of industrial applications for various activities like pick and place, painting, assembling of subsystems and in hazardous places for material handling etc. Nowadays robots in the use of surveillance is emerging because of their miniature size allowing them to enter in tunnels, mines and small holes in building and also have capability to survive in harsh and difficult climatic conditions for life long time without any defect and causing no harm. Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and objectoriented approach aim to help programmers write clear, logical code for small and large-scale projects.

CHAPTER 2

LITERATURE SURVEY

In earlier system has many problem such as such as high cost, low intelligence, poor stability, weak security. In order to solve these problems, S3C2440 microprocessor is adopted in this embedded video acquisition system, which combining with the Linux operating system. Video capture is realized by the Video 4 Linux. This paper has advantages such as higher intelligence, higher stability, and easy installation and disadvantage as it requires high cost and continues GSM network is required to send message, if the network is not available this project may not work properly. Below is the diagram showing the flowchart of Video4Linux that has been used in this paper.

2.1 SURVEILLANCE ROBOT USING RASPBERRY PI FOR HOME SECURITY PURPOSES

The authors Gaurav S Bagul et al. proposed a gadget in 2018 to layout and put into effect a manually controlled IOT based Surveillance Robot. The foremost reason of the robotic is to transport in and around the given environment while transmitting returned stay video to the floor station over the internet or Wi-Fi. This stay facts can then be used by the controller to move the robotic round. In this proposed system, the robot is self-contained with wireless transmission of information. This device will help to manipulate/spy at the terrorist assaults at some stage in the arena via tracking and manage of robot through the internet with the Raspberry Pi board. The monitoring and controlling of robot actions are navigated thru the wireless network by using the use of an internet-primarily based server and additionally storing the information and cloud and ship back to the group and we can retrieve the statistics from cloud. In Shubham Mittal and Jaynendra Kumar Rai proposed device is a Wadoro an autonomous mobile robot for household surveillance in open-spaces like roofs in the course of night and shaded regions in day-time. This robot has the capability of detecting humans close to real-time round the clock using PIR sensors and digi-cam. The robot cycle is divided into 5 stages i.e., human detection, tracking, reputation and alert-generation with alongside the segment of self-safety. After detection of a human, it starts tracking to come across the face using an set of rules they used in the challenge after the subsequent popularity is performed using the nearby binary sample histograms method to Human face and if the face matches with the face in database and after the mismatch it offers an alert inside the form of smart phone call

to the mobile smart phone of the consumer. Self-protection ensures the collision-unfastened actions of the robots and then prevent it from being stolen with the aid of generating an alert name on detecting its choose up from the ground. The challenge proposed by explained by means of Ashish U. Bokade and V. R. Ratnaparkhein [3] approximately the procedure for controlling a robot within the surveillance the use of an cellular application that's constructed through the android platform. This android application opens a web page which shows the stay streaming video display and the approach of controlling the robotic of which and the total machine is developed in the raspberry pi module. Android clever telephone and the raspberry pi board were connected thru the Wi-Fi and this android clever cell phone sends a commands which have been received by way of the raspberry pi and in step with our position which way we need to head give the instructions to the raspberry pi thru our clever phone and we are able to see video live streaming via our telephone and we can recognise the item and people are within the filed this could be used specially inside the navy software. The paper offers with the layout and implementation of cell robotic of the 3 subsystems. The obstacle avoidance, face recognition and detection leakage of combustible gases are the three subsystems of the mission. In the first subsystem of the task, an implementation of an synthetic neural network on area programmable analog array has been used to control the movement of the robot so that it may stumble on the boundaries being happened in among. In the second subsystem the robotic recognizes the face. The third subsystem uses MQ4 sensor to discover the leakage of dangerous gases in the environment which is used to implement the proposed subsystem in This robot is used to able to climbing all the surfaces like a horizontal and vertical surface areas and also imparting the controlling the consumer with the surveillance in their area. This model is used for the shooting the real time snap shots and on-line video streaming and audio streaming in order to provide the surveillance over a field or the individual or the place in which the robot must display. Raspberry pi processor is used to govern the robot through the wi-fi verbal exchange community for a statistics processing and transmission and this is beneficial for in navy programs like tracking a person or region and the vicinity of interest and to help to offer the tactical advantages in struggle filed. The framework is reconnaissance at faraway and unstable zones which had been utilizing the multifunctional robot depended on the modern generation and innovation utilized in safety and the one-of-a-kind navy applications were held. This mechanical automobile has capability to substitute the soldier at risky zones to present reconnaissance. The robotic car works each as self-enough and physically controlled robot using the webpage as correspondence medium. This multi robot used to pick out human,

bombs, dangerous gases and hearth at far off and war discipline zones. Customarily, far off safety robot obsoletes due to confined recurrence range and restrained guide manipulate. These impediments are surmounted through making use of 3G innovation which has boundless variety. This framework additionally improvements the use of sustainable asset of robot with the aid of outfitting with solar-orientated board. A self-governing robot was controlled through ultrasonic sensor and infrared sensors. Whereas the Manual assignment became managed by using DTMF decoder and cellular phones applied as camcorder by way of introducing modern-day 3G video call technology and changed the manner of robot as indicated via continuous facts of encompassing. This paper likewise outlines the exploratory consequences of tilt side willpower of solar-orientated board of the guide robotic and strength utilization in programmed and manual mode. This mechanical robot is intended for statement and reconnaissance in particular situations is proposed through Kaur and Dilip Kumar. This mission offers with the wi-fi robot which gives the stay stream of video statistics, takes and save the photos and stay video statistics. The robot turned into managed via a nearby Wi-Fi server by means of a web utility. The main goal of the challenge is to broaden that may perform the more than one duties and cost effective. In this version they are used the Arduino Uno microcontroller and the 2 android phones to discover the audio and video for sending and receiving the information and the NodeMcu ESP Module for wi-fi connection to the robot.

2.2 RASPBERRY PI CONTROLLED NIGHT VISION PATROLLING ROBOT

The Internet of things is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Earlier the robots were controlled through wired networks but now to make robot more users friendly, they are framed to make user commanded work. There is no distance limitation issues in this project. The robot is capable to work everywhere where there is a wireless connection. This project can be used for security purposes where we need to get information about some suspicious area/people. We can do this by sitting at a far secure place and safely devise a plan to tackle their activities. It acquires image from cameras through a web browser. As the internet of things is the concept, newly introduced in the field of electronics. The concept is about handling the things with the use of internet and the best model for these applications is raspberry pi. When the surveillance is considered, raspberry pi serve his purpose. On the other hand it can also be very helpful in explorers and animal psychologists need to observe closely the life style of various dangerous

animals like lions, snakes and small insects so they use such kind of robots because human life is at risk or their presence can disturb animal patterns of livings. Similarly it can be used in laboratories where dangerous chemicals and gases are tested. It can go to places where chemists can't go, check the leakage and also can perform other tasks. Robots can be classified into different types based on their environment and mechanism of interaction such as mobile and fixed robot of which mobile robot can be further classified as aquatic, terrestrial and airborne. The terrestrial robots are much in use and their applications are vast in each and every field, they are of two types (i) wheeled and (ii) legged each having a different use. Robots are being used in variety of industrial applications for various activities like pick and place, painting, assembling of subsystems and in hazardous places for material handling etc. Nowadays robots in the use of surveillance is emerging because of their miniature size allowing them to enter in tunnels, mines and small holes in building and also have capability to survive in harsh and difficult climatic conditions for life long time without any defect and causing no harm. Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and objectoriented approach aim to help programmers write clear, logical code for small and large-scale projects.

The objective is to safeguard the entire region. Any small sound resulting in sending the notification through the Blynk robot to the person concerned consists of night vision camera from that we can see the live video through the smartphone sends and capture the area and send it to the user. Night vision camera plays a significant role in rendering the robotic device automatic. Robotics is a modern technology that is transforming human existence, with control and automation being a crucial and emerging component of robotics. Robots function as a computer, and can be controlled remotely. Patrolling is nothing more than keeping track of an area where the corresponding robot patrolling area is constantly moving and traveling is continuously moving in the area allocating to the robot. The robot takes the pictures at 360degree rotation. Then, these images are transmitted to the user in real time, they it will be evaluated by the user and appropriate action will be taken if any problems are found. Using camera motor, we may gather knowledge from both sides of the external field. We have two possibilities for controlling the robot: wired and wireless. Wireless monitoring helps us operate robot from various locations. GSM is used within this module and MCU is used for camera support node. Any minor sound will trigger an alarm, and the robot will automatically go to

the location, take a picture of the scene, and emails to the user. The Raspberry Pi linked to the camera is crucial in the development of an automated robotic device. The robotic vehicle has night vision cameras and sound sensors and it moves at different intervals. It employs a predetermined line to follow its direction when patrolling. Once the sound has been detected, the HD camera will rotate to detect any intrusion. It has the ability to track sound in the vicinity. If a sound-signal is detected, it begins to move in the direction of the sound. It then uses its camera to scan the area for any known human faces. Upon detecting a sound or a human face, it immediately takes and begins transmitting images of the situation. In this case IOT gecko is used to get transmitted images and view them with warning sounds to the user. As a result, we're presenting a totally autonomous secured robot that operates relentlessly and patrols large regions alone to protect the building of its own. Patrolling robot is primarily used in the industrial field, military zone, hospitals, shopping mall, national functions, etc. Women's safety has become a serious concern in our country, since women are unable to leave their homes at any time, particularly at night. It is mostly due to their fear of being physically or sexually mistreated or facing violence. Harassment against women is not only a problem outside the home, but it can also occur inside. Even in the twenty-first century, when technology is continuously evolving and new gadgets are being invented, women and girls continue to face challenges. To promote liberty, they frequently cooperate across ethnic, religious, political, and cultural divisions. We all recognize the importance of women's safety in our society, but it is also the responsibility of individuals to ensure that they are properly safeguarded. Not only that, but we must establish a climate in our society in which women feel safe outside their homes at all times, especially when they are alone. Because women are not as physically fit as males, a helping hand would be a blessing in their time of need. Recognize, defend, and hunt up resources to help you out of dangerous situations is the best approach to lower your chances of becoming a victim of violent crime (robbery, sexual assault, rape, domestic abuse). If a woman is in a bind or gets separated from her friends on a night out, or if someone is following her with malicious intent (sexual assault), or if she doesn't know how to get back home, this device will protect her and bring assistance when she needs it by sending her current location and health conditions to her associates and control center via SMS and call. This technology not only assists family and law enforcement, but it also aids in obtaining medical assistance as quickly as feasible.

