A MAJOR PROJECT

ON

OPEN CV BASED OBJECT TRACKING ROBOT USING IMAGE PROCESSING WITH RASPBERRY PI

Submitted in the partial fulfilment of the academic requirements

For the award of the Degree of

BACHELOR OF TECHNOLOGY

In

ELECTRONICS AND COMMUNICATION ENGINEERING

By

M SHIVA KUMAR	(17B61A0485)
M AJAY KUMAR	(17B61A0490)
M NIKHITHA	(17B61A0495)
M SAI KUMAR	(17B61A04A0)

Under the guidance of

Mrs. SREEVALLI

Assistant professor, ECE Department

Department of Electronics and Communication Engineering
NALLA MALLA REDDY ENGINEERING COLLEGE
Autonomous Institution

(Accredited by NAAC with 'A' Grade, NBA Accredited,
Affiliated to Jawaharlal Nehru Technological University, Hyderabad)
Divya Nagar, Kachavani Singaram Post, Ghatkesar (M), Medchal (Dist.)-500088.

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CERTIFICATE

This is to certify that the Major project report titled "OPEN CV BASED OBJECT TRACKING ROBOT USING IMAGE PROCESSING WITH RASPBERRY PI" is being submitted by the following students in partial fulfillment of the academic requirements for the degree of Bachelor of Technology in **Electronics and Communication Engineering, Nalla Malla Reddy Engineering College, JNTU, Hyderabad** during the academic year 2020-2021.

M SHIVA KUMAR	**(17B61A0485)**
M AJAY KUMAR	**(17B61A0490)**
M NIKHITHA	**(17B61A0495)**
M SAI KUMAR	**(17B61A04A0)**

Mrs. T.SREEVALLI
(Internal Guide)

Mrs. T. Rajani

(Head of the Department)

Dr. M.N.V.Ramesh
(Principal)

DECLARATION

We hereby declare that the Major project report entitled "OPEN CV BASED OBJECT TRACKING ROBOT USING IMAGE PROCESSING WITH RASPBERRY PI" is the bonafide work done and submitted by us under the guidance of Mrs.T.Sreevalli, Assistant Professor, Department of ECE, in partial fulfillment of requirements for the award of the degree of Bachelor of Technology in Electronics and Communication Engineering.

Further we declare that this report has not been submitted by anyone to any other institute or university for award of any other degree or diplo

M SHIVA KUMAR	(17B61A0485)
M AJAY KUMAR	(17B61A0490)
M NIKHITHA	(17B61A0495)
M SAI KUMAR	(17B61A04A0)

Date:

Place:

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M SHIVA KUMAR	(17B61A0485)
M AJAY KUMAR	(17B61A0490)
M NIKHITHA	(17B61A0495)
M SAI KUMAR	(17B61A04A0)

ABSTRACT

Autonomous vision based robots are intelligent robots which take visual data, process it and provide appropriate output. These robots are totally independent and don’t need any kind of human intervention since they are preferred with instructions. A robot is designed on Raspberry Pi using OpenCV, which is used for object detection based on its colour, size and shape. Here only a single object is being detected at a time. The tracking of the object is based on division of the image into virtual grids. The movement of the robot is based on the position of the object in the grid. An arm is incorporated to pick the object once it is stationary. After picking the object, it would be dropped into its respective coloured container which has a predefined position

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CHAPTER 1

OBJECT TRACKING ROBOT ON RASPBERRY PI USING OPENCV

1 INTRODUCTION

According to the Oxford English Dictionary, the word robotics was first used in print by Isaac Asimov, in his science fiction short story "Liar!". Asimov was unaware that he was coining the term and he assumed robotics already referred to the science and technology of robots. Stories of artificial helpers, companions and attempts to create them have a long history, but fully autonomous machines only appeared in the 20th century. Artificial Intelligence (AI) powers the evolution of robotics in the modern era. The core of robotics is AI and computer science is a building block of AI. Highly intelligent robots and robots with AI are fruits of continuous research and years of development. The present project was time and resources bound to build a robot with high level AI; hence, a simple, yet an intelligent robot which could act on real time information was built. Image Processing has been the talk of e-world for some years. Its varied applications have found its uses in almost every field. In Electrical Engineering and Computer Science, image processing is any form of signal processing for which the input is an image, such as photographs or frames of video; the output of image processing can be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Robotic Vision deals with image processing and Computer Vision. The whole idea behind robotic vision is: viewing an object from the robot’s perspective, deciding on object of interest and to act accordingly. It is about giving artificial sight to robots. The implemented robot can be used in various chemical industries, military application, coin separation, pencil industry.

CHAPTER 2

2. Introduction of Embedded System

Each day, our lives become more dependent on 'embedded systems', digital information technology that is embedded in our environment. More than 98% of processors applied today are in embedded systems, and are no longer visible to the customer as 'computers' in the ordinary sense. An Embedded System is a special-purpose system in which the computer is completely encapsulated by or dedicated to the device or system it controls. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few pre-defined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded systems are often mass-produced, benefiting from economies of scale. The increasing use of PC hardware is one of the most important developments in high-end embedded systems in recent years. Hardware costs of high-end systems have dropped dramatically as a result of this trend, making feasible some projects which previously would not have been done because of the high cost of non-PC-based embedded hardware. But software choices for the embedded PC platform are not nearly as attractive as the hardware.

Typically, an embedded system is housed on a single microprocessor board with the programs stored in ROM. Virtually all appliances that have a digital interface -- watches, microwaves, VCRs, cars -- utilize embedded systems. Some embedded systems include an operating system, but many are so specialized that the entire logic can be implemented as a single program.

Physically, Embedded Systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants.

In terms of complexity embedded systems can range from very simple with a single microcontroller chip, to very complex with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

2.1 Definition of an Embedded System : Embedded system is defined as, for a particular/specific application implementing the software code to interact directly with that particular hardware what we built. Software is used for providing features and flexibility, Hardware = {Processors, ASICs, Memory...} is used for Performance (& sometimes security)

There are many definitions of embedded system but all of these can be combined into a single concept. An embedded system is a special purpose computer system that is used for particular task.

2.2 Features of Embedded Systems

The versatility of the embedded computer system lends itself to utility in all kinds of enterprises, from the simplification of deliverable products to a reduction in costs in their development and manufacture. Complex systems with rich functionality employ special operating systems that take into account major characteristics of embedded systems. Embedded operating systems have minimized footprint and may follow real-time operating system specifics.

The special computers system is usually less powerful than general-purpose systems, although some expectations do exist where embedded systems are very powerful and complicated. Usually, a low power consumption CPU with a limited amount of memory is used in embedded systems. Many embedded systems use very small operating systems; most of these provide very limited operating system capabilities.

Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Some embedded systems have to operate in extreme environment conditions such as very high temperature & humidity. For high volume systems such as portable music players or mobile phones, minimizing cost is usually the primary design consideration. Engineers typically select hardware that is just “good enough” to implement the necessary functions.

For low volume or prototype embedded systems, general purpose computers may be adapted by limiting the programs or by replacing the operating system with a real-time operating system.

2.3 Characteristics of Embedded Systems

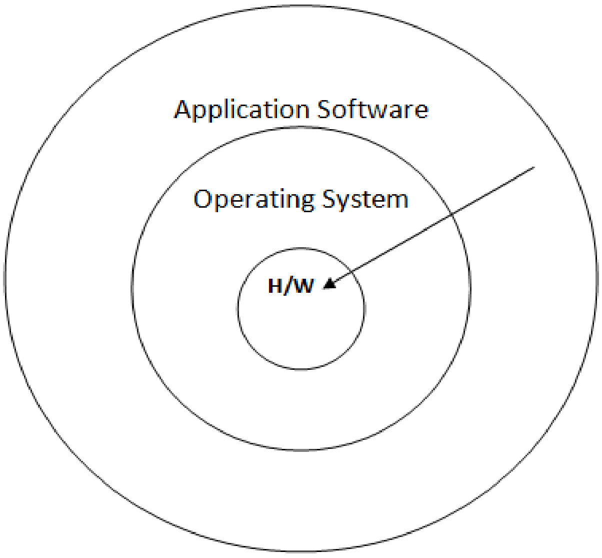
Embedded computing systems generally exhibit rich functionality—complex functionality is usually the reason for introducing CPUs into the design. However, they also exhibit many non-functional requirements that make the task especially challenging:

- Real-time deadlines that will cause system failure if not met;
- Multi-rate operation;
- In many cases, low power consumption;
- Low manufacturing cost, which often means limited code size.

Workstation programmers often concentrate on functionality. They may consider the performance characteristics of a few computational kernels of their software, but rarely analyse the total application. They almost never consider power consumption and manufacturing cost. The need to juggle all these requirements makes embedded system programming very challenging and is the reason why embedded system designers need to understand computer architecture.

2.4 Overview of an Embedded System Architecture

Every Embedded system consists of a custom-built hardware built around a central processing unit. This hardware also contains memory chips onto which the software is



loaded.

Fig 2.1 Embedded system Architecture

The operating system runs above the hardware and the application software runs above the operating system. The same architecture is applicable to any computer including desktop computer. However, these are significant differences. It is not compulsory to have an operating system in every embedded system. For small applications such as remote control units, air conditioners, toys etc

2.5 Applications of Embedded Systems

Some of the most common embedded systems used in everyday life are

Small embedded controllers: 8-bit CPUs dominate, simple or no operating system (e.g., thermostats)

Control systems: Often use DSP chip for control computations (e.g., automotive engine control)

Distributed embedded control: Mixture of large and small nodes on a real-time Embedded networks (e.g., cars, elevators, factory automation)

System on chip: ASIC design tailored to application area (e.g., consumer electronics, set-top boxes)

Network equipment: Emphasis on data movement/packet flow

(e.g., network switches; telephone switches)

Critical systems: Safety and mission critical computing (e.g., pacemakers, automatic trains)

Signal processing: Often use DSP chips for vision, audio, or other signal Processing (e.g., face recognition)

Robotics: Uses various types of embedded computing (especially Vision and control) (e.g., autonomous vehicles)

Computer peripherals: Disk drives, keyboards, laser printers, etc.

Wireless systems: Wireless network-connected “sensor networks” and “Motes” to gather and report information

Embedded PCs: Palmtop and small form factor PCs embedded into Equipment

Command and control: Often huge military systems and “systems of systems” (e.g., a fleet of warships with interconnected Computers)

Home Appliances, intercom, telephones, security systems, garage door openers, answering machines, fax machines, home computers, TVs, cable TV tuner, VCR, camcorder, remote controls, video games, cellular phones, musical instruments, sewing machines, lighting control, paging, camera, pinball machines, toys, exercise equipment

Office Telephones, computers, security systems, fax machines, microwave, copier, laser printer, colour printer, paging

Auto Trip computer, engine control, air bag, ABS, instrumentation, security system, transmission control, entertainment, climate control, cellular phone, keyless entry

2.6 TYPES OF EMBEDDED SYSTEMS

Based on functionality and performance embedded systems categorized as 4 types

1. Stand-alone embedded systems
2. Real time embedded systems
3. Networked information appliances
4. Mobile devices

2.6.1 Stand-alone embedded systems:-

As the name implies, stand-alone systems work in standalone mode. They take i/p, process them and produce the desire o/p. The i/p can be an electrical signal from transducer or temperature signal or commands from human being. The o/p can be electrical signal to drive another system an led or LCD display

ex digital camera, microwave oven, CD player, Air conditioner etc

2.6.2 Real time embedded systems:-

In this type of an embedded system a specific work has to be complete in a particular period of time.

Hard Real time systems: - embedded real time used in missiles

Soft Real time systems: - DVD players

2.6.3 Networked information appliances:-

Embedded systems that are provided with n/w interfaces and accessed by n/w such as local area n/w or internet are called Network Information Appliances

Ex A web camera is connected to the internet. Camera can send pictures in real time to any computers connected to the internet

2.6.4 Mobile devices:-

Actually, it is a combination of both VLSI and Embedded System Mobile devices such as Mobile phone, Personal digital assistants, smart phones etc are special category of embedded systems

CHAPTER 3

3.Literature Review

Autonomous vision based robots are intelligent robots which take visual data, process it and provide appropriate output. These robots are totally independent and don’t need any kind of human intervention since they are prefer with instructions. A robot is designed on Raspberry Pi using OpenCV, which is used for object detection based on its colour, size and shape. Here only a single object is being detected at a time. The tracking of the object is based on division of the image into virtual grids. The movement of the robot is based on the position of the object in the grid. An arm is incorporated to pick the object once it is stationary. After picking the object, it would be dropped into its respective coloured container which has a predefined position.

The ongoing research on object tracking in video sequences has attracted many researchers. Detecting the objects in the video and tracking its motion to identify its characteristics has been emerging as a demanding research area in the domain of image processing and computer vision. This paper proposes a literature review on the state-of-the-art tracking methods, categorize them into different categories, and then identify useful tracking methods. Most of the methods include object segmentation using background subtraction. The tracking strategies use different methodologies like Mean-shift, Kalman filter,

Particle filter etc. The performance of the tracking methodsvary with respect to back ground information. In this survey, we have discussed the feature descriptors that are used in tracking to describe the appearance of objects which are being tracked as well as object detection techniques. In this survey, we have classified the tracking methods into three groups, and a providing a detailed description of representative methods in each group, and find out their positive and negative aspects

This project presents FPGA (Field Programmable Gate Array) based solution for an embedded object tracking system. The tracking design was applied at FPGA as rich information of FPGA offers one of the powerful ideas in object tracking system. Object tracking system well-known as the system that is very useful in most real application that requires object detection, for example factory camera surveillance system. There are lots of algorithms available including the detection of handwriting, moving people, animals and the barcode number. This project will focus on shape detection to observe the real object image and the expected experimental object shape image. Shapes that cover are square, circle, triangle and etc. The black and white image will be used in the design and will be converted to binary signals before entering the tracker process. Then the design system will be embedded to the FPGA to confirm the shape that obtained using Quartus II Altera software. The pixels detected represent the available of intensity within the image. No error and correction included in the system. The system represented only fixed image without noise and no assorted.

Autonomous vision based robots are intelligent robots which take visual data, process it and provide appropriate output. These robots are totally independent and don’t need any kind of human intervention since they are prefer with instructions. A robot is designed on Raspberry Pi using OpenCV, which is used for object detection based on its colour, size and shape. Here only a single object is being detected at a time. The tracking of the object is based on division of the image into virtual grids. The movement of the robot is based on the position of the object in the grid. An arm is incorporated to pick the object once it is stationary. After picking the object, it would be dropped into its respective coloured container which has a predefined position.

In vector calculus, Green's theorem relates a line integral around a simple closed curve *C* to a double integral over the plane region *D* bounded by *C*. It is the two-dimensional special case of Stokes' theorem.

-This paper is about offside detection in the game of football using contour detection in computer vision. Here we use contour detection method to decide whether the player is in offside position or not. The purpose of contour detection method in this project is to find the position of furthermost defender and attacker, while the attacker is receiving the pass from his teammate. Their horizontal positions are compared with respect to each other to give the final results. Various filtering techniques are used to obtain the desired output. The main objective is to determine offside in football matches so that the officials can improve the accuracy of decision making.

The project aims to build a monocular vision autonomous car prototype using Raspberry Pi as a processing chip. An HD camera along with an ultrasonic sensor is used to provide necessary data from the real world to the car. The car is capable of reaching the given destination safely and intelligently thus avoiding the risk of human errors. Many existing algorithms like lane detection, obstacle detection is combined together to provide the necessary control to the car.

CHAPTER 4

4.1 Existing System

In the existing system object detection is done with the help of sensors.

Multiple object detector sensor was available but right sensor is difficult to identify because each having own features for object detection it can use proximity sensor, ultrasonic sensor, capacitive sensor, photo electric and inductive sensors. For tracking purpose proximity or image sensor. The sensor identification is not simple task for every kind of operation; individual sensor is used so selection of sensors is done by following conditions namely accuracy, resolution, range control interface, environmental conditions and cost. These are measure factors to be considered.

Block diagram

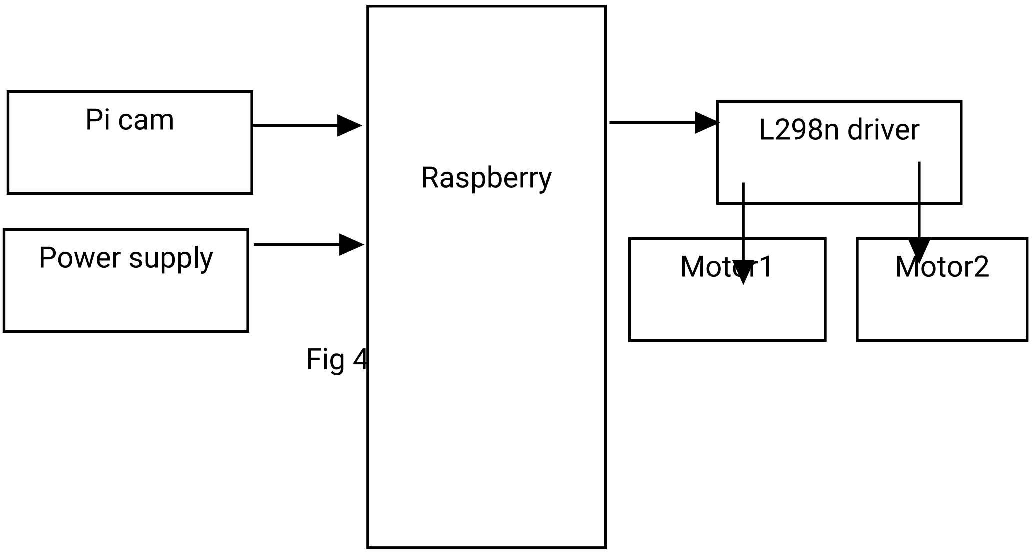


Fig 4

Hardware requirements:

Power supply:

Regulated power supply section

In mains-supplied electronic systems the AC input voltage must be converted into a DC voltage with the right value and degree of stabilization. In these basic configurations the peak voltage across the load is equal to the peak value of the AC voltage supplied by the transformer’s secondary winding. For most applications the output ripple produced by these circuits is too high. However, for some applications - driving small motors or lamps, for example - they are satisfactory. If a filter capacitor is added after the rectifier diodes the output voltage waveform is improved considerably. The section b-c is a straight line. During this time, it is the filter capacitor that supplies the load current.

The slope of this line increases as the current increases, bringing point c lower.

Consequently, the diode conduction time (c-d) increases, increasing ripple. With zero load current the DC output voltage is equal to the peak value of the rectified AC voltage. Figure shows how to obtain positive and negative outputs referred to a common ground. In particular they are helpful in determining the voltage ripple for a given load current and filter capacitor value. The value of the voltage ripple obtained is directly proportional to the load current and inversely proportional to the filter capacitor value. The performance of a supply commonly used in consumer applications – in audio amplifiers.

Often the degree of stability provided by the circuits described above is insufficient and a stabilizer circuit is needed. This circuit is often used as a reference voltage to apply to the base of a transistor of to the input of an op amp to obtain higher output current. The simplest example of a series regulator is shown in Figure. In this circuit the transistor is connected as a voltage follower and the output voltage is about 600 - 700mV lower than the Zener voltage.

The resistor R must be dimensioned so that the Zener is correctly biased and that sufficient base current is supplied to the base of Q1. For high load currents the base current of Q1 is no longer negligible. To avoid that the current in the Zener drops to the point where effective regulation is not possible a Darlington may be used in place of the transistor. When better performance is required the op amp circuit shown in Figure is recommended. In this circuit the output voltage is equal to the reference voltage applied to the input of the op amp. With a suitable output buffer higher currents can be obtained. The output voltage of the Figure 14 circuit can be varied by adding a variable divider in parallel with the Zener diode and with its wiper connected to the op amp's input.

The design of stabilized supplies has been simplified dramatically by the introduction of voltage regulator ICs such as the L78xx and L79xx - three-terminal series regulators which provide a very stable output and include current limiter and thermal protection functions. Regulated power supply is mainly used to providing power to this project because it is providing regulated dc power and it converts 220v ac supply into regulated dc power of 5v, 9v, 12v, 15v etc. Regulated power supply consists of step down transformer, bridge rectifier which is combination of 4 diodes connected in bridge shape. Bridge rectifier has the maximum efficiency and it is best than other rectifiers that's why we prefer it. This rectifier converts ac into pulsating dc. After rectifier filter circuit is employed, usually capacitor in parallel is used as filter or we can use number of capacitors in parallel and number of inductors in series. All these filters are low pass filters as we required dc at the o/p. Then after capacitor voltage regulator is used for observing the pure dc o/p. We can use various voltage regulators for obtaining pure dc o/p but we prefer 78xx series voltage regulators as they are simpler, cheaper and easier than others.

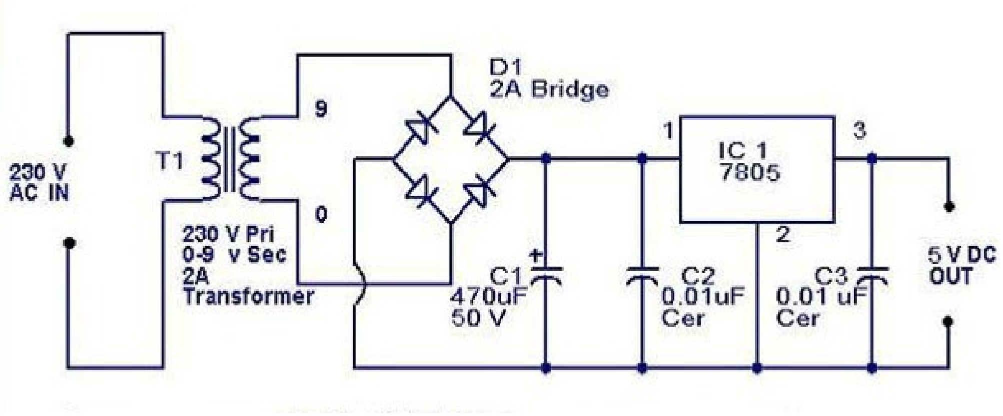


Fig. 4.2: Circuit diagram of regulated power supply section

1) AC Input: This is the input supply from the public utility where the device will be energized. It is also supplied directly to the relay contacts in the device which connects the load to the supply when the supply is within 200V – 240V range.