2.3 RASPBERRY PI BASED INTELLIGENT ROBOT FOR MILITARY APPLICATIONS

At present, human work is greatly reduced by machines in each doable method. Mostly, computers and robots play a serious role in our day to day life. In recent times, most the military organizations take the assistance of military robots to hold several risky jobs. In general, a mechanism could be a combination of mechanical and physics model designed by humans to perform a particular task. Robots have immense applications in military and industrial space, such as, for lifting significant weights and playing same task many times with efficiency with none committing any errors in contrast to humans. In recent years, the Indian border military forces face a large destruction because of the attacks of neighboring countries. In several things, our troopers got to venture into enemy's base that could be a risky job. Such dangerous jobs can be avoided by mistreatment robots. Robots with high resolution cameras will monitor over long distances. mechanism loaded with totally different sensors performs numerous tasks. they'll even find hidden chemical objects with the assistance of gas sensing element that cannot be done by humans. Generally, air is associate odorless one that consists of compounds made from 2 main components - carbon and element referred to as hydrocarbons. If the harmful level exceeds the traditional level, the sensing element detects it. the most part used is Raspberry pi and like several alternative laptop, it also can settle for several programming languages as well as Python. It supports several in operation systems like Raspbian, Fedora, Debian, Windows IOT Core, Kali UNIX and Arch UNIX ARM and that we use Raspbian OS. We have created a borderline military mechanism that stops the large destruction of human lives. This mechanism also can be used for spying enemy territories throughout vital things within the border and it also can monitor the movements of enemies coming into our country. Since the mechanism is extremely tiny in size it will send to the enemy's camp to watch their movements.

2.4 BORDER SECURITY ROBOT USING AI

Security is the degree of protection, which separates the assets and potential threats. Security can be classified into different types; they are information technology security, physical security, potential security, monitory security etc. The design and development of robots now a day's focuses on unstructured and natural environments rather than for industrial environment. Robots are used for rescue security and surveillance. The skill of robot can be utilized were a human is not capable for doing it. For monitoring remote areas an intelligent robot can be designed with reliable economic communication. Robots have replaced humans

in performing repetitive and dangerous tasks which humans prefer not to do, or are unable to do because of size limitations, or which take place in extreme environments such as outer space or the bottom of the sea. There are concerns about the increasing use of robots and their role in society. Robots are blamed for rising technological unemployment as they replace workers in increasing numbers of functions. The use of robots in military combat raises ethical concerns. The possibilities of robot autonomy and potential repercussions have been addressed in fiction and may be a realistic concern in the future. The proposed border security robot using AI can perform surveillance around areas of boundaries for monitoring of any illegal or suspicious activities inclusions or ceasefire violations. The number of soldiers who are recruited in the borders can be reduced by deploying the AI robot. Here the robot can identify trespassers using video surveillance, which provides a 24-hour surveillance. Intruder detection is performed with image processing. There are mainly three sections, namely software section, hardware section and Robotic action. It has the capability to automatically detect the trespassers in borders and to inform nearby control unit. This robot is working with the help of artificial intelligence.

2. PROPOSED ARCHITECTURE

2.1 Raspberry Pi 3B+ The Raspberry Pi 3 Model B is a third-generation Raspberry pi. This powerful, low cost and small size single board computer can be used for many major and minor applications. Raspberry pi 3 has most powerful processor and it is 10 times faster than previous generation. This third generation pi has additional wireless LAN and Bluetooth connectivity which is making it the ideal solution for powerful application. The Raspberry pi 3 contains many ports like camera connector, Ethernet port, GPIO pins which is mainly used for interfacing sensors and switches, USB port for external I/O devices, HDMI ports for monitor and audio jack port. These all are attached with a single board. It does not have any internal storage or own operation system, but we can insert an SD card with Linux based OS.

2.5 BORDER SECURITY USING RASPBERRY PI

Security is the primary objective to protect nations from terrorist attacks, infiltration, smuggling etc. Hence international border areas require high level of security round the clock. Surveillance system requires security personnel for monitoring designated areas using surveillance cameras. The manual surveillance system suffers from the following challenges:

It is hard for humans to maintain focus on monitoring continuously.

Continuous monitoring of multiple screens showing video streams from surveillance cameras is challenging.

Security guard falling asleep due to exhaustion while on job results in serious security breach.

Providing 24/7 monitoring requires guards to work in shifts, resulting in high cost.

In order to address these issues, an automated surveillance system with a robot equipped with various sensors at its core is proposed in this work.

A mathematical model is proposed to explore the characteristics of a two-wheel self-balancing robot and control its behavior on a planar surface and on an inclined plane [1]. A Raspberry Pi based robotic system is proposed for surveillance to automatically detect intruders and inform the control room. While the system provides remote control of a robot, it fails to distinguish between a known person and an intruder [2]. A security system using Raspberry Pi and OpenCV image processing techniques is presented to detect the presence of human or smoke during night times and provide an Email alert. But it fails to distinguish between a known person and an intruder [3]. A robotic system is proposed using sensors for detection of harmful gases and fire in war fields for military applications. The system sends an alert message to user when any of the sensors become active but it is unsuccessful to decide the presence of human movement from surrounding objects [4]. A microcontroller based automatic gun targeting system is developed to target trespassers in high security zones. The system gets triggered upon activation of sensors, but it fails to recognize the identity of the person [5]. A surveillance system using Raspberry Pi as a controller and Python-OpenCV as a programming language is proposed to provide for real-time video footage, in black and white, using Internet/Wi-Fi as a medium of connectivity [6].

It is observed from the literature that surveillance systems are designed for detecting human/object movements, gas or flame in target areas. But they suffer from their inability to recognize between a known person and an unknown person. The proposed robotic system addresses this issue by recognizing the known person using image processing techniques. The system generates an alert message in case of dangerous events in areas under surveillance.

CHAPTER 3

SYSTEM DESIGN

3.1 PROBLEM STATEMENT:

- Already existing systems use robots that have limited range of communication as they are based on RF Technology, Zigbee and Bluetooth.
- Some existing projects use short range wireless camera.
- Some existing robots can only be controlled with a manual mode which needs human supervision throughout the whole surveillance process.

3.2 PROPOSED SYSTEM

- The ordinary border patrol system suffers from intensive human involvement. Recently unmanned border patrol system consist of high tech devices, like unmanned aerial vehicles, unattended ground sensors, and surveillance towers equipped with wireless camera.
- However, any single technique encounters inextricable problems, such as high false alarm rate and line of sight constrains.
- There require a coherent system that co-ordinates various technologies to improve the system accuracy.
- In this project general idea of boarder security robot, wireless sensor network architecture for border patrol system, is introduced.
- Through web cam, we can take images and it send to the mail or Whatsapp.

3.3 ADVANTAGE:

- Accuracy
- Optimized character axis

- Less delay.
- Low cost

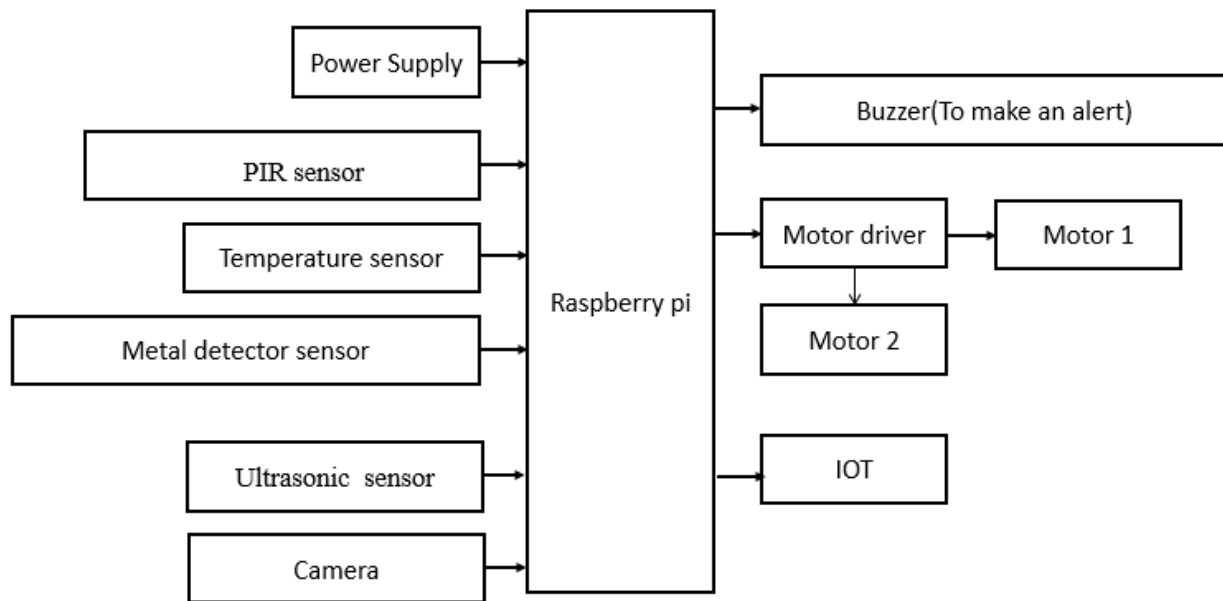
3.4 Problem Statement

- The framework for making a robot for surveillance purpose is proposed. It overcomes the problem of limited range surveillance by using the concept of IOT.
- We can control the robot with the help of laptop/mobile manually. Automatic monitoring can also be done. Our proposed robot is small in size thus maneuvering into area where human access is impossible.
- Wireless technology is one of the most integral technologies in the electronics field. This technology is used to serve our project as a supreme part of surveillance act.
- This provides highly efficient and a cost effective robot that replaces human work and reduces human labor and performing monitoring works in a well effective manner.

3.5 Motivation

- The main objective behind this paper is to develop a robot to perform the act of surveillance in domestic areas.
- The purpose of this robot is to roam around and provide audio and video information from the given environment and to send that obtained information to the user.
- In this project, one can control the robot with the help of mobile or laptop through Internet of Things (IoT) and also can get the live streaming of video both in daytime as well as at night with the help of wireless camera from the robot.
- The robot can be controlled both in manual as well as in automated mode with the help of raspberry pi microcontroller. This robot also uses various sensors that collect data and send it to the raspberry pi microcontroller which controls the robot behavior.
- Along with the obtained live streamed video output, user can also obtain the presence of metal bombs using metal detectors. Thus the action of surveillance can be performed. Further advancement in our project can provide surveillance even in defense areas.

3.6 BLOCK DIAGRAM:



3.7 HARDWARE TOOLS:

- Raspberry Pi
- Camera
- PIR sensor
- Temperature
- Metal sensor
- Ultrasonic sensor
- Motor
- Driver
- Buzzer

3.8 SOFTWARE TOOLS:

- Raspbian OS
- Python
- OpenCV

CHAPTER 4

HARDWARE DESCRIPTION

4.1 RASPBERRY PI

4.1 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.

4.2 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.

The overview of the Raspberry Pi Model B is shown in Figure 5-1.



Figure 5-1: Raspberry Pi Model B(Sanders, 2013)

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

4.2.1 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.

4.2.2 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.

4.2.3 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.

4.2.4 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.

4.2.5 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.

4.2.6 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.

4.2.7 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.

4.3 Raspberry Pi 2 Model B

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).



Figure 5-2: Raspberry Pi 2 Model B

4.4 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).

4.4.1 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 mal-function 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.

4.4.2 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.

4.4.3 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.

4.4.4 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.

4.4.5 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.

4.5 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.

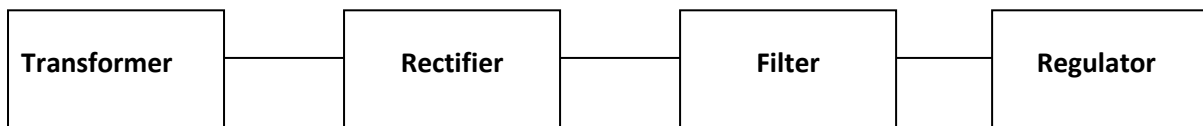
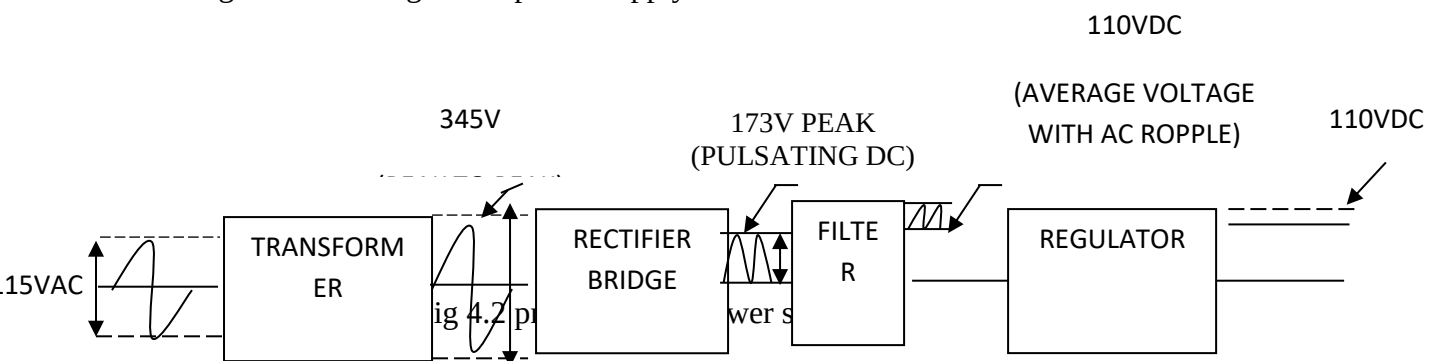


Fig4.1 Block diagram of power supply



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, $115 \text{ volts ac} \times 3 = 345 \text{ volts ac}$ (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).

4.5.1 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

4.6 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.

4.6.1 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.

4.6.2 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.

4.6.3 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



Webcam

4.7 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.

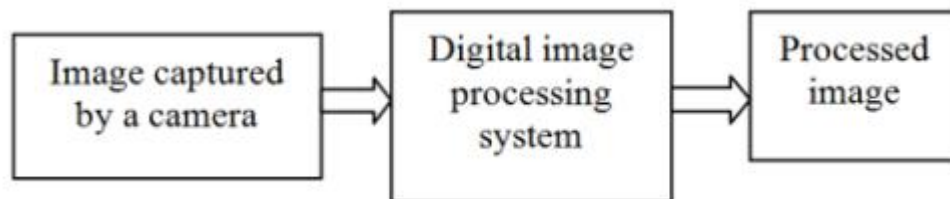
4.8 INTRODUCTION

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.

4.9 BASIC CONCEPT OF IMAGE PROCESSING

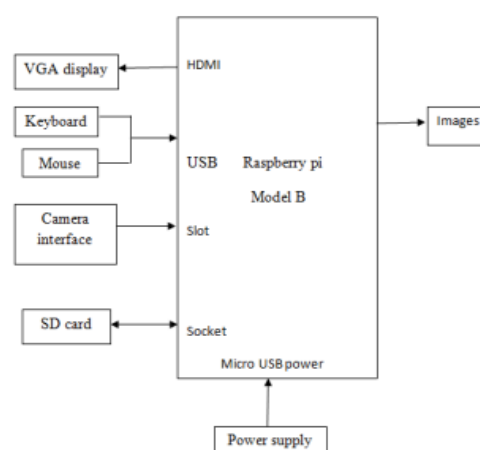
In general, any digital image processing algorithm consists of three stages: input, processor and output. In the input stage image is captured by a camera. It sent to a particular system to focus on a pixel of image that's gives, its output as a processed image.



General Block diagram of image processing

4.10 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.



System Block Diagram

Ultrasonic sensing

Ultrasonic sensing is one of the best ways to sense proximity and detect levels with high reliability.

Our technical support gets emails all of the time about how our sensors work and what environments our sensors work (or don't work) in.

This guide was created as an introduction to ultrasonic sensing, it's principles, and how ultrasonic sensors work in your applications.

At a top level, you need to know what an ultrasonic sensor is...

What is an ultrasonic sensor?

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves.

An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

High-frequency sound waves reflect from boundaries to produce distinct echo patterns.

How Ultrasonic Sensors Work

Ultrasonic sensors work by sending out a sound wave at a frequency above the range of human hearing. The transducer of the sensor acts as a microphone to receive and send the ultrasonic sound. Our ultrasonic sensors, like many others, use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse.

The working principle of this module is simple. It sends an ultrasonic pulse out at 40kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated.

Ultrasonic sensors are a great solution for the detection of clear objects. For liquid level measurement, applications that use infrared sensors, for instance, struggle with this particular use case because of target translucence.

For presence detection, ultrasonic sensors detect objects regardless of the color, surface, or material (unless the material is very soft like wool, as it would absorb sound.)

To detect transparent and other items where optical technologies may fail, ultrasonic sensors are a reliable choice.

Using Multiple Sensors & Avoiding Disruption

When using multiple sensors in an application, it's important to connect them in a way that will allow you to avoid issues like crosstalk or any other interference.

To prevent the disruption of the ultrasonic signals coming from your sensor, it's important to keep the face of the ultrasonic transducer clear of any obstructions.

Common obstructions include:

- Dirt
- Snow
- Ice

Other Condensation

For this particular use case, we offer our Self Cleaning sensors.

They are intended specifically for applications requiring the resistance of condensation in high moisture environments, our self-cleaning function is designed to run continuously in order for the self-cleaning feature to be active.

How are Ultrasonic Sensors used?

Our ultrasonic distance, level, and proximity sensors are commonly used with microcontroller platforms like Raspberry Pi, ARM, PIC, Arduino, Beagle Board, and more.

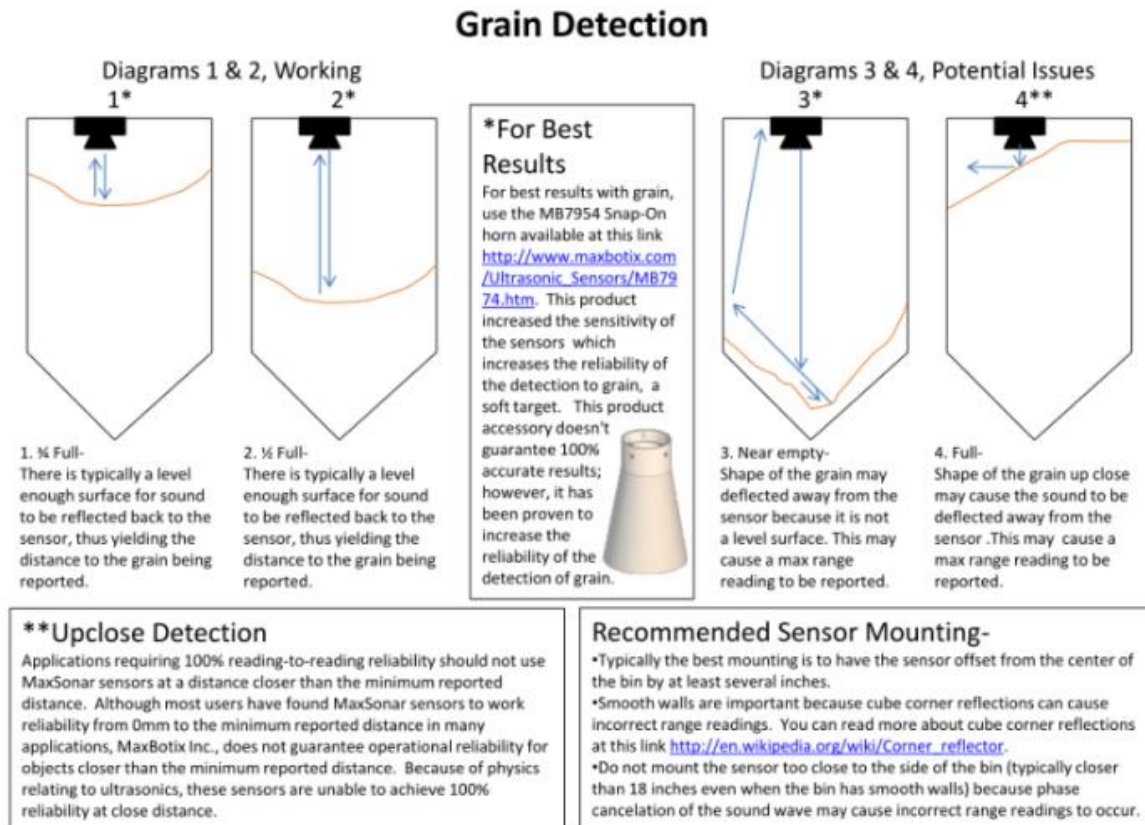
Ultrasonic sensors transmit sound waves toward a target and will determine its distance by measuring the time it took for the reflected waves to return to the receiver.

This sensor is an electronic device that will measure the distance of a target by transmitting ultrasonic sound waves, and then will convert the reflected sound into an electrical signal.

Our sensors are often used as proximity sensors.

Ultrasonic sensors are also used in obstacle avoidance systems, as well as in manufacturing.

Our ShortRange sensors offer the opportunity for closer range detection where you may need a sensor that ranges objects as close to 2cm. These are also built with very low power requirements in mind, as well as environments where noise rejection is necessary.



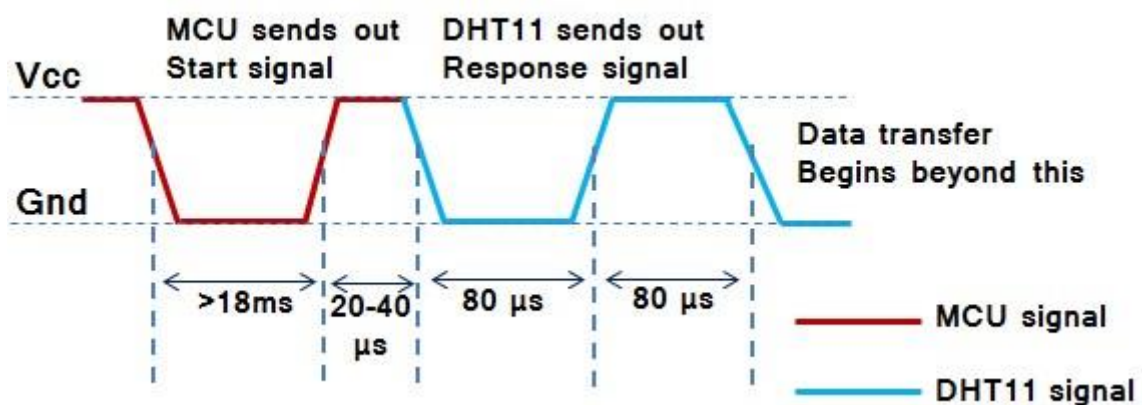
Humidity sensor

Measurement and control of temperature and relative humidity finds applications in numerous areas. These days devices are available which have both temperature and humidity sensors with signal conditioning, ADC, calibration and communication interface all built inside them. The use of such smart sensors greatly simplify the design and reduces the overall cost. We discussed in past about Humidity and temperature measurements with Sensirion's SHT1x/SHT7x sensors. These sensors are capable of measuring both temperature and relative humidity and provide fully calibrated digital outputs. While SHT1x/SHT7x are very accurate sensors, they are still expensive for hobbyists use. This articles discusses the DHT11 sensor which also provides calibrated digital outputs for temperature and humidity but is relatively lot cheaper than the Sensirion sensors. The DHT11 sensor uses a proprietary 1-wire protocol which we will be exploring here and implementing with the PIC16F628A microcontroller that will receive the temperature and humidity values from the sensor and display them on a 16×2 character LCD.