(2) Step down transformer: It steps down the AC supply into 5v on the secondary side. It is therefore a 230/5 v transformer. Any change in the primary reflects in the secondary of the transformer. So any fluctuations in the input are also reflected as a fluctuation in the output.

(3) Rectifier: A center tapped transformer, with four diodes for full wave rectification is used to convert the ac voltage to a pulsating dc voltage followed by a filter, comprising of a capacitor to filter out (smooth) the pulsation. After the rectification and smoothening, a sample of the output voltage is fed to the micro controller. This voltage is unregulated and therefore varies as the input mains voltage varies. Since the system is to prevent against over voltage, the transformer was designed and the windings were so selected for the device to be able to sense and withstand input mains voltage up to 600Vac.

Raspberry pi:

We assume the Raspberry Pi would love you. This machine, which is incredibly small and inexpensive, costs less than many video games but can also be used to encode, build robots and create all sorts of odd and wonderful projects. Raspberry Pi is able to do everything from surfing the internet to playing games and watching movies to hearing music, to doing everything you would expect of a computer. However, the Raspberry Pi is more than a modern machine. You can hit the middle of a device with a Raspberry Pi. You can set up your own operating system and directly connect wires and circuits to the pins on your screen. It was developed to teach young people how to programme in languages such as Scratch and Python, and the official operating system includes all major programming languages. The world is more than ever in need of programmers and the Raspberry Pi has sparked in a new generation a love of computer technology. Raspberry Pi is used by people of all ages to build exciting projects: from retro games consoles to Internet weather stations. So, if you want to make games, create robots, and hack strange and wonderful projects, you can start this book.

The Raspberry Pi is an amazing product, a machine that operates entirely in a small and inexpensive box. Every step of the way is assisted by the Raspberry Pi, if you're searching for a computer you can use for browsing the web an or playing games or are keen to learn how to write your own programmes or build your own circuits and physical devices. It is a computer, much like a laptop , desktop or mobile, based on a single printed circuit board, which means just what it sounds like: it is a computer, much like a desktop or a laptop. The Raspberry Pi, just like many single board PCs, is small – approximately the same footprint as a credit card – but it's not powerful, since a Raspberry Pi can do something that can be made bigger and power -hungry just not necessarily as rapidly. From the wish to foster practical computer learning around the world was born the Raspberry Pi family. The designers of the Raspberry Pi Foundation, unified for the purposes of non-consulting, had no idea that it would be so successful. Thousands of waters constructed in 2012 were sold down immediately and thousands were exported worldwide over the years since. These boards find ways of accessing homes , schools, workplaces, data centres, manufacturing and even self-piloting ships and airfield balloons. Since the original

Model B numerous Raspberry Pi versions have been released, each with improved specifications or special features for the particular case. For example, the RASPBERRI PI Zero family is a small version of a Raspberry PI, features that offer a significantly smaller range and reduces power requirements , especially multiple USB ports and a wired network port.

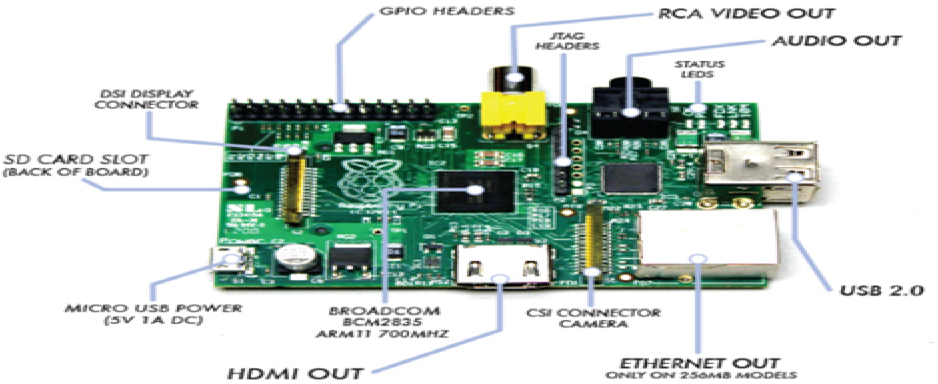
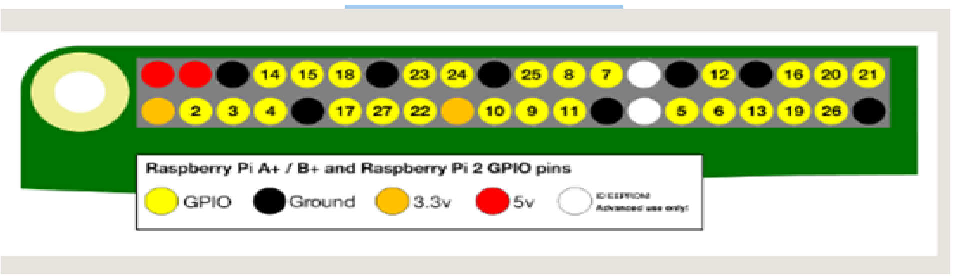

GPIO HEADERS
RCA VIDEO OUT
JTAG HEADERS
AUDIO OUT
STATUS LEDS
DSI DISPLAY CONNECTOR
SD CARD SLOT (BACK OF BOARD)
USB 2.0
MICRO USB POWER (5V 1A DC)
BROADCOM BCM2835 ARM11 700MHZ
CSI CONNECTOR CAMERA
HDMI OUT
ETHERNET OUT ONLY ON 256MB MODELS

Fig 4.2. Raspberry pi

The System-on - Chip name is a perfect indication of what would be found if you took off your metal cover: a silicon chip, which forms the bulk of the Raspberry Pi's system , known as an integrated circuit. This includes the central processing unit (CPU), generally considered to be the brain of a machine, and the GPU, the visual side of the thing. But a brain is no good without memory, and you'll see just the same on the bottom side of the Raspberry Pi: a tiny black plastic chip (Figure 1-3). The same thing happens to a chip. This is the random memory of Pi access (RAM). It is RAM that includes what you do while you are operating on the Pi; it is only written on a microSD card when you save your job. Combined, these are the volatile and non-flux memory of the Pi: when the Pi is turned off, volatile RAM loses its content and non- volatile microSD cards retain their content.

Definition of pin



The GPIO pins are not numerically numbered: GPIO pins 0 and 1 (physical pins 27 and 28) are present on the board but are reserved for advanced use (see below). On the board, there are two 5V pins and two 3V3 pins as well as some non-configurable soil pins (0V). All the remaining pins are 3V3 pins, which is adaptive to the performance of 3V3 and 3V3 inputs.

Exits

The high (3V3) or low (0V) can be set for a GPIO pin designated as the output pin.

Introduction

The high (3V3) or low (0V) can be read as a GPIO pin designated as the input pin. The use of internal pull-up or pull-down resistors makes this simpler. The GPIO2 and GPIO3 pins have fixed resistors, but can also be programmed in software for other pins.

Other facts

The GPIO pins can be used with a wide range of alternative operations, some on all pins, some on particular pins as well as with simple input and output devices.

CHAPTER 5

5 Working:

The board is fitted with an SD card from Raspberry Pi. This slot allows us to insert and use an SD card as our unit. The SD card, like a personal computer hard disc, is a main storage device for the raspberry pi board. You intend to use the bootable Linux feature system on the card. The pipeline supports the operating systems Linux, Qtonpi, ARM, Mac. You can use the disc manager programme to pick one OS and write it to an SD card. Other storage systems, like external USB hard drive or USB drive, may also be used. Most SD card brands are available in various sizes on the market. The Pi supports 64 GB SD card. The Pi supports max.

You will have to attach a monitor, a keyboard, a mouse like a PC before you start your raspberry pi. It supports three O / Ps, such as HDMI, composite and DSI, where DSI needs certain hardware. It supports the following: It can sell with or without an SD card when you buy a raspberry pi board. In raspberry pi board it is a very significant specification. It maintains its system, records and services. Since. If your raspberry pi doesn't have an SD card, the size of the minute 4 GB is required.

The advantages of the raspberry pi are, it is small in size and it can handle web traffic like a regular device. The Raspberry pi is one credit card device board that can be used for several tasks including games and text handling, tablets and HD video playback on your device. The Raspberry pi foundation from the United Kingdom was created. It is ready for public consumption since 2012 in order to make the device for children and students an accessible educational microcomputer. The main goal of the design of the pi board is to inspire students at school level to learn, experiment and create innovations. A compact , low cost raspberry pi board. In cell phones, full raspberry pi computers are used. In the second century, mobile technology has developed extremely strongly and mobile industries are the engine of a large segment of the production. ARM technology was used by 98% of cell phones.

Model A Board of Raspberry Pi :

The Pi Raspberry board is a SOC (chip system) Broadcom(BCM2835). The ARM-1176JZF-S core CPU, 256 MB SDRAM and 700MHz are available for download. The USB 2.0 raspberry pi ports only use external data interfaces. The PCB uses a micro USB Adapter with a range of 2 minutes. (500 MA) Watts. The advanced graphics chip is intended to speed up the rendering of picture calculations. This is developed with Broadcom IV Cable Video centre, which is useful when you are running a raspberry Pi for a game and video.