About DHT11 sensor

The DHT11 sensor comes in a single row 4-pin package and operates from 3.5 to 5.5V power supply. It can measure temperature from 0-50 °C with an accuracy of $\pm 2^{\circ}\text{C}$ and relative humidity ranging from 20-95% with an accuracy of $\pm 5\%$. The sensor provides fully calibrated digital outputs for the two measurements. It has got its own proprietary 1-wire protocol, and therefore, the communication between the sensor and a microcontroller is not possible through a direct interface with any of its peripherals. The protocol must be implemented in the firmware of the MCU with precise timing required by the sensor. The following timing diagrams describe the data transfer protocol between a MCU and the DHT11 sensor. The MCU initiates data transmission by issuing a “Start” signal. The MCU pin must be configured as output for this purpose. The MCU first pulls the data line low for at least 18 ms and then pulls it high for next 20-40 μs before it releases it.

Next, the sensor responds to the MCU “Start” signal by pulling the line low for 80 μs followed by a logic high signal that also lasts for 80 μs . Remember that the MCU pin must be configured to input after finishing the “Start” signal. Once detecting the response signal from the sensor, the MCU should be ready to receive data from the sensor. The sensor then sends 40 bits (5 bytes) of data continuously in the data line. Note that while transmitting bytes, the sensor sends the most significant bit first.



"Start" and "Response" signals

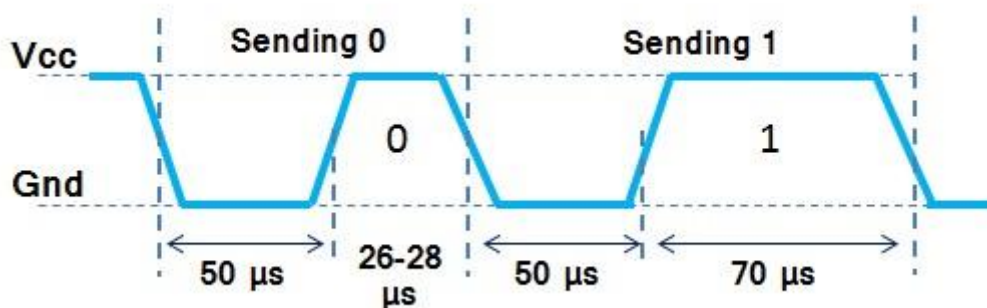
The 40-bit data from the sensor has the following structure.

Data (40-bit) = Integer Byte of RH + Decimal Byte of RH + Integer Byte of Temp. + Decimal Byte of Temp. + Checksum Byte

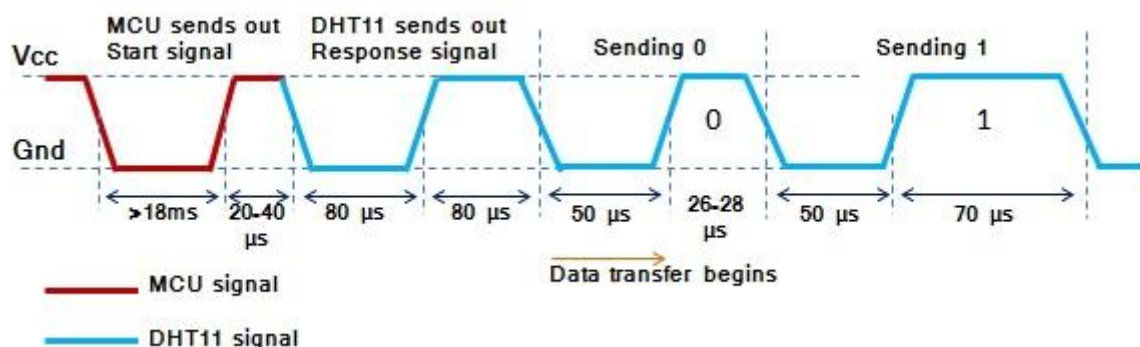
For DHT11 sensor, the decimal bytes of temperature and humidity measurements are always zero. Therefore, the first and third bytes of received data actually give the numeric values of the measured relative humidity (%) and temperature (°C). The last byte is the checksum byte which is used to make sure that the data transfer has happened without any error. If all the five bytes are transferred successfully then the checksum byte must be equal to the last 8 bits of the sum of the first four bytes, i.e.,

Checksum = Last 8 bits of (Integer Byte of RH + Decimal Byte of RH + Integer Byte of Temp. + Decimal Byte of Temp.)

Now let's talk about the most important thing, which is signalling for transmitting "0" and "1". In order to send a bit of data, the sensor first pulls the line low for 50 ?s. Then it raises the line to high for 26-28 ?s if it has to send "0", or for 70 ?s if the bit to be transmitted is "1". So it is the width of the positive pulse that carries information about 1 and 0.



Timing difference for transmitting "1s" and "0s"



Start, Response and Data signals in sequence

At the end of the last transmitted bit, the sensor pulls the data line low for 50 μ s and then releases it. The DHT11 sensor requires an external pull-up resistor to be connected between its Vcc and the data line so that under idle condition, the data line is always pulled high. After finishing the data transmission and releasing the data line, the DHT11 sensor goes to the low-power consumption mode until a new “Start” signal arrives from the MCU.

PIR Sensor

PIR sensors allow you to sense motion. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses.

Now, the big question is that how it will detect the human activities? Do not worry, this tutorial will guide you about the PIR sensor working principle.

What is a PIR Sensor?

A sensor that measures infrared light radiating from objects. PIR sensors are mostly used in PIR-based motion detectors. Also, it is used in security alarms and automatic lighting applications. The below image shows a typical pin configuration of the PIR sensor, which is quite simple to understand the pinouts. The PIR sensor consists of 3 pins

- Pin1 corresponds to the drain terminal of the device, which is connected to the positive supply 5V DC.
- Pin2 corresponds to the source terminal of the device, which connects to the ground terminal via a 100K or 47K resistor. The Pin2 is the output pin of the sensor. The pin 2 of the sensor carries the detected IR signal to an amplifier from the
- Pin3 of the sensor is connected to the ground.

What does a PIR Sensor detect?

Generally, **PIR sensor** can detect animal/human movement in a requirement range. PIR is made of a pyroelectric sensor, which is able to detect different levels of infrared radiation. The detector itself does not emit any energy but passively receives it.

It detects infrared radiation from the environment. Once there is infrared radiation from the human body particle with temperature, focusing on the optical system causes the pyroelectric device to generate a sudden electrical signal.

Simply, when a human body or any animal passes by, then it intercepts the first slot of the PIR sensor. This causes a positive differential change between the two bisects. When a human body leaves the sensing area, the sensor generates a negative differential change between the two bisects.

PIR Sensor Working Principle

The passive infrared sensor does not radiate energy to space. It receives the infrared radiation from the human body to make an alarm. Any object with temperature is constantly radiating infrared rays to the outside world. The surface temperature of the human body is between 36° C - 27 ° C and most of its radiant energy concentrated in the wavelength range of 8 um-12 um.

Passive infrared alarms classified into **infrared detectors** (infrared probes) and alarm control sections. The most widely used infrared detector is a pyroelectric detector. It uses as a sensor for converting human infrared radiation into electricity. If the human infrared radiation is directly irradiated on the detector, it will, of course, cause a temperature change to output a signal. But in doing all this, the detection distance will not be more. In order to lengthen the detection distance of the detector, an optical system must be added to collect the infrared radiation. Usually, plastic optical reflection system or plastic **Fresnel lens** used as a focusing system for infrared radiation.

In the detection area, the lens of the detector receives the infrared radiation energy of the human body through the clothing and focused on the pyroelectric sensor. When the human body moves in this surveillance mode, it enters a certain field of view in sequence and then walks out of the field of view. The **pyroelectric sensor** sees the moving human body for a while and then does not see it, so the infrared radiation of human body constantly changes the temperature of the pyroelectric material. So that it outputs a corresponding signal, which is the alarm signal.

What is the Range of PIR Sensor?

- Indoor passive infrared: Detection distances range from 25 cm to 20 m.
- Indoor curtain type: The detection distance ranges from 25 cm to 20 m.
- Outdoor passive infrared: The detection distance ranges from 10 meters to 150 meters.
- Outdoor passive infrared curtain detector: distance from 10 meters to 150 meters

Metal detector

A **metal detector** is an instrument that detects the presence of metal nearby. Metal detectors are useful for finding metal inclusions hidden within objects, or metal object buried underground. They often consist of a handheld unit with a sensor probe which can be swept over the ground or other objects. If the sensor comes near a piece of metal this is indicated by a changing tone in earphones, or a needle moving on an indicator. Usually the device gives some indication of distance; the closer the metal is, the higher the tone in the earphone or the higher the needle goes. Another common type are stationary "walk through" metal detectors (see § Security screening below) used at access points in prisons, courthouses, and airports to detect concealed metal weapons on a person's body.

The simplest form of a metal detector consists of an oscillator producing an alternating current that passes through a coil producing an alternating magnetic field. If a piece of electrically conductive metal is close to the coil, eddy currents will be induced (inductive sensor) in the metal, and this produces a magnetic field of its own. If another coil is used to measure the magnetic field (acting as a magnetometer), the change in the magnetic field due to the metallic object can be detected.

The first industrial metal detectors were developed in the 1960s and were used extensively for mineral prospecting and other industrial applications. Uses include detecting land mines, the detection of weapons such as knives and guns (especially in airport security), geophysical prospecting, archaeology and treasure hunting. Metal detectors are also used to detect foreign bodies in food, and in the construction industry to detect steel reinforcing bars in concrete and pipes and wires buried in walls and floors. It also used by army to find underground bomb

Modern developments

The modern development of the metal detector began in the 1920s. Gerhard Fischer had developed a system of radio direction-finding, which was to be used for accurate navigation. The system worked extremely well, but Fischer noticed there were anomalies in areas where the terrain contained ore-bearing rocks. He reasoned that if a radio beam could be distorted by metal, then it should be possible to design a machine which would detect metal using a search coil resonating at a radio frequency. In 1925 he applied for, and was granted, the first patent

for a metal detector. Although Gerhard Fischer was the first person granted a patent for a metal detector, the first to apply was Shirl Herr, a businessman from Crawfordsville, Indiana. His application for a hand-held Hidden-Metal Detector was filed in February 1924, but not patented until July 1928. Herr assisted Italian leader Benito Mussolini in recovering items remaining from the Emperor Caligula's galleys at the bottom of Lake Nemi, Italy in August 1929. Herr's invention was used by Admiral Richard Byrd's Second Antarctic Expedition in 1933, when it was used to locate objects left behind by earlier explorers. It was effective up to a depth of eight feet. However, it was one Lieutenant Józef Stanisław Kosacki, a Polish officer attached to a unit stationed in St Andrews, Fife, Scotland, during the early years of World War II, who refined the design into a practical Polish mine detector. These units were still quite heavy, as they ran on vacuum tubes, and needed separate battery packs.