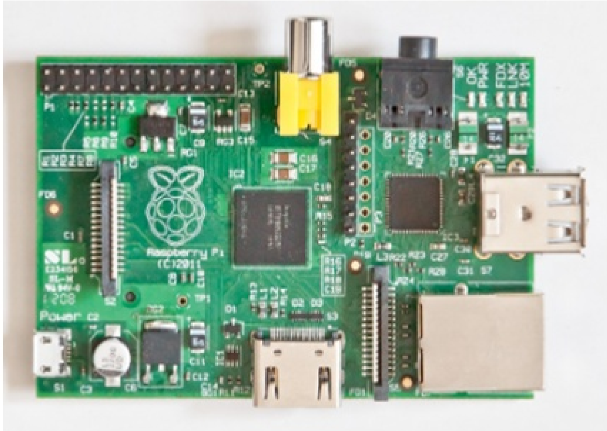


Fig 5.1 Pi Board of Model B

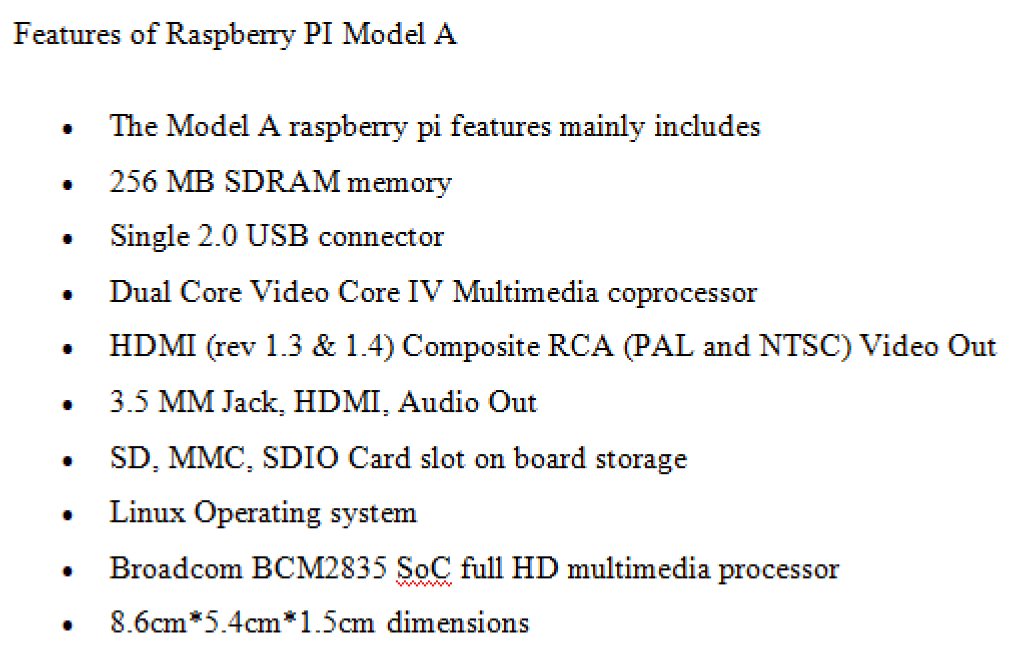
Raspberry

Raspberry Pi (chip board system) is a Broadcom BCM2835 SOC. It is fitted with an SDRAM core CPU of 700 MHz, 512 MB and ARM1176JZF-S. Only external data networking options are used for the USB 2.0 port. In model B, the Ethernet in the pi is the key gateway to connect to other devices and the Internet. The power is drawn by a USB micro adapter with a minimum 3.5-watt range (500 MA). The advanced chip graphics are designed to speed up image calculation manipulation. This is developed with Broadcom IV Cable Video centre, which is useful when you are running a raspberry Pi for a game and video.

Model B raspberry pi board

Features of Raspberry PI Model B

- 512 MB SDRAM memory
- Broadcom BCM2835 SoC full high definition multimedia processor
- Dual Core Video Core IV Multimedia coprocessor
- Single 2.0 USB connector
- HDMI (rev 1.3 and 1.4) Composite RCA (PAL & NTSC) Video Out
- 3.5 MM Jack, HDMI Audio Out
- MMC, SD, SDIO Card slot on board storage
- Linux Operating system
- Dimensions are 8.6cm*5.4cm*1.7cm
- On board 10/100 Ethernet RJ45 jack



Features of Raspberry PI Model A

- The Model A raspberry pi features mainly includes
- 256 MB SDRAM memory
- Single 2.0 USB connector
- Dual Core Video Core IV Multimedia coprocessor
- HDMI (rev 1.3 & 1.4) Composite RCA (PAL and NTSC) Video Out
- 3.5 MM Jack, HDMI, Audio Out
- SD, MMC, SDIO Card slot on board storage
- Linux Operating system
- Broadcom BCM2835 SoC full HD multimedia processor
- 8.6cm*5.4cm*1.5cm dimensions

Raspberry Pi applications

The PI boards for raspberry are used for many applications, such as Media streamers, arcades, tablet computers, domestic automation, carputers, Internet radios, roboteers regulating, Celestial computers, meteorite-hunting, café and for projects focused on raspberry pi.

The Raspberry Pi(/pa) is a series of small computers designed for basic computer science in schools and emerging economies in the UK by the Foundation Raspberry Pi. The original model was much more popular than planned and was marketed for uses such as robotics outside its target market. It does not include peripherals (for example, mouse and keyboards) or boxes. However, most official and in official bundles contain most accessories.

There are two weapons behind the company Raspberry Pi. The Raspberry Pi Foundation has created the first two versions. After the release of Pi Model B, the Foundation set up Raspberry Pi Trading to create the third model-the B+-with Ebben Upton as CEO. Raspberry Pi Trading develops the technology and the Foundation is an educational agency that supports the teaching in schools and in the developing countries of basic computer sciences.

More than 5 million Raspberry Pi have been sold by February 2015 as the best -selling British device according to the Raspberry Pi Base. They sold 11 million units by November 2016 and 13,5 million by March 2017, which made it the third best-selling device for the general use. Sales amounted to almost 15 million in July 2017. Sales amounted to 19 million in March 2018.

Most Pi’s are produced in the Sony plant in Pencoed, Wales.

Fig 5.3 Raspberry pi

Several generations have been freed from Raspberry Pi’s. All models have a chip based Broadcom (SoC) device with a built-in central processing unit (CPU) and graphics processing unit (GPU) for ARM compatibility.

For the Pi 3 model B + and 1.5 GHz for the Pi 4, the processor speed ranges from 700 MHz to 1.4 GHz; on-board memory ranges from 256 MB to 1 GB Random Access Memory (RAM), up to 4 GB of Pi 4. Stable digital cards (SD) are used to store operating system and programs' memory in the MicroSD form factor (SDHC on early models). The panels have 1 to 5 USB ports. A standard 3.5-mm ring-sleeve Jack for audio output is provided for the video output by HDMI and composite video. A number of GPIO pins supporting popular protocols such as I2C provide low-level performance. There is an 8P8C Ethernet port for B models and Wi-Fi 802.11n and Bluetooth are available on-board for Pi 3, Pi 4 and Pi Zero W. Prices vary between 5 and 55 US$.

In February 2012, the first generation (Raspberry Pi 1 Model B) was launches. The Structure launched a design board with enhanced design, Raspberry Pi 1 Model B+ in 2014. The Structure is also the most advanced. These credit card boards are roughly wide and constitute the regular key type factor. A year later improved models A+ and B+ were released. In April 2014 a "Compute Module" for embedded applications was introduced. In February 2015, the Raspberry Pi 2, with more RAM attached, was released.

In November 2015, US$ 5 was released for a smaller size Raspberry Pi Zero with a lower capability for input / output (I / O) and total input / output (GPIA). The Zero edition with Wi-Fi and Bluetooth features was released for 10 US$ on 28 February 2017. A Zero W version with pre-soldered GPIO headers was released on January 12, 2018.

The 1.2 GHz 64-bit quad core processor, on-Board 802.11n Wi-Fi, Bluetooth and USB boot functions of the Raspberry Pi 3 Model B were launched in February 2016. On the Pi day of 2018, a 1.4 GHz processor and a three-time faster gigabit Ethernet with an external USB 2.0.0 link restricted to approximately 300 Mbit / s, or a Dual Banded 3.4/5 GHz with an external WI-Fi (100 Mbit / s) were launched at Raspberry Pi 3 Model B.+. Power over Ethernet (PoE), USB boot and network boot (SD card is no longer needed) are other features.

The 1.5 GHz 4-bit ARM Cortex-A72 processor, 802.11ac Wi-Fi on-board, Bluetooth 5, full Gigabit Ethernet (no restricted performance), two USB 2.0 ports, 2 USB 3.0 ports and two dual monitor support (4 K resolution) is released in June 2019. Raspberry Pi 4 Modell B is available in June. It can also be operated by a USB-C port, which allows the downstream peripherals to be supplied with additional power when used with a suitable PSU. The Raspberry Pi 4 has a design flaw, which may wrongly recognise third-party USB cables, such as cables used for Apple Mac Books. In a potential board revision, this is planned to be corrected. Tom's hardware tested 14 cables and found that 11 of them switched on the Pi without any problems.

Period

Multiple versions of the Raspberry Pi hardware have changed with variations in memory capacity and application support.

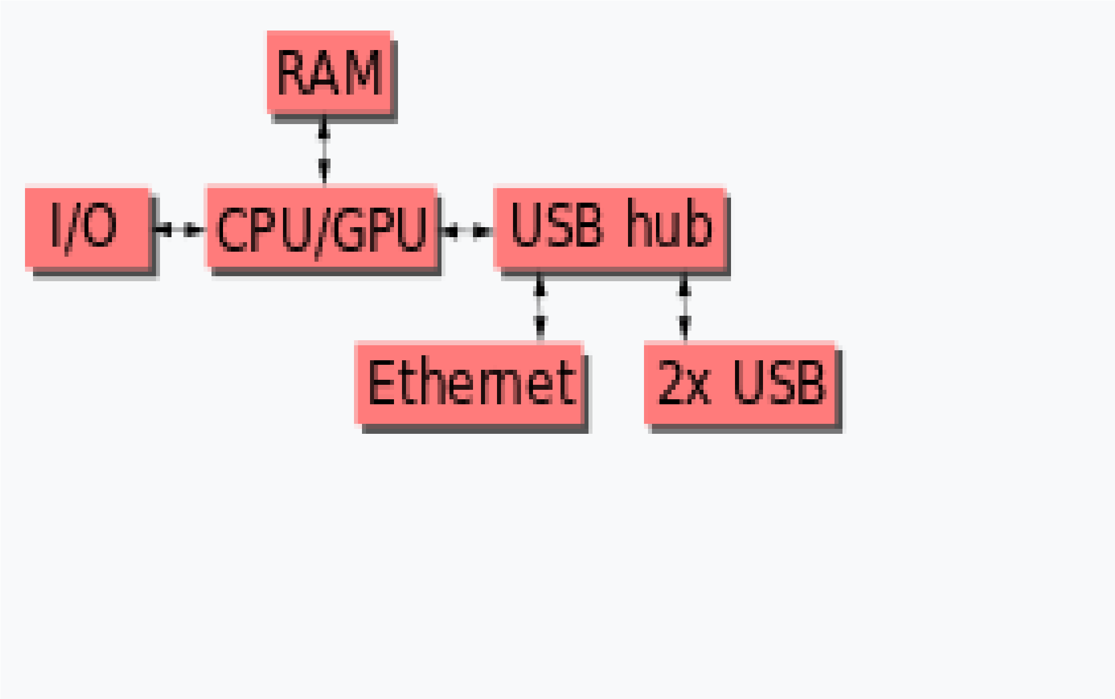


Fig 5.4 Block diagram of Raspberry pi

Model B and B+; Model A, A + and Pi zero are identical in this block scheme but they do not have Ethernet and USB hub modules. An extra USB port connects the Ethernet adapter internally. The USB port is attached to the device directly on a chip (SoC) in Model A, A+ and the Pi Zero. The USB chip features a five-port USB hub on the Pi 1 Model B+ and later models, of which four ports are available and only two on the Pi 1 Model.

The USB port on Pi Zero also has direct connexions to the SoC, but uses a USB micro port (OTG). The 40 pin GPIO connector on the Pi Zero is omitted in holes only on the Pin position, unlike all other versions from the Pi Zero. The Pi Zero WH fixes

Model B and B+; model A, A+ and Pi Zero are identical in this Block diagram, but Ethernet and USB Hub components are not present. An external USB port is attached internally to the Ethernet adapter. The USB port is directly connected to the chip system (SoC) in Models A, A+ and Pi Zero. The USB chip includes a 5-port USB hub for both the Pi 1 Model B+ and later models, of which only two are available on the Pi 1 Model B. The USB port is directly connected to the SoC on the Pi Zeera, but it uses a mini USB port (OTG). In the Pi Zero, the 40-pin GPIO connector is omitted with so high length pads only in pin positions, contrary to all other Pi versions. This is remedied by the Pi Zero WH.

COMMUNITIES

In collaboration with the Broadcom and Raspberry Pi Base, all Socs in Raspberry Pi's are custom created.