The design invented by Kosacki was used extensively during the Second Battle of El Alamein when 500 units were shipped to Field Marshal Montgomery to clear the minefields of the retreating Germans, and later used during the Allied invasion of Sicily, the Allied invasion of Italy and the Invasion of Normandy.

As the creation and refinement of the device was a wartime military research operation, the knowledge that Kosacki created the first practical metal detector was kept secret for over 50 years.

Beat Frequency Induction

Many manufacturers of these new devices brought their own ideas to the market. White's Electronics of Oregon began in the 1950s by building a machine called the Oremaster Geiger Counter. Another leader in detector technology was Charles Garrett, who pioneered the BFO (Beat Frequency Oscillator) machine. With the invention and development of the transistor in the 1950s and 1960s, metal detector manufacturers and designers made smaller, lighter machines with improved circuitry, running on small battery packs. Companies sprang up all over the United States and Britain to supply the growing demand. Beat Frequency Induction requires movement of the detector coil; akin to how swinging a conductor near a magnet induces an electric current; except the pulse is electric EMF and not magnetic EMF

Refinements

Modern top models are fully computerized, using integrated circuit technology to allow the user to set sensitivity, discrimination, track speed, threshold volume, notch filters, etc., and

hold these parameters in memory for future use. Compared to just a decade ago, detectors are lighter, deeper-seeking, use less battery power, and discriminate better.

State of the art metal detectors have further incorporated extensive wireless technologies for the earphones, connect to Wi-Fi networks and Bluetooth devices. Some also utilize built in GPS locator technology to keep track of searching location and the location of items found. Some connect to smartphone applications to further extend functionality.

Discriminators[edit]

The biggest technical change in detectors was the development of a tunable induction system. This system involved two coils that are electro-magnetically tuned. One coil act as an RF transmitter the other as a receiver; in some cases these can be tuned to between 3 and 100 kHz. When metal is in their vicinity, a signal is detected owing to eddy currents induced in the metal. What allowed detectors to discriminate between metals was the fact that every metal has a different phase response when exposed to alternating current; longer waves (low frequency) penetrate ground deeper, and select for high conductivity targets like silver, and copper; than shorter waves (higher frequency) which, while less ground penetrating, select for low conductivity targets like iron. Unfortunately, high frequency is also sensitive to ground mineralisation interference. This selectivity or discrimination allowed detectors to be developed that could selectively detect desirable metals, while ignoring undesirable ones.

Even with discriminators, it was still a challenge to avoid undesirable metals, because some of them have similar phase responses (e.g. tinfoil and gold), particularly in alloy form. Thus, improperly tuning out certain metals increased the risk of passing over a valuable find. Another disadvantage of discriminators was that they reduced the sensitivity of the machines.

New coil designs

Coil designers also tried out innovative designs. The original induction balance coil system consisted of two identical coils placed on top of one another. Compass Electronics produced a new design: two coils in a D shape, mounted back-to-back to form a circle. This system was widely used in the 1970s, and both concentric and D type (or widescan as they became known) had their fans. Another development was the invention of detectors which could cancel out the effect of mineralization in the ground. This gave greater depth, but was a non-discriminate mode. It worked best at lower frequencies than those used before, and frequencies of 3 to 20 kHz were found to produce the best results. Many detectors in the 1970s

had a switch which enabled the user to switch between the discriminate mode and the non-discriminate mode. Later developments switched electronically between both modes. The development of the induction balance detector would ultimately result in the motion detector, which constantly checked and balanced the background mineralization.

Pulse induction

At the same time, developers were looking at using a different technique in metal detection called pulse induction. Unlike the beat frequency oscillator or the induction balance machines which both used a uniform alternating current at a low frequency, the pulse induction (PI) machine simply magnetized the ground with a relatively powerful, momentary current through a search coil. In the absence of metal, the field decayed at a uniform rate, and the time it took to fall to zero volts could be accurately measured. However, if metal was present when the machine fired, a small eddy current would be induced in the metal, and the time for sensed current decay would be increased. These time differences were minute, but the improvement in electronics made it possible to measure them accurately and identify the presence of metal at a reasonable distance. These new machines had one major advantage: they were mostly impervious to the effects of mineralization, and rings and other jewelry could now be located even under highly mineralized black sand. The addition of computer control and digital signal processing have further improved pulse induction sensors.

One particular advantage of using a pulse induction detector includes the ability to ignore the minerals contained within heavily mineralized soil; in some cases the heavy mineral content may even help the PI detector function better. Where a VLF detector is affected negatively by soil mineralization, a PI unit is not.

Security screening

In 1926, two Leipzig, Germany scientists installed a walk-through enclosure at a factory, to ensure that employees were not exiting with prohibited metallic items.

A series of aircraft hijackings led the United States in 1972 to adopt metal detector technology to screen airline passengers, initially using magnetometers that were originally designed for logging operations to detect spikes in trees.^[21] The Finnish company Outokumpu adapted mining metal detectors in the 1970s, still housed in a large cylindrical pipe, to make a commercial walk-through security detector. The development of these systems continued in a spin-off company and systems branded as Metor Metal

Detectors evolved in the form of the rectangular gantry now standard in airports. In common with the developments in other uses of metal detectors both alternating current and pulse systems are used, and the design of the coils and the electronics has moved forward to improve the discrimination of these systems. In 1995 systems such as the Metor 200 appeared with the ability to indicate the approximate height of the metal object above the ground, enabling security personnel to more rapidly locate the source of the signal. Smaller hand held metal detectors are also used to locate a metal object on a person more precisely.

Industrial metal detectors

Industrial metal detectors are used in the pharmaceutical, food, beverage, textile, garment, plastics, chemicals, lumber, mining, and packaging industries.

Contamination of food by metal shards from broken processing machinery during the manufacturing process is a major safety issue in the food industry. Metal detectors for this purpose are widely used and integrated into the production line.

Current practice at garment or apparel industry plants is to apply metal detecting after the garments are completely sewn and before garments are packed to check whether there is any metal contamination (needle, broken needle, etc.) in the garments. This needs to be done for safety reasons.

The industrial metal detector was developed by Bruce Kerr and David Hiscock in 1947. The founding company Goring Kerr^[23] pioneered the use and development of the first industrial metal detector. Mars Incorporated was one of the first customers of Goring Kerr using their Metlokate metal detector to inspect Mars bars.

The basic principle of operation for the common industrial metal detector is based on a 3 coil design. This design utilizes an AM (amplitude modulated) transmitting coil and two receiving coils one on either side of the transmitter. The design and physical configuration of the receiving coils are instrumental in the ability to detect very small metal contaminants of 1 mm or smaller. Today modern metal detectors continue to utilize this configuration for the detection of tramp metal.

The coil configuration is such that it creates an opening whereby the product (food, plastics, pharmaceuticals, etc.) passes through the coils. This opening or aperture allows the product to enter and exit through the three coil system producing an equal but mirrored signal on the two receiving coils. The resulting signals are summed together effectively nullifying

each other. Fortress Technology innovated a new feature, that allows the coil structure of their BSH Model to ignore the effects of vibration, even when inspecting conductive products.

When a metal contaminant is introduced into the product an unequal disturbance is created. This then creates a very small electronic signal. After suitable amplification a mechanical device mounted to the conveyor system is signaled to remove the contaminated product from the production line. This process is completely automated and allows manufacturing to operate uninterrupted.

Civil engineering

In civil engineering, special metal detectors (cover meters) are used to locate reinforcement bars inside walls. American metal finders are a term that refer to the devices and equipment or instruments made by American companies or manufacturers, that can be used to find or detect metal objects nearby or buried underground such as silver or golden coins or small jewelry like rings, collars and so on. Metal finders' more accurate term is: Metal Detectors, as the metal detector's main function is to detect the presence of metal objects including for example underground buried metal targets such as gold treasures, bronze statues, archaeological artifacts made of different metal types.

The most common type of metal detector is a hand-held metal detector or coil-based detectors that use a oval-shaped plastic disks with built-in coils made of copper usually, the search coil works as sensor probe and must be swept or moved over the ground to detect the potential metal targets buried underground, when the search coil detect a metal object the device give a feedback as an acoustic feedback as changed audio tone via speaker or earphone, and in most metal detectors the feedback is an analog or digital indicator as a unique number called Target ID based on target metal type.

These metal detectors first invented and manufactured commercially in United States of America in twentieth century by Fisher Labs in 1930s then other companies like Garrett established and developed the metal detectors in terms of technology and features in following decades to reach the current form of metal detector that is common in use by hobbyists and treasure hunters or gold prospectors.

Skilled prospectors have put their confidence in American metal detectors due to the high quality of their industry and low cost of production, they are known all over the world.

Military

The first metal detector, designed by Alexander Graham Bell, proved to be a practical metal detector, and it served as the prototype for all subsequent metal detectors.

Initially, these machines were huge and complex, and they used vacuum tubes to operate.

Nonetheless, it proved to be useful, and it grew in popularity among users and prospectors for specific applications.

One of the early common uses of the first metal detectors, for example, was the detection of landmines and unexploded bombs in a number of European countries following the First and Second World Wars.

Uses and benefits

Metal detectors can be used if for several military uses, which can be summarized as follows:

- Exposing the mines planted in the fields during the war or after the end of the war
- Detect dangerous explosives and cluster bombs dangerous to people's lives
- Hand-held metal detectors can be used to search people for weapons and explosives

War mine detection

Demining, also known as mine removal, is the method of clearing a field of landmines.

The aim of military operations is to clear a path through a minefield as quickly as possible, which is mostly accomplished using equipment like mine plows and blast waves.

Humanitarian demining, on the other hand, aims to clear all landmines to a certain depth and make the land secure for human use.

The process of finding or detection of mines done by a special designed metal detector exclusively developed to detect mines and bombs.

Landmine detection techniques have been studied in a wide range of ways.

Electromagnetic technologies are most popular, and one of them (ground penetrating radar) has been used in conjunction with metal detectors.

Mine casings produce a cavity that can be detected using acoustic methods or sensors to detect vapor leakage from landmines. Rats and mongooses, for example, can walk safely over a minefield and detect explosives, and animals can even be used to screen air samples over

possible minefields. Bees, plants, and bacteria may all be useful. Nuclear quadrupole resonance and neutron probes can also be used to detect explosives in landmines.

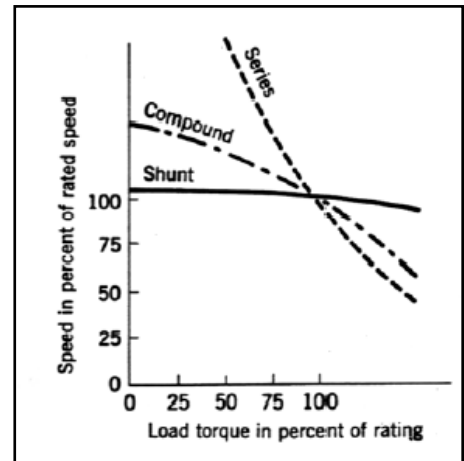
Specially trained dogs are often used to focus the search and confirm that an area has been cleared, mines are often cleared using mechanical equipment such as flails and excavators.

DC MOTORS

A. General Information

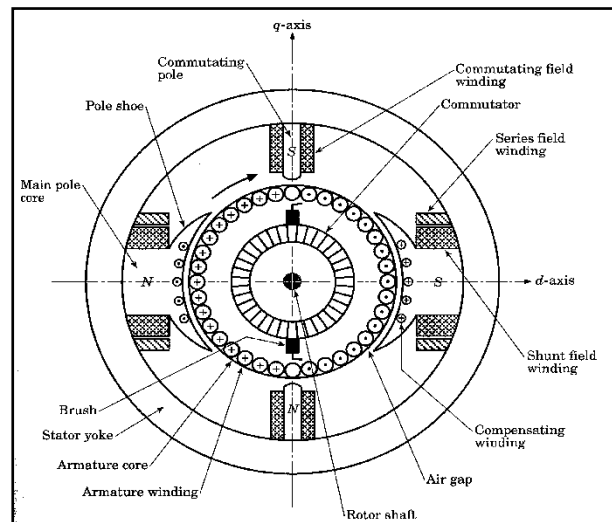
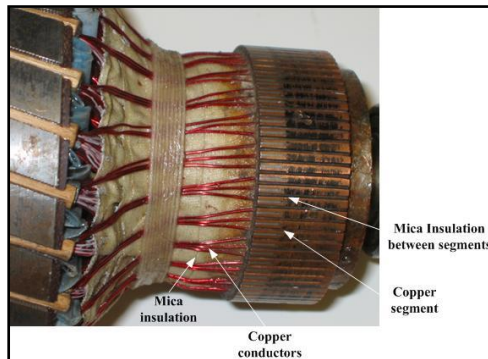
A DC motor is used to drive a mechanical load. In this lab, a separately excited DC generator provides the load. The load on the motor is adjusted by varying the generator field current. By increasing the field current of the DC generator, the load on the DC motor increases and thus the armature current increases. In general, DC motors are characterized by their torque-speed curves as shown in Figure 9.1. Since the measuring equipment for shaft torque is not available in the

lab it is necessary to use alternative means of characterizing the DC motor. One alternative is to plot shaft speed versus armature current since torque is directly proportional to the armature current ($T = K_a \phi_d I_a$) with a constant field current supplied to the motor. Shaft speed is also a function of the field current in a DC motor while maintaining a constant armature voltage ($E_a = K_a \phi_d \omega$) as field current is directly proportional to the direct axis flux produced in the machine.



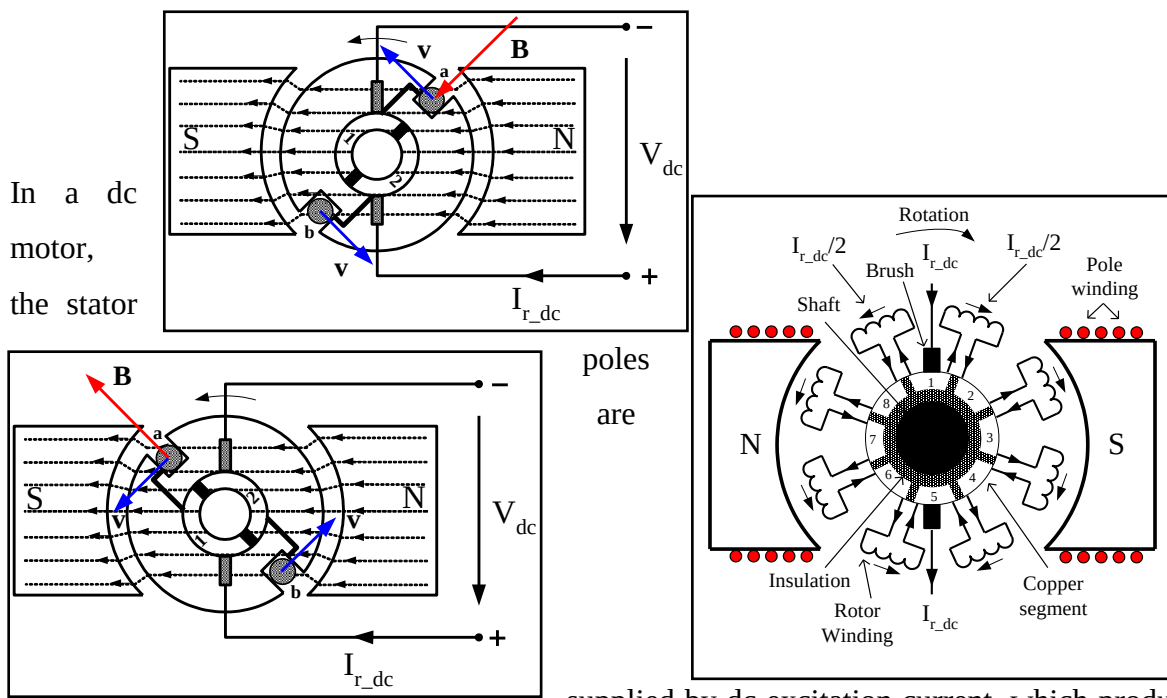
B. Construction

The stator of the dc motor has poles, which are excited by dc current to produce magnetic



fields. In the neutral zone, in the middle between the poles, commutating poles are placed to reduce sparking of the commutator. The commutating poles are supplied by dc current. Compensating windings are mounted on the main poles. These short-circuited windings damp rotor oscillations. The poles are mounted on an iron core that provides a closed magnetic circuit. The motor housing supports the iron core, the brushes and the bearings. The rotor has a ring-shaped laminated iron core with slots. Coils with several turns are placed in the slots. The distance between the two legs of the coil is about 180 electric degrees. The coils are connected in series through the commutator segments. The ends of each coil are connected to a commutator segment. The commutator consists of insulated copper segments mounted on an insulated tube. Two brushes are pressed to the commutator to permit current flow. The brushes are placed in the neutral zone, where the magnetic field is close to zero, to reduce arcing. The rotor has a ring-shaped laminated iron core with slots. The commutator consists of insulated copper segments mounted on an insulated tube. Two brushes are pressed to the commutator to permit current flow. The brushes are placed in the neutral zone, where the magnetic field is close to zero, to reduce arcing. The commutator switches the current from one rotor coil to the adjacent coil, the switching requires the interruption of the coil current. The sudden interruption of an inductive current generates high voltages. The high voltage produces flashover and arcing between the commutator segment and the brush.

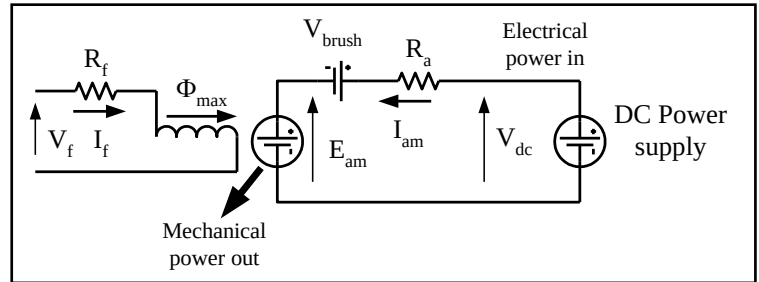
C. DC Motor Operation



supplied by dc excitation current, which produces a dc magnetic field. The rotor is supplied by dc current through the brushes, commutator and coils. The interaction of the magnetic field and rotor current generates a force that drives the motor. The magnetic field lines enter into the rotor from the north pole (N) and exit toward the south pole (S). The poles generate a magnetic field that is perpendicular to the current carrying conductors. The interaction between the field and the current produces a Lorentz force; the force is perpendicular to both the magnetic field and conductor. The generated force turns the rotor until the coil reaches the neutral point between the poles. At this point, the magnetic field becomes practically zero together with the force. However, inertia drives the motor beyond the neutral zone where the direction of the magnetic field reverses. To avoid the reversal of the force direction, the commutator changes the current direction, which maintains the counterclockwise rotation. Before reaching the neutral zone, the current enters in segment 1 and exits from segment 2. Therefore, current enters the coil end at slot a and exits from slot b during this stage. After passing the neutral zone, the current enters segment 2 and exits from segment 1, this reverses the current direction through the rotor coil, when the coil passes the neutral zone. The result of this current reversal is the maintenance of the rotation.

D. DC Motor Equivalent circuit

The following figures show the equivalent circuit of a separately excited dc motor. Equivalent circuit is similar to the generator only the current directions are different. The operation equations are:



Armature voltage equation

$$V_{dc} = E_{am} + I_{am} R_a + V_{brush}$$

The induced voltage and motor speed vs angular frequency

$$E_{am} = K_m I_f \omega \quad \omega = 2\pi n_m$$

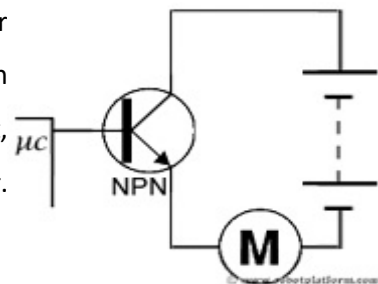
The combination of the equations results in

$$K_m I_f \omega = E_{am} = V_{dc} - I_{am} R_m$$

The current is calculated from this equation. The output power and torque are:

$$P_{out} = E_{am} I_{am} \quad T = \frac{P_{out}}{\omega} = K_m I_{am} I_f$$

Generally, even the simplest robot requires a motor to rotate a wheel or performs particular action. Since motors require more current than the microcontroller pin can typically generate, you need some type of a switch (Transistors, MOSFET, Relay etc.,) which can accept a small current, amplify it and generate a larger current, which further drives a motor. This entire process is done by what is known as a **motor driver**.



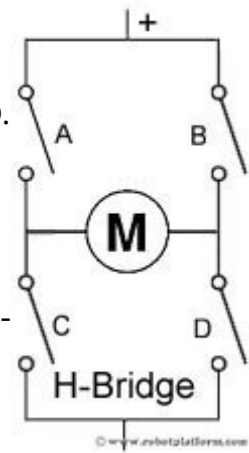
Motor driver is basically a current amplifier which takes a low-current signal from the microcontroller and gives out a proportionally higher current signal which can control and drive

a motor. In most cases, a transistor can act as a switch and perform this task which drives the motor in a single direction.

Turning a motor ON and OFF requires only one switch to control a single motor in a single direction. What if you want your motor to reverse its direction? The simple answer is to reverse its polarity. This can be achieved by using four switches that are arranged in an intelligent manner such that the circuit not only drives the motor, but also controls its direction. Out of many, one of the most common and clever design is a H-bridge circuit where transistors are arranged in a shape that resembles the English alphabet "H".

As you can see in the image, the circuit has four switches A, B, C and D. Turning these switches ON and OFF can drive a motor in different ways.

1. Turning on Switches **A** and **D** makes the motor rotate clockwise
2. Turning on Switches **B** and **C** makes the motor rotate anti-clockwise
3. Turning on Switches **A** and **B** will stop the motor (Brakes)
4. Turning off all the switches gives the motor a free wheel drive
5. Lastly turning on **A & C** at the same time or **B & D** at the same time shorts your entire circuit. So, do not attempt this.