BCM2835 SoC is used by the Broadcom BCM 26 in the first-generation Raspberry Pi[26], including ARM1176JZF-S 700 MHz, GPU[27], and RAM. It is fitted with a 16 KB Level 1 cache and a 128 KB cache Level 2 (L2). The GPU mostly uses Level 2 cache. The SoC stacks below the RAM chip, so that only its edge can be seen. The ARM1176JZ(F)-S is similar to the original iPhone[28] but is much faster and clocked with a much higher clock rate.

A BCM2836 SoC with a 900 MHz 32-bit quad-core ARM Cortex-A7 processor, with a shared L2 cache of 256 KB, was used in the previous V1.1 Raspberry models.[29] Raspberry Pi 2 V1.2 was upgraded to a BCM2837 SoC with 1.2 GHz 64-bit ARM Cortex-A53 processor, the same SoC used on the Raspberry Pi 3, but underclocked (default) at the same speed of 900 MHz CPU clock. At the end of 2016 the BCM2836 SoC is out of manufacture.

The Raspberry Pi 3 Model B uses a BCM2837 SoC Broadcom with a 1.2 GHz 64-bit Cortex-A53 ARM quad-core cache, sharing a cache of 512 KB. The A+ and B+ versions are 1.4 GHz.

In addition to a 1.5GHz 64-bit ARM Cortex-A72 Quad-core processor, the Raspberry Pi 4 uses a 1 MB common L2 caching soc.

Pi Zero and Zero W use the same Broadcom BCM2835 SoC as the Raspberry Pi of the first generation, although they now work at a speed of 1 GHz CPU clock.

SOLIGNING

The Raspberry Pi first generation produced real-world efficiency of about 0.041 GFLOPS, while running at 700 MHz by design. The performance on the CPU level is comparable to a Pentium II 300 MHz from 1997 to 99. The GPU offers graphics processing output for 1 G pixel s or 1.5 pixel / s or 24 GFLOPS of general purpose. The Raspberry Pi 's graphical features are almost the same as the 2001 Xbox.

The Pi 2 V1.1 Raspberry features a Cortex-A7 CPU with 4 to 5 times more CPU performance than its predecessor, with an output of 900 MHz and 1 GB RAM. The GPU was the same as the original one. The Raspberry Pi 2 V1.1 can be up to 14 times higher in parallel benchmarks than the Raspberry Pi 1 Variant B+.

The Raspberry Pi 3 is defined as having 10 times the output of Raspberry Pi 1. ARM Cortex-A53 processor quad-core is used. In parallel, benchmarks have shown that Raspberry Pi 3 has been about 80% faster than that of Raspberry Pi 2.

Over time Over

Most devices on-chip Raspberry Pi can be overclocked to 800 MHz and around 1000 MHz In exceptionally high situations, even 1500 MHz (without all protection and voltage limitation), the Raspberry Pi 2 can be equally overclocked. In Raspbian Linux, the overclocking options on the boot can be distorted by the "SUDO RASPI-CONFIG" programme command without voiding the guarantee.[42) If the temperature of the chip is 85 ° C (185 ° F), the Pi shuts down automatically when the overclocking is done; the correct size is h (no warranty);

New firmware versions provide the ability to choose from five overclock presents ("turbo") that try to optimise SoC output without impairing board life when used. The chip 's core temperature and the CPU load are controlled and the Clock and the core voltage dynamically changed. If the CPU demand is poor or the clock speed is too high, but if the CPU has a lot to do and the temperature is appropriate, the clock speeds of up to 1 GHz boost the output briefly, depending upon which board version the turbo setting is used. Depending on which type of board you like. The SDRAM clock was initially 500MHz in the highest (turbo) present, but it was modified later to 600MHz, as 500MHz also causes SD card corruption. At the same time, the core clock speed has been decreased in high mode from 450 to 250 MHz and from 333 to 250 MHz in medium mode . Even when overclocked, the CPU on both the Raspberry Pi board of first and second generation did not need refreshments like a heat sink or fan, however the Raspberry Pi 3 will provide more thermal energy when overclocked.

BOOK:

Just 256 MB of RAM is included in the early concepts of the Raspberry Pi Model A and B boards. Of this, 128 MB is allocated to the GPU by default by early beta Model B boards, leaving only 128 MB for the CPU. Three separate splits were possible in early 256 MB releases of models A and B. The default division for CPU was 192 MB, which would be enough to decode stand-alone 1080p video or to process it easily in 3D. 224 MB had just a 1080p framebuffer for processing in Linux, and possibly had no video or 3D. 128 MB, perhaps even with video decoding, was for intense 3D processing. In contrast, the Broadcom Video Core IV uses the Nokia 701 with 128 MB.

The later Model B has 512 MB RAM, initially released with a memory splits of 256 MB, 384 MB, and 496 MB CPU RAM, and a video split file of 256 MB, 128 MB and 16 MB respectively. However, about a week after that, a new version of start. Elf was released which could read a new config.txt entry (Gpu mem = xx) and allocate a dynamically large RAM (from 16 to 256 MB, in 8 MB steps) to a GPU, obsolete the earlier memory sharing method and a single star. Elf was working the same with Raspberry Pi’s for 256 MB and 512 MB.

1 GB RAM is available in the Raspberry Pi 2. In the B and B+ series, the Raspberry Pi

3 has one GB of RAM, and in the A+ model, a Ram of 512 MB. The Pi Zero and Zero W raspberries are made from 512 MB of RAM.A choice of 1 , 2 or 4 GB of RAM is available on the Raspberry Pi 4 when generated. The guide to safety and user-friendliness Raspberry Pi 4 Model B discusses "Raspberry Pi 4 Model B 1 GB, 2 GB, 4 GB + 8 GB" but the model 8 GB was not available at 2019 launch. Connectedness No Ethernet circuits are provided on the model A, A+ and Pi Zero and are normally linked via an external USB Ethernet or a Wi-Fi connector provided to the network. The built-in USB Ethernet adapter is supplied with the LAN9514 SMSC chip in both Model B and B+ port. The Raspberry Pi 3 and Pi Zero W (wireless) are fitted with the Broadcom BCM43438 FullMAC chip, with no official monitor mode support, but which can also be introduced by unofficial firmware patching[55], with 10/100 Mbit / s Ethernet port. The Broadcom BCM43438 FullMAC chip has no official support for the monitor mode. The Raspberry Pi 3B + is equipped with IEEE 802.11b / g / n / a dual band WIFI and Gigabit Ethernet, with a USB 2.0 bus between them and SoC restricted to approximately 300 Mbit / s. The Raspberry Pi 4 comes fitted with full gigabit Ethernet (the performance is not constrained as the USB chip is not funnelled).

5. 1 L298N driver

L293D “H” BRIDGE

The motor driver package L293D is interfaced with 89C51 microcontroller through IN1 to IN4 of H Bridge (L293D). Both the enable pins (EN1 and EN2) of motor driver L293D is combined together and fed to controller to access the command signals. Depending up on the command signals issued by the controller, the enable pins are activated to control all the four internal drivers of L293D respectively to drive two geared DC motors. Hear H Bridge is required, because the microcontroller output is not sufficient to drive the DC motors, so current drivers are required for motor rotation.

The L293D is a quad, high current, half-H driver designed to provide bidirectional drive currents of up to 600mA at voltages from 4.5V to 36V. It makes it easier to drive the DC motors. The L293D consists of four drivers. Pins IN1 through IN4 and OUT1 through OUT4 are input and output pins, respectively, of driver 1 through driver 4. Drivers 1 and 2, and drivers 3 and 4 are enabled by enable pin 1 (EN1) and pin 9 (EN2), respectively. When enable input EN1 (Pin1) is high, drivers 1 and 2 are enabled and the outputs corresponding to their inputs are active. Similarly, enable input EN2 (Pin9) enables drivers 3 and 4.

DETAILS ABOUT DC MOTORS

Permanent magnet DC motor responds to both voltage and current. The steady state voltage across a motor determines the motor's running speed, and the current through its armature windings determines the torque. Apply a voltage and the motor will start running in one direction; reverse the polarity and the direction will be reversed. If you apply a load to the motor shaft, it will draw more current, if the power supply does not able to provide enough current, the voltage will drop and the speed of the motor will be reduced. However, if the power supply can maintain voltage while supplying the current, the motor will run at the same speed. In general, you can control the speed by applying the appropriate voltage, while current controls torque. In most cases, DC motors are powered up by using fixed DC power supply, therefore; it is more efficient to use a chopping circuit.

Consider what happens when a voltage applied to a motor's windings is rapidly turned ON and OFF in such a way that the frequency of the pulses produced remains constant, but the width of the ON pulse is varied. This is known as Pulse Width Modulation (PWM). Current only flows through the motor during the ON portion of the PWM waveform. If the frequency of the PWM input is high enough, the mechanical inertia of the motor cannot react to the ripple wave; instead, the motor behaves as if the current were the DC average of the ripple wave. Therefore, by changing the width of pulse, we can control the motor speed.

At the most basic level, electric motors exist to convert electrical energy into mechanical energy. This is done by way of two interacting magnetic fields -- one stationary, and another attached to a part that can move. A number of types of electric motors exist, but most BEAM bots use DC motors in some form or another. DC motors have the potential for very high torque capabilities (although this is generally a function of the physical size of the motor), are easy to miniaturize, and can be "throttled" via adjusting their supply voltage. DC motors are also not only the simplest, but the oldest electric motors.

Oersted, Gauss, and Faraday discovered the basic principles of electromagnetic induction in the early 1800's. By 1820, Hans Christian Oersted and Andre Marie Ampere had discovered that an electric current produces a magnetic field. The next 15 years saw a flurry of cross-Atlantic experimentation and innovation, leading finally to a simple DC rotary motor. A number of men were involved in the work, so proper credit for the first DC motor is really a function of just how broadly you choose to define the word "motor

Principles of operation

In any electric motor, operation is based on simple electromagnetism. A current carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current -carrying conductor and an external magnetic field to generate rotational motion. Let's start by looking at a simple 2-pole DC electric motor (here dark black represents a magnet or winding with a "North" polarization, while light colour represents a magnet or winding with a "South" polarization).

Every DC motor has six basic parts -- axle, rotor (a.k.a., armature), stator, commutator, field magnets, and brushes. In most common DC motors, the external magnetic field is produced by high-strength permanent magnets. The stator is the stationary part of the motor -- this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor (together with the axle and attached commutator) rotates with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator. The above diagram shows a common motor layout -- with the rotor inside the stator (field) magnets.