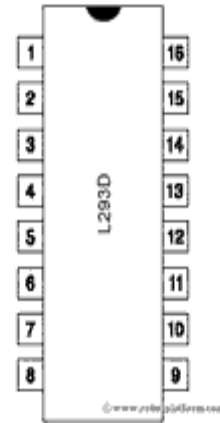


H-bridges can be built from scratch using relays, mosfets, field effect transistors (FET), bipolar junction transistors (BJT), etc. But if your current requirement is not too high and all you need is a single package which does the job of driving a small DC motor in two directions, then all you need is a L293D IC. This single inexpensive package can interface not one, but two DC motors. L293, L293B and few other versions also does the same job, but pick the L293D

version as this one has an inbuilt fly back diode which protects the driving transistors from voltage spikes that occur when the motor coil is turned off.

Introduction to L293D IC

L293D IC generally comes as a standard 16-pin DIP (dual-in line package). This motor driver IC can simultaneously control two small motors in either direction; forward and reverse with just 4 microcontroller pins (if you do not use enable pins). Some of the features (and drawbacks) of this IC are:

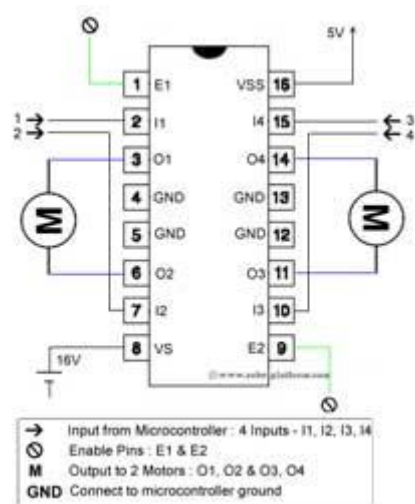


1. Output current capability is limited to 600mA per channel with peak output current limited to 1.2A (non-repetitive). This means you cannot drive bigger motors with this IC. However, most small motors used in hobby robotics should work. If you are unsure whether the IC can handle a particular motor, connect the IC to its circuit and run the motor with your finger on the IC. If it gets really hot, then beware... Also note the words "non-repetitive"; if the current output repeatedly reaches 1.2A, it might destroy the drive transistors.
2. Supply voltage can be as large as 36 Volts. This means you do not have to worry much about voltage regulation.
3. L293D has an enable facility which helps you enable the IC output pins. If an enable pin is set to logic high, then state of the inputs match the state of the outputs. If you pull this low, then the outputs will be turned off regardless of the input states
4. The datasheet also mentions an "over temperature protection" built into the IC. This means an internal sensor senses its internal temperature and stops driving the motors if the temperature crosses a set point
5. Another major feature of **L293D** is its internal clamp diodes. This flyback diode helps protect the driver IC from voltage spikes that occur when the motor coil is turned on and off (mostly when turned off)
6. The logical low in the IC is set to 1.5V. This means the pin is set high only if the voltage across the pin crosses 1.5V which makes it suitable for use in high frequency applications like switching applications (upto 5KHz)
7. Lastly, this integrated circuit not only drives DC motors, but can also be used to drive relay solenoids, stepper motors etc.

L293D Connections

The circuit shown to the right is the most basic implementation of L293D IC. There are 16 pins sticking out of this IC and we have to understand the functionality of each pin before implementing this in a circuit

1. Pin1 and Pin9 are "Enable" pins. They should be connected to +5V for the drivers to function. If they pulled low (GND), then the outputs will be turned off regardless of the input states, stopping the motors. If you have two spare pins in your microcontroller, connect these pins to the microcontroller, or just connect them to regulated positive 5 Volts.
2. Pin4, Pin5, Pin12 and Pin13 are ground pins which should ideally be connected to microcontroller's ground.
3. Pin2, Pin7, Pin10 and Pin15 are logic input pins. These are control pins which should be connected to microcontroller pins. Pin2 and Pin7 control the first motor (left); Pin10 and Pin15 control the second motor(right).
4. Pin3, Pin6, Pin11, and Pin14 are output pins. Tie Pin3 and Pin6 to the first motor, Pin11 and Pin14 to second motor
5. Pin16 powers the IC and it should be connected to **regulated** +5Volts
6. Pin8 powers the two motors and should be connected to positive lead of a secondary battery. As per the datasheet, supply voltage can be as high as 36 Volts.



Truth table

I have shown you where to connect the motors, battery and the microcontroller. But how do we control the direction of these motors? Let us take an example:

Suppose you need to control the left motor which is connected to Pin3 (O1) and Pin6 (O2). As mentioned above, we require three pins to control this motor - Pin1 (E1), Pin2 (I1) and Pin7 (I2). Here is the truth table representing the functionality of this motor driver.

Pin 1	Pin 2	Pin 7	Function
High	High	Low	Turn Anti-clockwise (Reverse)
High	Low	High	Turn clockwise (Forward)
High	High	High	Stop
High	Low	Low	Stop
Low	X	X	Stop

High ~+5V, Low ~0V, X=Either high or low (don't care)

In the above truth table you can observe that if Pin1 (E1) is low then the motor stops, irrespective of the states on Pin2 and Pin7. Hence it is essential to hold E1 high for the driver to function, or simply connect enable pins to positive 5 volts.

With Pin1 high, if Pin2 is set high and Pin7 is pulled low, then current flows from Pin2 to Pin7 driving the motor in anti-clockwise direction? If the states of Pin2 and Pin7 are flipped, then current flows from Pin7 to Pin2 driving the motor in clockwise direction.

The above concept holds true for other side of the IC too. Connect your motor to Pin11 and Pin14; Pin10 and Pin15 are input pins, and Pin9 (E2) enables the driver.

Micro dc 3-6v micro submersible pump mini water pump for fountain garden mini water circulation system diy project dc 3v to 6v submersible pump micro mini submersible water pump 3v to 6vdc water pump for diy dc pump for hobby kit mini submersible pump motor this is a low cost, small size submersible pump motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220ma. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. The dry run may damage the motor due to heating and it will also produce noise.

FEATURES

- Voltage: 2.5-6V
- Maximum lift: 40-110cm / 15.75"-43.4"
- Flow rate: 80-120L/H
- Outside diameter: 7.5mm / 0.3"
- Inside diameter: 5mm / 0.2"
- Diameter: Approx. 24mm / 0.95"
- Length: Approx. 45mm / 1.8"
- Height: Approx. 30mm / 1.2"
- Material: Engineering plastic
- Driving mode: DC design, magnetic driving

APPLICATIONS

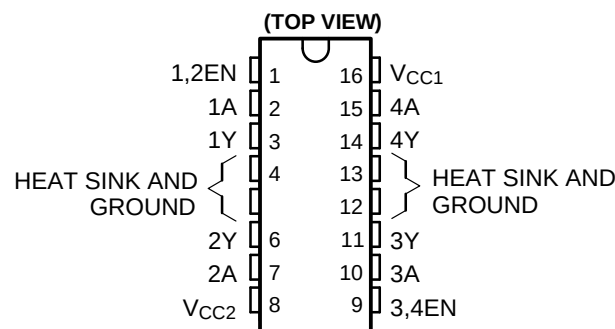
- Controlled fountain water flow
- Controlled Garden watering systems
- Hydroponic Systems
- Fresh water intake or exhaust systems for fish aquarium

L293D MOTOR DRIVER

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar

stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

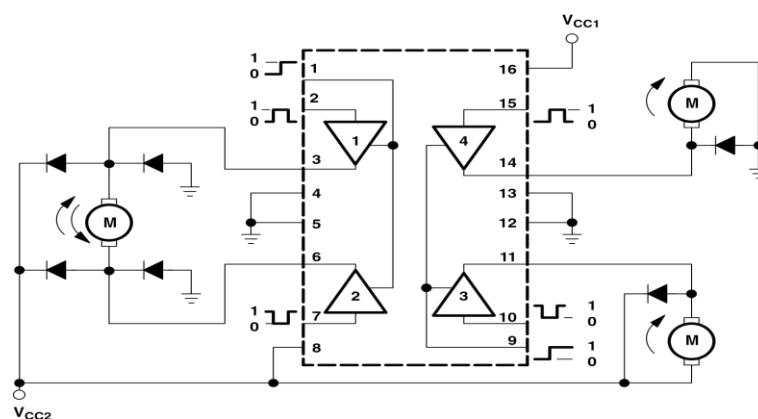
Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled, and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.



On the L293, external high-speed output clamp diodes should be used for inductive transient suppression. A V_{CC1} terminal, separate from V_{CC2} , is provided for the logic inputs to minimize device power dissipation.

The L293 and L293D are characterized for operation from 0°C to 70°C.

BLOCK DIAGRAM



Output diodes are internal in L293D.

FUNCTION TABLE

(each driver)

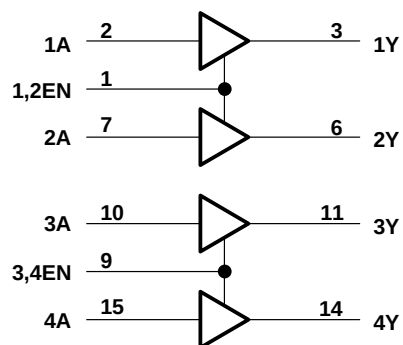
INPUTS [†]		OUTPUT
A	EN	Y
H	H	H
L	H	L
X	L	Z

H = high level, L = low level, X = irrelevant,

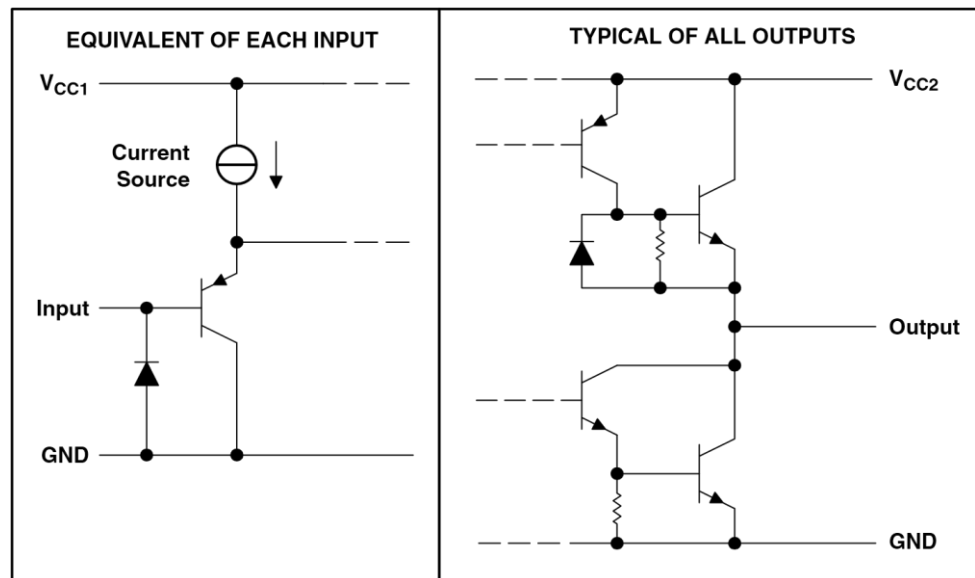
Z = high impedance (off)

[†] In the thermal shutdown mode, the output is in the high-impedance state, regardless of the input levels.