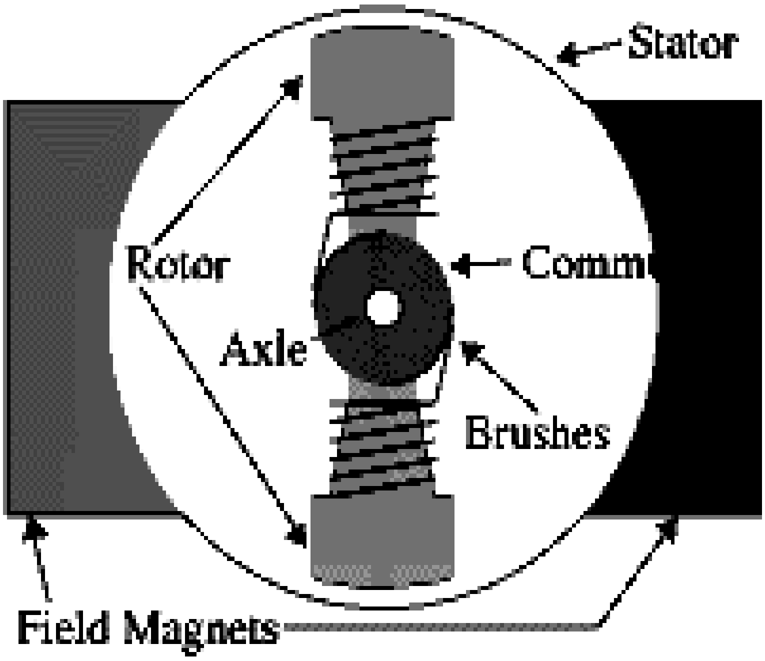


Fig 5.5 DC Motors

The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnet(s) are misaligned, and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts, and energize the next winding. Given our example two-pole motor, the rotation reverses the direction of current through the rotor winding, leading to a "flip" of the rotor's magnetic field, driving it to continue rotating.

In real life, though, DC motors will always have more than two poles (three is a very common number). In particular, this avoids "dead spots" in the commutator. You can imagine how with our example two-pole motor, if the rotor is exactly at the middle of its rotation (perfectly aligned with the field magnets), it will get "stuck" there. Meanwhile, with a two-pole motor, there is a moment where the commutator shorts out the power supply (i.e., both brushes touch both commutator contacts simultaneously). This would be bad for the power supply, waste energy, and damage motor components as well. Yet another disadvantage of such a simple motor is that it would exhibit a high amount of torque "ripple" (the amount of torque it could produce is cyclic with the position of the rotor).

D.C. Motors with field coils is classified as series. Shunt, compound and separately excited according to how the field windings and armature windings are connected. With the series-wound motor the armature and fields coils are in series. Such a motor exerts the highest starting torque and has the greatest no-load speed. With light loads there is a danger that a series-wound motor might run at too high a speed. Reversing the polarity of the supply to the coils has no effect on the direction of rotation of the motor, it will continue rotating in the same direction since both the field and armature currents have been reversed.

With the shunt wound motor the armature and field coils are in parallel. it provides the lowest starting torque, a much lower no- load speed and has good speed regulation. Because of this almost constant speed regardless of load, shunt wound motors are very widely used to reverse the direction of rotation, either the armature or field supplied must be reversed. For this reason, the separately excited windings are preferable for such a situation.

The compound motor has two field windings, one in series with the armature and one in parallel. Compound wound motors aim to get the best features of the series and shunt wound motors, namely a high starting torque and good speed regulation. The separately excited motor has separate control of the armature and field currents and can be considered to be a special case of the shunt wound motor. The torque-speed characteristics of the above motors and the speed of such D.C. Motors can be changed by either changing the armature current or the field current. Generally, it is the armature current that is varied. The choice of motor will depend on its application. For example, with a robot, manipulator, and the robot wrist might use a series-wound motor because the speed decreases as the load increases. a shunt wound motor would be used where a constant speed was required, regardless of the load. The speed of a permanent magnet motor depends on the current through the armature coil. With a field coil motor either varying the armature current or the field current can change the speed; generally, it is the armature current that is varied. Thus, speed control can be obtained by controlling the voltage applied to the armature. However, because fixed voltage supplies are often used, an electronic circuit obtains a variable voltage.

With an alternating current supply, the thyristor circuit can be used to control the average voltage applied to the armature. However, we are often concerned with the control of D.C. Motors by means of control signals emanating from microprocessors. In such cases the technique known as pulse width modulation (PWM) is generally used. This basically involves taking a constant D.C. supply voltage and chopping it so that the average value is varied.

5.2 DESCRIPTION ABOUT 'H' - BRIDGE

Introduction

Whenever a robotics hobbyist talks about making a robot, the first thing comes to his mind is making the robot move on the ground. And there are always two options in front of the designer whether to use a or a stepper motor. When it comes to speed, weight, size, and cost... DC motors are always preferred over stepper motors. There are many things, which we can do with DC motor when interfaced with a micro controller. For example, we can control the speed of motor, we can control the direction of rotation, we can also do encoding of the rotation made by DC motor i.e. keeping track of how many turns are made by the motors etc. So we can see DC motors are better than stepper motors.

In this part of tutorial, we will learn to interface a DC motor with a micro controller. Usually H-bridge is preferred way of interfacing a DC motor. These days many IC manufacturers have H-bridge motor drivers available in the market like L293D is most used H -Bridge driver IC. H-bridge can also be made with the help of transistors and MOSFET's etc. rather of being cheap, they only increase the size of the design board, which is sometimes not required so using a small 16 pin IC is preferred for this purpose. L293D is having two 'H' Bridges inside, so that we can drive two DC motors simultaneously. Before discussing about this device, first we must learn basic theory of 'H' Bridges. The following is the description.

Basic Theory

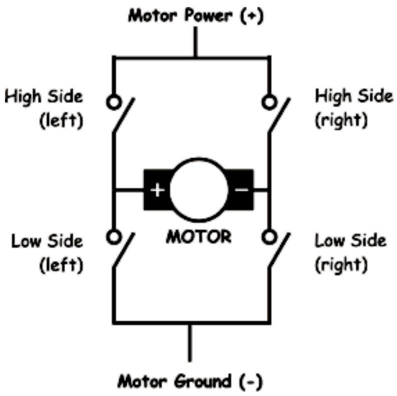


Fig 5.6 ‘H’Bridge

Let's start with the name, H-bridge. Sometimes called a "full bridge" the H-bridge is so named because it has four switching elements at the "corners" of the H and the motor forms the cross bar. The basic bridge is shown in the figure above. The key fact to note is that there are, in theory, four switching elements within the bridge. These four elements are often called, high side left, high side right, low side right, and low side left (when traversing in clockwise order).

The switches are turned on in pairs, either high left and lower right, or lower left and high right, but never both switches on the same "side" of the bridge. If both switches on one side of a bridge are turned on it creates a short circuit between the battery plus and battery minus terminals. If the bridge is sufficiently powerful it will absorb that load and your batteries will simply drain quickly. Usually however the switches in question melt.

To power the motor, turn on two switches that are diagonally opposed. The current flows and the motor begin to turn in a "positive" direction. Switch off these two switches and switch on other two switches diagonally in other direction then the motor starts rotating in opposite direction. Actually, it is quite simple, the tricky part comes in when we decide what to use for switches. Anything that can carry a current will work, from four SPST switches, one DPDT switch, relays, transistors, to enhancement mode power MOSFET’s.

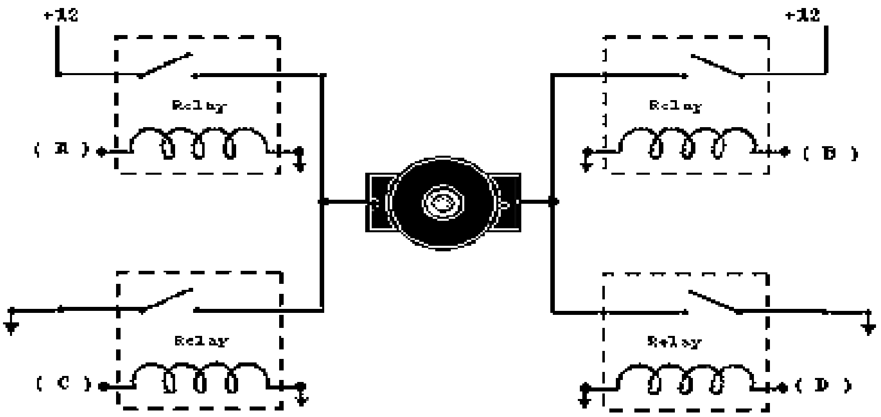
One more topic in the basic theory section is quadrants. If each switch can be controlled independently then we can do some interesting things with the bridge, some folks call such a bridge a "four quadrant device" (4QD). If we built it out of a single DPDT relay, we can really only control forward or reverse. We can build a small truth table that tells us for each of the switch's states, what the bridge will do. As each switch has one of two states, and there are four switches, there are 16 possible states. However, since any state that turns both switches on one side on is "bad", there are in fact only four useful states (the four quadrants) where the transistors are turned on.

High Side Left	High Side Right	Low Side Left	Low Side Right	Quadrant Description
On	Off	Off	On	Forward Running
Off	On	On	Off	Backward Running
On	On	Off	Off	Braking
Off	Off	On	On	Braking

Table 5.1. Table for four quadrants

In the above table the last two rows describes condition about short circuit the motor that causes the motors generator effect to work against it. The turning motor generates a voltage, which tries to force the motor to turn the opposite direction. This causes the motor to rapidly stop spinning and is called "braking" on a lot of H-bridge designs. Of course, there is also the state where all the transistors are turned off. In this case the motor coasts freely if it was spinning and does nothing if it was doing nothing.

1. Using Relays: A simple implementation of a H Bridge using four SPST relays is shown. Terminal A is High Side Left, Terminal B is High Side Right, Terminal C is Low Side Left and Terminal D is Low Side Right. The logic followed is according to the table above. Warning: Never turn on A and C or B and D at the same time. This will lead to a short circuit of the battery and will lead to failure of the relays due to the large current.



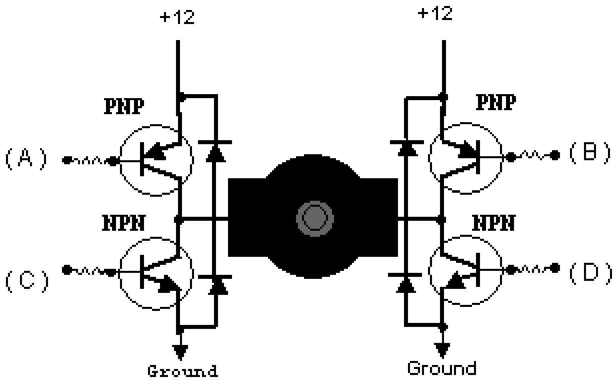
A	B	C	D	Function
1	0	0	1	Forward
0	1	1	0	Reverse
1	1	0	0	Brake
0	0	1	1	Brake

Fig 5.7 H Bridge using four SPST relays

2. Using Transistors:

We can better control our motor by using transistors or Field Effect Transistors (FET's). Most of what we have discussed about the relays H-Bridge is true of these circuits. See the diagram showing how they are connected. We should add diodes across the transistors to catch the back voltage that is generated by the motor's coil when the power is switched on and off. This fly back voltage can be many times higher than the supply voltage.

Don't turn on A and C or B and D at the same time.



Transistors, being a semiconductor device, will have some resistance, which causes them to get hot when conducting much current. This is called not being able to sink or source very much power, i.e.: Not able to provide much current from ground or from plus voltage.

MOSFET’s are much more efficient, they can provide much more current and not get as hot. They usually have the fly back diodes built in so we don't need the diodes anymore. This helps guard against fly back voltage frying our ICs.To use MOSFET’s in an H-Bridge, we need P-Channel MOSFET’s on top because they can "source" power and N-Channel MOSFET’s on the bottom because they can "sink" power. It is important that the four quadrants of the H-Bridge circuits be turned on and off properly. When there is a path between the positive and groundside of the H-Bridge, other than through the motor, a condition exists called "shoot through". This is basically a direct short of the power supply and can cause semiconductors to become ballistic, in circuits with large currents flowing. There are H-bridge chips available that are much easier, and safer, to use than designing our own H-Bridge circuit.

5.2 L293D Dual H-Bridge Motor Driver

L293D is a dual H-Bridge motor driver, so with one IC we can interface two DC motors, which can be controlled in both clockwise and counter clockwise directions. Since the device is having four half ‘H’ Bridges, thereby if required four motors can be driven through this single device, moreover the task is to run all four motors in one direction only. L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover, for protection of circuit from back EMF output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver.

In this IC there are two different power supplies (Vcc1 and Vcc2). Vcc1 is for logic input circuit while Vcc2 is supply for the output circuit. This means that we should apply about 5V to Vcc1 and whatever voltage required by the motor (up to 36V max for this IC) to Vcc2. Each Half H-Bridge has an individual Ground. So we must ground the terminal corresponding to the Half H-Bridge, depending up on the circuit design, if required all four terminals of bridges can be connected to the ground.

Each Half H-Bridge has an Input (A) and output (Y). Also, there are enable pins to turn on the Half H-Bridges. Once a Half H-bridge is enabled, then the truth table is as follows:

INPUT A	OUTPUT Y
L	L
H	H

So, we just give a high level when we want to turn the Half H-Bridge on and Low level when we want to turn it off. When the Half H-Bridge is on, the voltage at the output is equal to Vcc2.If we want to make a Full H-Bridge, we must connect the motor (or the load) between the outputs of two Half H-Bridges and the inputs will be the two inputs of the Half H-Bridges.

Suppose we have connected Half H-Bridges 1 and 2 to form a Full H-Bridge. Now the truth table is as follows:

INPUT 1A	INPUT 2A	OUTPUT 1Y	OUTPUT 2Y	Description
L	L	L	L	Braking (both terminals of motor are Gnd)
L	H	L	H	Forward Running
H	L	H	L	Backward Running
H	H	H	H	Braking (both terminals of motor at

				Vcc2)

Table 5.2 Truth table for H Bridge

CHAPTER 6

6.1 SOFTWARE

Python: 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 object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects.

Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including structured (particularly, procedural,) object-oriented, and functional programming. Python is often described as a "batteries included" language due to its comprehensive standard library.

Python was conceived in the late 1980s as a successor to the ABC language. Python 2.0, released in 2000, introduced features like list comprehensions and a garbage collection system capable of collecting reference cycles. Python 3.0, released in 2008, was a major revision of the language that is not completely backward-compatible, and much Python 2 code does not run unmodified on Python 3.

The Python 2 language, i.e., Python 2.7.x, was officially discontinued on 1 January 2020 (first planned for 2015) after which security patches and other improvements will not be released for it. With Python 2's end-of-life, only Python 3.5.x and later are supported.

Python interpreters are available for many operating systems. A global community of programmers develops and maintains Python, an open source reference implementation. A non-profit organization, the Python Software Foundation, manages and directs resources for Python and Python development.

Python is used for:

- web development (server-side),
- software development,
- mathematics,
- system scripting.

Python does?

- Python can be used on a server to create web applications.
- Python can be used alongside software to create workflows.
- Python can connect to database systems. It can also read and modify files.
- Python can be used to handle big data and perform complex mathematics.
- Python can be used for rapid prototyping, or for production-ready software development.

Why Python?

- Python works on different platforms (Windows, Mac, Linux, Raspberry Pi, etc).
- Python has a simple syntax similar to the English language.
- Python has syntax that allows developers to write programs with fewer lines than some other programming languages.
- Python runs on an interpreter system, meaning that code can be executed as soon as it is written. This means that prototyping can be very quick.
- Python can be treated in a procedural way, an object-orientated way or a functional way.

Python compared to other programming languages

- Python was designed for readability, and has some similarities to the English language with influence from mathematics.
- Python uses new lines to complete a command, as opposed to other

programming languages which often use semicolons or parentheses.

- Python relies on indentation, using whitespace, to define scope; such as the scope of loops, functions and classes. Other programming languages often use curly-brackets for this purpose.

Python installation procedure:

Windows Based

It is highly unlikely that your Windows system shipped with Python already installed. Windows systems typically do not. Fortunately, installing does not involve much more than downloading the Python installer from the python.org website and running it. Let's take a look at how to install Python 3 on Windows:

Step 1: Download the Python 3 Installer

1. Open a browser window and navigate to the Download page for Windows at python.org.
2. Underneath the heading at the top that says Python Releases for Windows, click on the link for the Latest Python 3 Release - Python 3.x.x. (As of this writing, the latest is Python 3.6.5.)
3. Scroll to the bottom and select either Windows x86-64 executable installer for 64-bit or Windows x86 executable installer for 32-bit. (See below.)

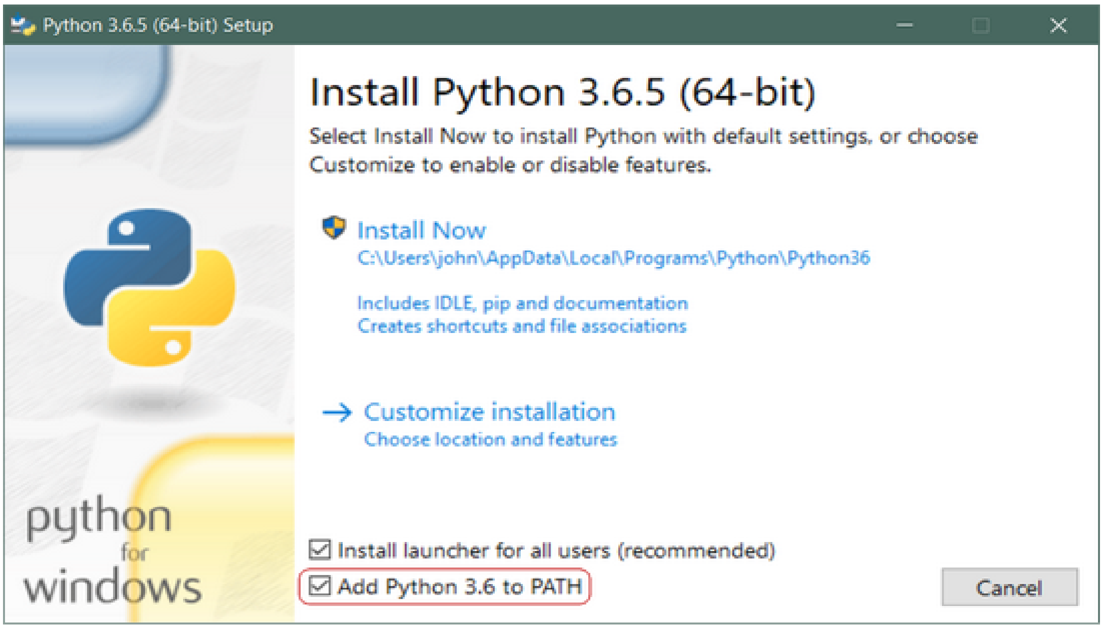
Sidebar: 32-bit or 64-bit Python?
For Windows, you can choose either the 32-bit or 64-bit installer. Here's what the difference between the two comes down to:

- If your system has a 32-bit processor, then you should choose the 32-bit installer.
- On a 64-bit system, either installer will actually work for most purposes. The 32-bit version will generally use less memory, but the 64-bit version performs better for applications with intensive computation.
- If you're unsure which version to pick, go with the 64-bit version.

Note: Remember that if you get this choice "wrong" and would like to switch to another version of Python, you can just uninstall Python and then re-install it by downloading another installer from python.org.

Step 2: Run the Installer

Once you have chosen and downloaded an installer, simply run it by double-clicking on the downloaded file. A dialog should appear that looks something like this:



Python 3.6.5 (64-bit) Setup

Install Python 3.6.5 (64-bit)

Select Install Now to install Python with default settings, or choose Customize to enable or disable features.

Install Now
C:\Users\john\AppData\Local\Programs\Python\Python36

Includes IDLE, pip and documentation
Creates shortcuts and file associations

→ Customize installation
Choose location and features

☑ Install launcher for all users (recommended)
☑ Add Python 3.6 to PATH

Important: You want to be sure to check the box that says Add Python 3.x to PATH as shown to ensure that the interpreter will be placed in your execution path. Then just click Install Now. That should be all there is to it. A few minutes later you should have a working Python 3 installation on your system.

Mac OS based

While current versions of macOS (previously known as “Mac OS X”) include a version of Python 2, it is likely out of date by a few months. Also, this tutorial series uses Python 3, so let’s get you upgraded to that.

The best way we found to install Python 3 on macOS is through the Homebrew package manager. This approach is also recommended by community guides like The Hitchhiker's Guide to Python.

Step 1: Install Homebrew (Part 1)

To get started, you first want to install Homebrew:

1. Open a browser and navigate to http://brew.sh/. After the page has finished loading, select the Homebrew bootstrap code under "Install Homebrew". Then hit cmd+c to copy it to the clipboard. Make sure you've captured the text of the complete command because otherwise the installation will fail.
2. Now you need to open a Terminal app window, paste the Homebrew bootstrap code, and then hit Enter. This will begin the Homebrew installation.
3. If you're doing this on a fresh install of macOS, you may get a pop up alert asking you to install Apple's "command line developer tools". You'll need those to continue with the installation, so please confirm the dialog box by clicking on "Install".

At this point, you're likely waiting for the command line developer tools to finish installing, and that's going to take a few minutes. Time to grab a coffee or tea!

Step 2: Install Homebrew (Part 2)

You can continue installing Homebrew and then Python after the command line developer tools installation is complete:

1. Confirm the "The software was installed" dialog from the developer tools installer.
2. Back in the terminal, hit Enter to continue with the Homebrew installation.
3. Homebrew asks you to enter your password so it can finalize the installation. Enter your user account password and hit Enter to continue.
4. Depending on your internet connection, Homebrew will take a few minutes to download its required files. Once the installation is complete, you'll end up back at the command prompt in your terminal window.

Whew! Now that the Homebrew package manager is set up, let's continue on with installing Python 3 on your system.

Step 3: Install Python

Once Homebrew has finished installing, return to your terminal and run the following command:

```
$ brew install python3
```

Note: When you copy this command, be sure you don’t include the $ character at the beginning. That’s just an indicator that this is a console command.

This will download and install the latest version of Python. After the Homebrew brew install command finishes, Python 3 should be installed on your system.

You can make sure everything went correctly by testing if Python can be accessed from the terminal:

1. Open the terminal by launching Terminal app.
2. Type pip3 and hit Enter.
3. You should see the help text from Python’s “Pip” package manager. If you get an error message running pip3, go through the Python install steps again to make sure you have a working Python installation.

Assuming everything went well and you saw the output from Pip in your command prompt window…congratulations! You just installed Python on your system, and you’re all set to continue with the next section in this tutorial.

Packages need for python based programming:

- **NumPy**

  NumPy is a Python package which stands for 'Numerical Python'. It is the core library for scientific computing, which contains a powerful n-dimensional array object, provide tools for integrating C, C++ etc. It is also useful in linear algebra, random number capability etc.
- **Pandas**

  Pandas is a high-level data manipulation tool developed by Wes McKinney. It is built on the NumPy package and its key data structure is called the Data Frame. Data Frames allow you to store and manipulate tabular data in rows of observations and columns of variables.

- **Kera's**

  Kera's is API, written in Python and capable of running on top of TensorFlow, CNTK, or Theano. Use Kera's if you need a image processing library that: Allows for easy and fast prototyping (through user friendliness, modularity, and extensibility).

- **Sklearn**

  Scikit-learn is a free machine learning library for Python. It features various algorithms like support vector machine, random forests, and k-neighbors, and it also supports Python numerical and scientific libraries like NumPy and SciPy.

- **SciPy**

  SciPy is an open-source Python library which is used to solve scientific and mathematical problems. It is built on the NumPy extension and allows the user to manipulate and visualize data with a wide range of high-level commands.

- **TensorFlow:** TensorFlow is a Python library for fast numerical computing created and released by Google. It is a foundation library that can be used to create Image processing models directly or by using wrapper libraries that simplify the process built on top of TensorFlow.

- **Django**

  Django is a high-level Python Web framework that encourages rapid development and clean, pragmatic design. Built by experienced developers, it takes care of much of the hassle of Web development, so you can focus on writing your app without needing to reinvent the wheel. It's free and open source.

- **Pyodbc**

  pyodbc is an open-source Python module that makes accessing ODBC databases simple. It implements the DB API 2.0 specification but is packed with even more Pythonic convenience. Precompiled binary wheels are provided for most Python versions on Windows and macOS. On other operating systems this will build from source.

- **Matplotlib**

  Matplotlib is an amazing visualization library in Python for 2D plots of arrays. Matplotlib is a multi-platform data visualization library built on NumPy arrays and designed to work with the broader SciPy stack. It was introduced by John Hunter in the year 2002.

- **OpenCV**

  OpenCV-Python is a library of Python bindings designed to solve computer vision problems. Python is a general-purpose programming language started by Guido van Rossum that became very popular very quickly, mainly because of its simplicity and code readability.

- **Nltk**

  Natural Language Processing with Python NLTK is one of the leading platforms for working with human language data and Python, the module NLTK is used for natural language processing. NLTK is literally an acronym for Natural Language Toolkit. In this article you will learn how to tokenize data (by words and sentences).

- **SQLAlchemy**

  SQLAlchemy is a library that facilitates the communication between Python programs and databases. Most of the times, this library is used as an Object Relational Mapper (ORM) tool that translates Python classes to tables on relational databases and automatically converts function calls to SQL statements.

- **Urllib**

  urllib is a Python module that can be used for opening URLs. It defines functions and classes to help in URL actions. With Python you can also access and retrieve data from the internet like XML, HTML, JSON, etc. You can also use Python to work with this data directly.

Installation of packages:

Syntax for installation of packages via cmd terminal using the basic

Step:1- First check pip cmd

First check pip cmd

If ok then

Step:2- pip list

Check the list of packages installed and then install required by following cmds

Step:3- pip install package name

The package name should as requirement

6.2 INTRODUCTION TO OPENCV

Open cv:

OpenCV was started at Intel in 1999 by Gary Brodsky and the first release came out in 2000. Vadim Pisarevsky joined Gary Brodsky to manage Intel's Russian software OpenCV team. In 2005, OpenCV was used on Stanley, the vehicle who won 2005 DARPA Grand Challenge. Later its active development continued under the support of Willow Garage, with Gary Brodsky and Vadim Pisarevsky leading the project. Right now, OpenCV supports a lot of algorithms related to Computer Vision and Machine Learning and it is expanding day-by-day. Currently OpenCV supports a wide variety of programming languages like C++, Python, Javaetc and is available on different platforms including Windows, Linux, OS X, Android, iOS etc. Also, interfaces based on CUDA and OpenCL are also under active development for high-speed GPU operations. OpenCV-Python is the Python API of OpenCV. It combines the best qualities of OpenCV C++ API and Python language.

OpenCV-Python Python is a general purpose programming language started by Guido van Rossum, which became very popular in short time mainly because of its simplicity and code readability. It enables the programmer to express his ideas in fewer lines of code without reducing any readability. Compared to other languages like C/C++, Python is slower. But another important feature of Python is that it can be easily extended with C/C++. This feature helps us to write computationally intensive codes in C/C++ and create a Python wrapper for it so that we can use these wrappers as Python modules. This gives us two advantages: first, our code is as fast as original C/C++ code (since it is the actual C++ code working in background) and second, it is very easy to code in Python. This is how OpenCV-Python works, it is a Python wrapper around original C++ implementation. And the support of NumPy makes the task easier. NumPy is a highly optimized library for numerical operations.

It gives MATLAB-style syntax. All the OpenCV array structures are converted to-and-from NumPy arrays. So whatever operations you can do in NumPy, you can combine it with OpenCV, which increases number of weapons in your arsenal. Besides that, several other libraries like SciPy,

Matplotlib which supports NumPy can be used with this. So OpenCV-Python is an appropriate tool for fast prototyping of computer vision problems.

Since OpenCV is an open source initiative, all are welcome to make contributions to this library. And it is same for this tutorial also. So, if you find any mistake in this tutorial (whether it be a small spelling mistake or a big error in code or concepts, whatever), feel free to correct it. 1.1. Introduction to OpenCV 7 OpenCV-Python Tutorials Documentation, Release 1 And that will be a good task for fresher's who begin to contribute to open source projects. Just fork the OpenCV in GitHub, make necessary corrections and send a pull request to OpenCV.

OpenCV developers will check your pull request, give you important feedback and once it passes the approval of the reviewer, it will be merged to OpenCV. Then you become a open source contributor. Similar is the case with other tutorials, documentation etc. As new modules are added to OpenCV-Python, this tutorial will have to be expanded. So those who knows about particular algorithm can write up a tutorial which includes a basic theory of the algorithm and a code showing basic usage of the algorithm and submit it to OpenCV. Remember, we together can make this project a great success!!! Contributors Below is the list of contributors who submitted tutorials to OpenCV-Python.

1. Alexander Mordvintsev (GSoC-2013 mentor)

2. Abid Rahman K. (GSoC-2013 intern)

Additional Resources

1. A Quick guide to Python - A Byte of Python

2. Basic NumPy Tutorials

3. NumPy Examples List

4. OpenCV Documentation

5. OpenCV Forum

Install OpenCV-Python in Windows

Goals In this tutorial

We will learn to setup OpenCV-Python in your Windows system. Below steps are tested in a Windows 7-64 bit machine with Visual Studio 2010 and Visual Studio 2012. The screenshots show VS2012.

Installing Open CV from prebuilt binaries

1. Below Python packages are to be downloaded and installed to their default locations.

Python-2.7.x.

NumPy.

Matplotlib (Matplotlib is optional, but recommended since we use it a lot in our tutorials).

2. Install all packages into their default locations. Python will be installed to C:/Python27/.

3. After installation, open Python IDLE. Enter import NumPy and make sure NumPy is working fine.

4. Download latest OpenCV release from source forge site and double-click to extract it.

5. Go to OpenCV/build/python/2.7 folder.

6. Copy cv2.pyd to C:/Python27/lib/site-packeges.

7. Open Python IDLE and type following codes in Python terminal.

```
>>> import cv2

>>> print cv2.__version__
```

If the results are printed out without any errors, congratulations!!! You have installed OpenCV-Python successful Download and install necessary Python packages to their default locations

1. Python 3.6.8.x

2. NumPy

3. Matplotlib (Matplotlib is optional, but recommended since we use it a lot in our tutorials.) Make sure Python and NumPy are working fine.

4. Download OpenCV source. It can be from Source forge (for official release version) or from GitHub (for latest source).

5. Extract it to a folder, OpenCV and create a new folder build in it.

6. Open CMake-gui (Start > All Programs >CMake-gui)

7. Fill the fields as follows (see the image below):

7.1. Click on Browse Source... and locate the OpenCV folder.

7.2. Click on Browse Build... and locate the build folder we created.

7.3. Click on Configure.

7.4. It will open a new window to select the compiler. Choose appropriate compiler (here, Visual Studio 11) and click Finish.

7.5. Wait until analysis is finished.

8. You will see all the fields are marked in red. Click on the WITH field to expand it. It decides what extra features you need. So, mark appropriate fields. See the below image:

9. Now click on BUILD field to expand it. First few fields configure the build method. See the below image:

10. Remaining fields specify what modules are to be built. Since GPU modules are not yet supported by Open CV Python, you can completely avoid it to save time (But if you work with them, keep it there). See the image below:

11. Now click on ENABLE field to expand it. Make sure ENABLE_SOLUTION_FOLDERS is unchecked (Solution folders are not supported by Visual Studio Express edition). See the image below:

12. Also make sure that in the PYTHON field, everything is filled. (Ignore PYTHON_DEBUG_LIBRARY). See image below:

13. Finally click the Generate button.

14. Now go to our opencv/build folder. There you will find OpenCV.sln file. Open it with Visual Studio.

15. Check build mode as Release instead of Debug.

16. In the solution explorer, right-click on the Solution (or ALL_BUILD) and build it. It will take some time to finish.

17. Again, right-click on INSTALL and build it. Now OpenCV-Python will be installed.

18. Open Python IDLE and enter import cv2. If no error, it is installed correctly

CHAPTER 7

7. RESULT

At the end of the automatic mode, robot tracks, analyses the colour of the picked object and drops the object into the respective coloured container. At the end of manual mode, robot moves and does the task as desired by the user according to the commands given through the application(app).

FUTURE ENHANCEMENT

Tracking of multiple objects. Position of container can be autonomous. Area of coverage can be expanded.

CHAPTER 8

8.ACKNOWLEDGEMENT

We would like to thank VGST (Vision Group on Science and Technology), Government of Karnataka, India for providing infrastructure facilities through the K-FIST Level II project at KSIT, CSE R&D Department, Bengaluru

CHAPTER 9

9 REFERENCES

[1] Dhruv Pande, Chavis Sharma, Vikas Upadhyaya, “Object Detection and Path Finding Using Monocular Vision”,Inc. 2014 IEEE.

[2] Hyung-Bok Kim and Kween-Bo Sim, “A Particular Object Tracking in An Environment of Multiple Moving Objects”, International Conference on Control, Automation and Systems 2010.

[3] MaimunHujaHusin, FauzilianaOsma, “Development of shape pattern recognition for FPGA-based object tracking system” Inc 2014.

[4] Ana Maria Ocana, Francisco Calderon, “preliminary studies on the taxonomy of objects tracking algorithm in video sequences” Inc. 2013.

[5] https://en.Wikipedia.org/wiki/Green%27s_theorem

[6] Jaya P and GeethuBalakrishnan, Contour Based Object Tracking, IJCSIT 2014.

[7] Narayan Pandharinath Pawar & Meenakshi M. Patil, Driver Assistance System based on Raspberry Pi, International Journal of Computer Applications (0975 – 8887) Volume 95– No.16, June 2014, pp. 36-39