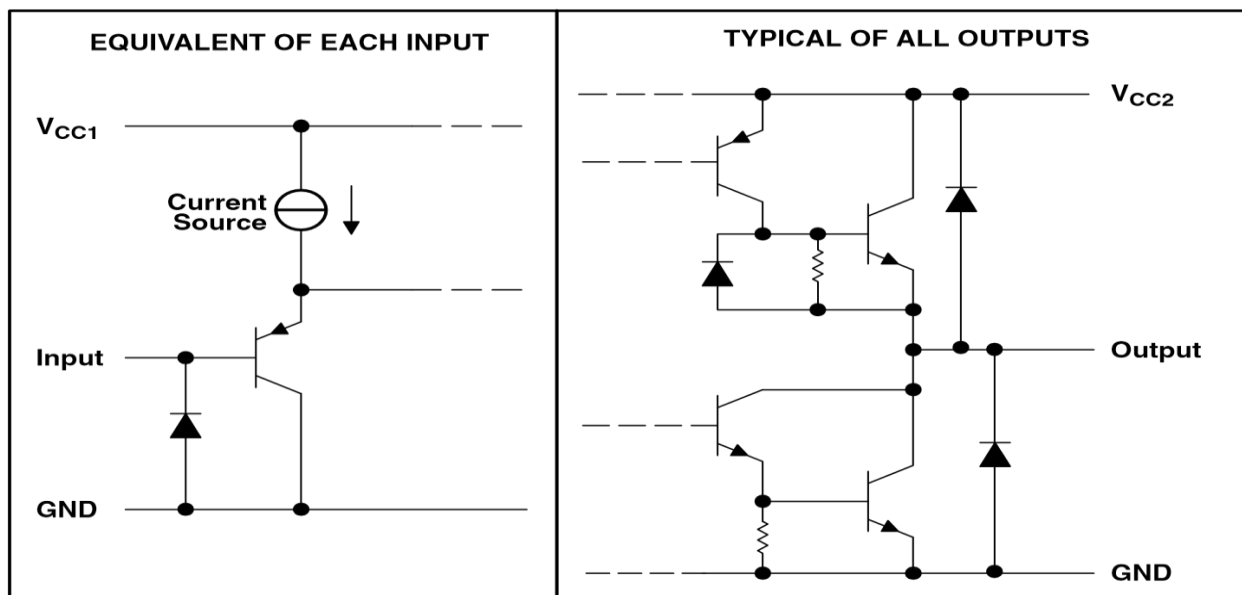
LOGIC DIAGRAM



SCHEMATICS OF INPUTS AND OUTPUTS (L293)



SCHEMATICS OF INPUTS AND OUTPUTS (L293D)



CHAPTER 5

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; Figure 12-1, Figure 12-2 and Figure 12-3.

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".

1 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 12-4.

Finally, click on “open” button and as a result; window will be displayed as shown in Figure 12-6.

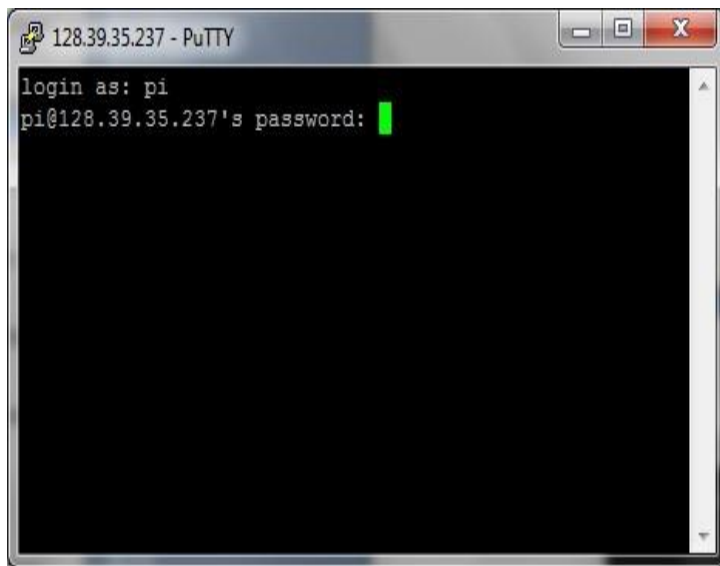


Figure 12-6: PuTTY login windows

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 12-7.

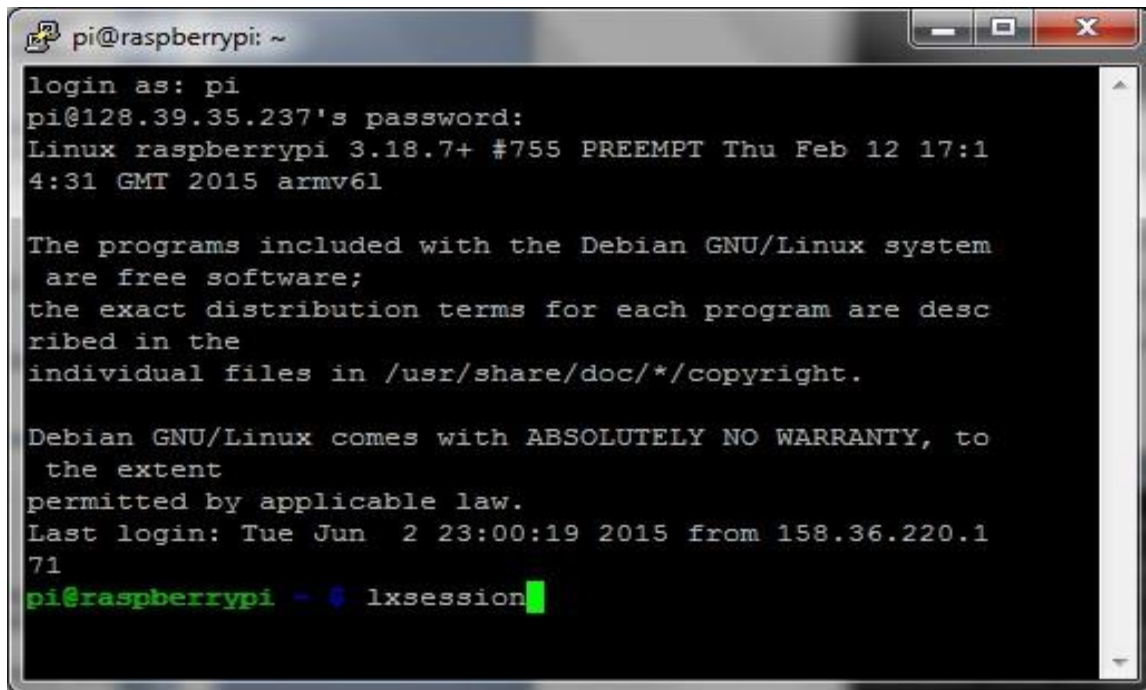


Figure 12-7: PuTTY success windows

Then, you will be able to see the desktop of Raspberry Pi in the laptop as shown in Figure 12-8 and mouse and keyboard can be used for the Raspberry Pi.

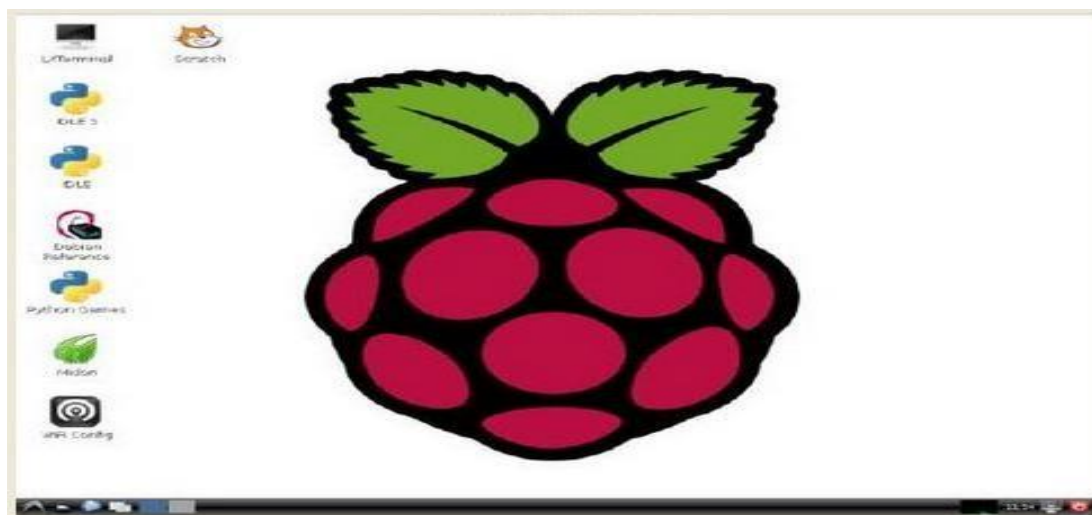


Figure 12-8: Raspberry Pi Desktop on your Laptop Display

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, interrupt, 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)`

OpenCV — Storing Images

CHAPTER 6

6.1 CONCLUSION

In this paper, the framework for making a robot for surveillance purpose is proposed. It overcomes the problem of limited range surveillance by using the concept of IOT. We can control the robot with the help of laptop/mobile manually. Automatic monitoring can also be done. Our proposed robot is small in size thus maneuvering into area where human access is impossible. Wireless technology is one of the most integral technologies in the electronics field. This technology is used to serve our project as a supreme part of surveillance act. This provides highly efficient and a cost effective robot that replaces human work and reduces human labor and performing monitoring works in a well effective manner.

6.2 RESULTS AND DISCUSSION

The robotics is a progressive sector in the current era of electronics. In the future, most of the jobs done by the humans may be replaced by the robots. Here in this project the robot is able to solve certain problems which human cannot solve. Since the Indian government is also spending more amounts for robots which can help in military applications, the proposed robot is having high importance. In the future the robot can be used for bigger purposes. It is concluded that surveillance system using Raspberry pi capable of capturing video/image and transmitting through emails. Also this paper contains detailed information for controlling a robotic vehicle guided via internet. All this techniques can be used in any conditions and areas where safety is important and mandatory for secure place to live. It can monitor the areas and secures a place from the adversaries which can be done by surveillance robot all the times with great accuracy and high precision.

6.3 FUTURE SCOPE

The present work can be extended by adding unusual event detection in order to recognize the activities of unknown or known person. As algorithms used in image processing are illumination affected, advanced algorithm can be deployed to insulate the robot from light effects.

6.4 REFERENCE PAPERS:

[1] T. Hellström, “On the moral responsibility of military robots,” *Ethics and Information Technology*, vol. 15, no. 2, pp. 99–107, 2013.

[2] K. Brannen, “Army kills off MULE unmanned vehicle,” *Military Times*, 2011.

[3] May 2014, <http://robotics.org>. [4] M. Deng, A. Inoue, Y. Shibata, K. Sekiguchi, and N. Ueki, “An obstacle avoidance method for two wheeled mobile robot,” in *Proceedings of the IEEE International Conference on Networking, Sensing and Control (ICNSC '07)*, pp. 689–692, London, UK, April 2007.

[4] S. Yue, F. C. Rind, M. S. Keil, J. Cuadri, and R. Stafford, “A bio-inspired visual collision detection mechanism for cars: optimization of a model of a locust neuron to a novel environment,” *Neurocomputing*, vol. 69, no. 13–15, pp. 1591–1598, 2006.

APPENDIX:

