

Rover for Forest Exploration and Forest Mapping

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
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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MAY - 2022



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION
ENGINEERING**

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **A AAKASH** (38130001) and **K ASHIF RASHEED** (38130017) who carried out the project entitled **ROVER FOR FOREST EXPLORATION AND FOREST MAPPING** under my supervision from December 2021 to May 2022.

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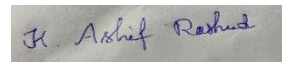
We **A AAKASH (38130001)** and **K ASHIF RASHEED (38130017)** hereby declare that the Project Report entitled **ROVER FOR FOREST EXPLORATION AND FOREST MAPPING** done by us under the guidance of Ms.T.THAJ MARY DELSY., M.E., (Ph.D.) is submitted in partial fulfillment of the requirements for the award of a Bachelor of Engineering degree in ELECTRONICS AND COMMUNICATION ENGINEERING.

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ACKNOWLEDGEMENT

I am very pleased to acknowledge my sincere thanks to the Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

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

I would like to express my sincere and deep sense of gratitude to my Project Guide **Ms.T.THAJ MARY DELSY, M.E., (Ph.D.)** for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

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

Abstract

Exploring new forest terrains has always been dangerous and extremely difficult. The major factors making it dangerous are the unknown fauna and habitat. This is where the Rover comes into play which helps us Identify the species of a particular habitat. The mainframe of this entire system is the raspberry pi 4. The image processing library uses VGG16 object classification algorithm for identification of the object from the real time data that has been transferred through the cam and the ultrasonic sensor is used to detect the obstacle that comes in the way during the course of the rover.

The software architecture is designed in such a way that it won't put extra burden on the raspberry pi since it doesn't have a powerful CPU. So initially the webcam observes the environment with the help of an ultrasonic sensor and if it identifies any objects such as an animal like Elephant, Wild Boar etc. it captures at the location where it was found and stores it in the Rom. But in case if it doesn't identify the animals, it runs the object detection algorithm to identify the species and stores it accordingly.

The hardware isn't that complicated either. The motor shield(L298) has been employed to control the motors of the rover and has been supervised by the Arduino and gets command from the raspberry pi which acts as a central network for both the software and hardware architecture.

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CHAPTER - 1

INTRODUCTION

Forestry is a large rural sector in India, as well as a vital environmental resource. India is one of the world's top 10 forest-rich countries. India and the other nine countries account for 67 percent of the world's total forest area.

Following decades of great worry about forest degradation, India's forest cover grew at a pace of 0.20 percent per year between 1990 and 2000, and has grown at a rate of 0.7 percent per year between 2000 and 2010, after decades of serious concern about forest degradation.

The United Nations Food and Agriculture Organization estimates India's forest cover to be over 68 million hectares, or 22 percent of the country's total area, as of 2010. According to satellite data, India's forest cover expanded to 69.8 million hectares by 2012, a gain of 5,871 square kilometers in two years, according to the 2013 Forest Survey of India.

However, the gains were concentrated in northern, central, and southern Indian states, with a net loss of forest cover in northeastern states from 2010 to 2012. India's total forest and tree cover climbed to 24.39 percent, or 8,02,088 km², in 2018. In 2019, it climbed to 24.56 percent, or 807,276 square kilometers.

India's rural and urban poor will continue to have to meet their energy needs through unsustainable forest destruction and fuel wood use unless the country makes a massive, quick, and continuous effort to develop electricity generation and power plants.

India's reliance on fuel wood and forestry products as a key energy source is not only unsustainable for the environment, but it is also a major contributor to the country's near-permanent haze and air pollution.

In India, forestry is considerably more than just wood and fuel. Latex, gums, resins, essential oils, flavors, perfumes, and aroma compounds, incense sticks, handicrafts, thatching materials, and medicinal plants are all produced in India's non-wood forest products business.

Local consumption accounts for about 60% of non-wood forest product production. Non-wood forest products account for over half of the entire revenue generated by India's forestry industry.

1.1 Objectives

The following are the objectives of this project:

The main objective of the project is to identify the species of a new habitat before sending humans in person so that we can minimize the casualties that could happen in unknown terrain.

Usually, we send researchers to a new habitat in order to identify the place and species with the help of forest officers or local tribes.

But this in most cases doesn't go well and may result in casualties or accidents.

This IOT AI rover could prevent that from happening by analyzing the habitat and species before sending in the human task force. Thereby generating a rational report of the habitat.

The rational report of the habitat is stored as a Spatio-Temporal Data (Spatiotemporal data are data that relate to both space(location) and time).

CHAPTER – 2

Literature Survey

2.1 VGG16 Algorithm

Xuemei Xie et al. in 2022, discussed the state-of-the-art real-time detection network single-shot multi-box detector (SSD) for multi-target detection. It is based on the VGG16 base network and includes some convolutional layers. When utilized for 21 categories classification in the VOC dataset, its basic network VGG16, which was intended for 1000 categories in the ImageNet dataset, is clearly overparameterized. In this paper, we use the deconvolution approach to display the VGG16 base network in an SSD network. Due to its semantic nature, we investigate the discriminative feature learned by the VGG16 network's last layer conv5 3.

2.2 Convolutional Neural Networks

Nopparut Li et al. in 2020 discussed about the Many attempts that have been made to detect animals using Convolutional Neural Networks and Many of them, however, failed to detect animals behind cage bars because the mesh patterns of such bars often interfered with a detection model's detectability. One of the key hypotheses is that most existing animal detection methods don't have enough photographs of animals behind cage bars in their training set. The panda and the deer are utilized as case studies in this paper. The training data was collected specifically for this study.

Anugrah Bintang Perdana et al. in 2020 discussed the Biometric technology such as facial recognition, retina scans, and fingerprint mapping that are currently used in identification and verification systems to recognize a person's identity. Traditional approaches for face recognition normally include four stages: face detection, face alignment, feature extraction, and classification. Deep learning has recently gained popularity in the face recognition job because to its superior performance over previous approaches and the simplicity of its design, which combines feature extraction and classification in a single architecture. Face recognition programs have effectively integrated deep learning, particularly Convolutional Neural Networks (CNN). Many different CNN-based algorithms have been successful in improving face recognition ability.

Benjamin Kellenberger et al. in 2019 showed how to reuse a deep Convolutional Neural Network (CNN)-based object detector on a new data set using an Active Learning (AL) technique. Their goal is to train an animal detector that can be utilized for repeated acquisitions, such as in follow-up years, given a collection of photos obtained with an Unmanned Aerial Vehicle (UAV) and manually annotated ground truth. Such a straight model application is usually impossible due to domain shifts between data sets. As a result, they recommend that AL be used to bridge this gap, as well as the introduction of a new criterion dubbed Transfer Sampling (TS). TS uses Optimal Transport (OT) to discover matching regions in the space of CNN activations between the source and target data sets.

Famxu meng et al. in 2021 discussed about the residual connection that allows for the training of very deep neural networks, its multi-branch architecture makes it unsuitable for online inference. This has prompted many academics to focus their efforts on developing DNNs with no residual connections during the inference stage. When deploying, RepVGG, for example, re-parameterizes multi-branch topology to a VGG-like (single-branch) model, resulting in excellent performance when the network is shallow. RepVGG, on the other hand, is unable to convert ResNet to VGG in the same way because re-parameterizing methods can only be applied to linear blocks, and non-linear layers (ReLU) must be placed outside of the residual connection, resulting in limited representation ability, particularly for deeper networks.

These papers have talked in depth of various aspect of new innovations and notions that helped us in the process of building the rover and AI model which acts as the central neural system. The AI model uses CNN and VGG16 to create object detection model that identifies the wildlife in the given terrain. The obstacle detection and avoiding system uses ultra-sonic sensors to detect the things that come in the way and act according to it during the course of the route. For the future advancement, implementation of radar and GPS, system could enable a better navigation system and also come up with a passage for the humans during further expedition in the future.

CHAPTER - 3

AIM AND SCOPE

3.1 AIM

We aim to achieve an ecosystem between the software and hardware for the rover that synchronously runs the software and helps to achieve the desired result that the project is expected to deliver. This software-hardware ecosystem for the rover that executes software synchronously and contributes to the project's planned outcome.

3.2 SCOPE

The major scope for the project is to deliver a Rover that helps to monitor areas that are hard to govern or unreachable areas for humans like the forest, farmland, barns etc. The project's main goal is to develop a Rover that can monitor regions that are difficult to control or inaccessible to humans. The future scope for the project, increase the battery life and make it more of an off-road mechanic system this will allow us to get into deep forest area where the terrain is rough. Also planning in to prepare swam that will coordinate with each other through an AI system that monitors and tracks the activity of each other. This helps in widening the terrain of search and wildlife, which enables this much more of an expedition, gets much better data about the flora and fauna of the area.

Finally, we can add a miniature drone to each rover which can examine the ariel area of the terrain that could help us to get a better 3d imaging of the area as well as the better imaging of the wildlife over there. These drones also can capture the predators that could hide themselves well in the tree tops which could help the future human team to avoid them when there are exploring those regions in person. For better navigation, planning on adding radar systems and GPS for determining the routes of the given terrain and also helps in coming up with a better route for human exploration.

CHAPTER – 4

METHODS AND PROCESS

4.1 Proposed System

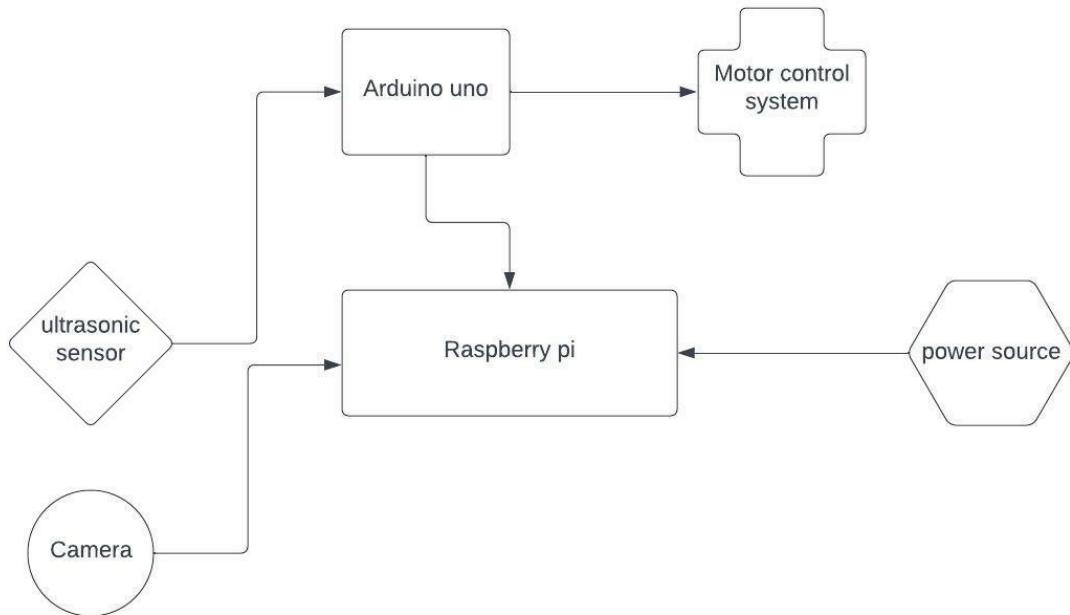


Fig. 4.1: BLOCK DIAGRAM

In this block diagram the Raspberry pi is connected to the camera. The pictures taken is sent to the raspberry pi, where the image processing algorithm detects animals. An Arduino uno which is also connected to the raspberry pi controls the ultrasonic sensor and motor control system which is responsible for the movement of the rover. The power source is connected to the raspberry pi.

4.2 Working Methodology

The system has two sections, hardware and software. Hardware consists of Raspberry pi 4 which is connected through USB using the UART protocol to an Arduino UNO that governs the motor shield and the ultrasonic sensor. Raspberry pi acts as a hub for collecting data from the Arduino and the camera and run's object identification process on it. The presence of animal in the surrounding data is governed through the ultrasonic sensor and captures the animal and sends it to the Raspberry through UART where it runs an image processing algorithm to identify the animal and stores it in its database.

4.3 Detection methodology

4.3.1 CNN

Deep learning techniques are based on neural networks, which are a subset of machine learning. They're made up of node levels, each of which has an input layer, one or more hidden layers, and an output layer.

Each node is connected to the others and has a weight and threshold assigned to it. If a node's output exceeds a certain threshold value, the node is activated, and data is sent to the next tier of the network.

For classification and computer vision tasks, convolutional neural networks (ConvNets or CNNs) are more commonly used. Identifying things in photos before CNNs required laborious, time-consuming feature extraction approaches.

Convolutional neural networks use principles from linear algebra, notably matrix multiplication, to discover patterns inside an image, making them more scalable for image classification and object recognition tasks. They can, however, be computationally intensive, necessitating the use of graphics processing units (GPUs) to train models.

4.3.2 VGG16 Architecture

ImageNet, a massive visual database project used in visual object detection, uses VGG16, a simple and widely used Convolutional Neural Network (CNN) Architecture.

The convnets are fed a fixed-size 224 x 224 RGB picture during training. The only pre-processing done here is subtracting the mean RGB value derived on the training set from each pixel.

The image is processed through a stack of convolutional (conv.) layers, where filters with a very narrow receptive field are utilized, such as 3 x 3 (which is

the smallest size to capture the notions of left/right, up/down, and center and has the same effective receptive field as one 7×7).

It's more complex, with more non-linearities and fewer parameters. 1×1 convolution filters, which can be thought of as a linear transformation of the input channels (followed by non-linearity), are also used in one of the configurations.

For 3×3 convolutional layers, the convolution stride and spatial padding of the conv. layer input are both set to 1 pixel, ensuring that the spatial resolution is kept after convolution. Spatial pooling is aided by five max-pooling layers that follow parts of the convolutional layers. Max-pooling is done with stride 2 over a 2×2 -pixel window.

Following a stack of convolutional layers (which have varying depths in various designs), there are three Fully-Connected (FC) layers: the first two have 4096 channels apiece, while the third performs 1000-way ILSVRC classification and so has 1000 channels (one for each class)

The soft-max layer comes last. All networks have the same configuration of completely linked layers. In ILSVRC, the 16-layer VGG architecture performed best, with a top-five error rate of 7.3 percent (92.7 percent accuracy).

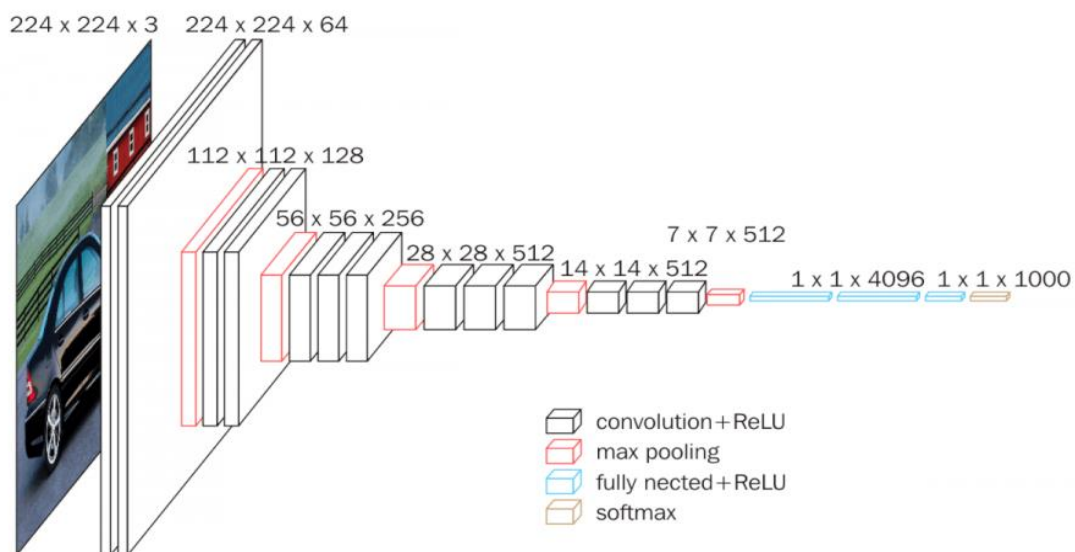


Fig. 4.2: Object model classification

4.4 Workflow for motion

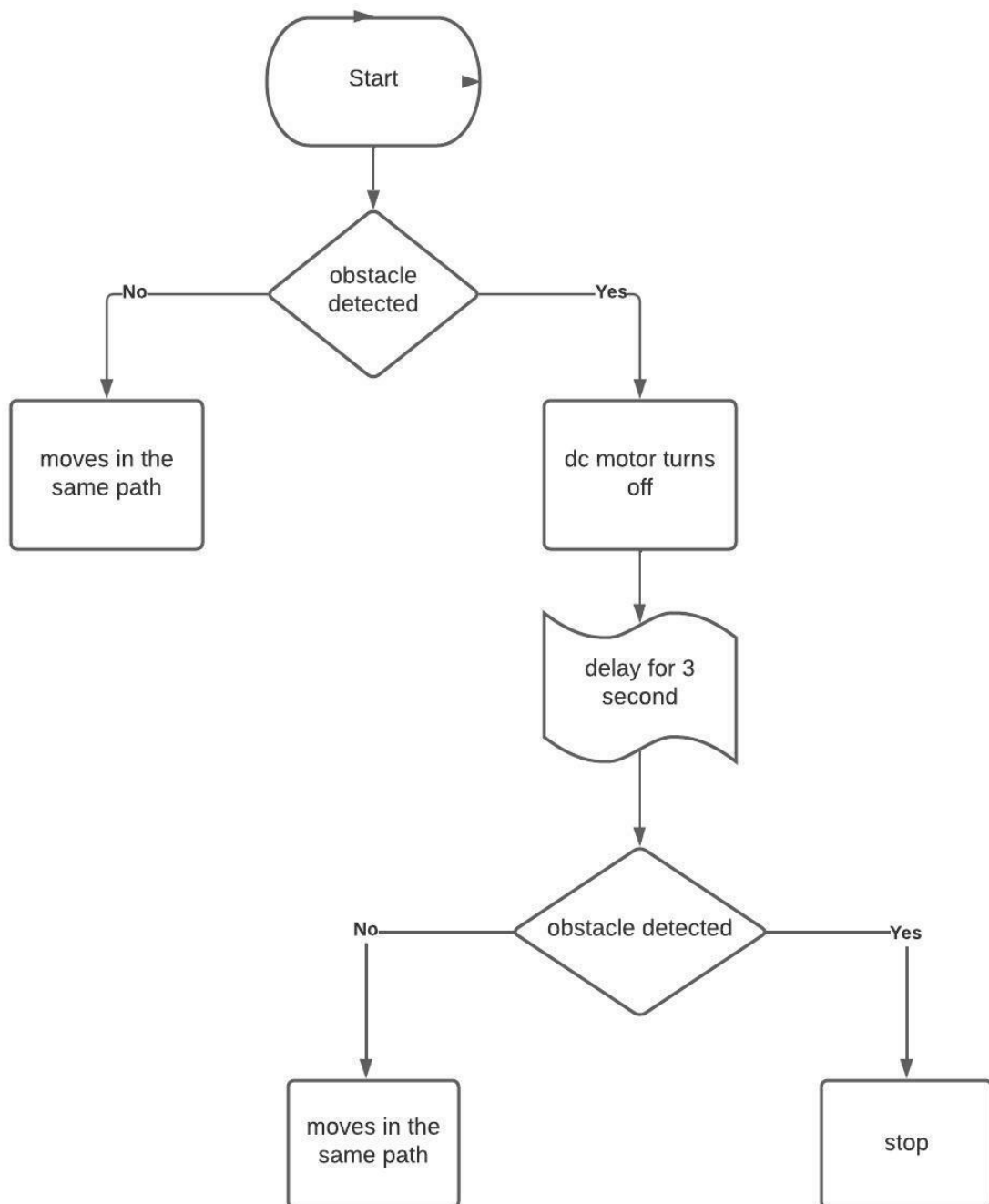


Fig. 4.3: Work flow for motion

The rover starts moving after it's turned on. If an obstacle is its way the rover detects it and stops and the dc motor is turned off for 3 seconds. The rover looks

again if the obstacle is still present the rover stops completely or else it starts moving in the same path.

4.5 Workflow for detection

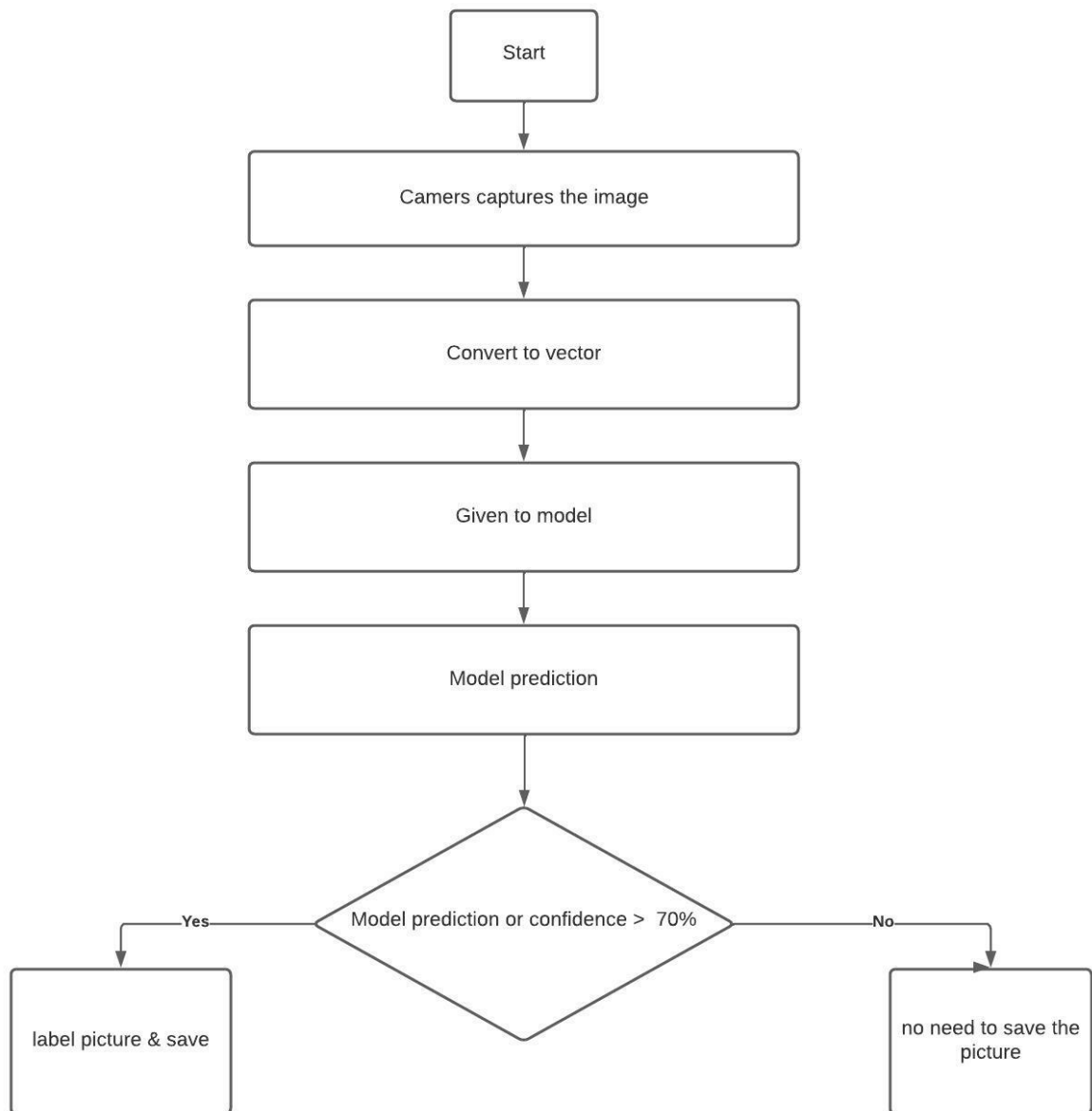


Fig. 4.4: Workflow for detection

The rover takes a picture which is converted into a vector and sent to the model. The model then makes a prediction. If the confidence is greater than 70% the picture is labeled and saved if not the picture is discarded.

4.6 Standards

Various standards used in this project are:

- **UART**

It's essentially an asynchronous multi-master protocol based on Serial communication that lets you communicate across the two boards. Don't worry, there are libraries that can take care of all the low layers for you.

The term "multi-master" refers to the ability for all linked devices to deliver data whenever they choose. This is one of the most significant changes from master-slave protocols, in which only the master device can initiate communication.

When you need master-slave configurations, you'll usually utilize other protocols like I2C and SPI, such as when you have one Arduino board and many sensors or actuators.

You can use the Arduino Uno board's single UART either using a USB cable or from the RX/TX ports (but not both at the same time). Some boards have more UARTs than others. The Arduino Mega, for example, has many Serials (Serial, Serial1, Serial2, Serial3), whereas the Arduino Zero only has a native USB connector (use Serial USB instead of Serial).

Many Serial devices can be connected to the Raspberry Pi's USB ports. Each device will have a unique name. The GPIOs (RX0/TX0) can also be used as an extra UART.

- **Secure Shell (SSH)**

It's a cryptographic network protocol for securely delivering network services across an unprotected network. SSH may be used to secure any network service, including remote command-line login and execution. In a client-server architecture, SSH connects an SSH client programme to an SSH server and offers a secure route over an unprotected network. SSH-1 and SSH-2 are two significant versions of the protocol specified in the protocol specification. SSH uses port 22 as its standard

TCP port. In our project, we're utilizing it to connect to the Raspberry Pi using PuTTY as an SSH client.

4.7 Software Details

Google colab and Jupiter Notebook, Keras, Scikit-learn.

4.7.1 Google Colab

To be more specific, Colab is a cloud-based Jupyter notebook environment that is free to use. Most importantly, it doesn't require any setup, and the notebooks you create may be modified concurrently by your team members, much like Google Docs projects. Many common machine learning libraries are supported by Colab and can be quickly loaded into your notebook.

4.7.2 Keras

Keras is a Google-developed high-level deep learning API for creating neural networks. It is built in Python and is used to make neural network construction simple. It also allows for the calculation of numerous neural networks in the backend.

Keras is simple to understand and use since it gives a high-level python frontend with the possibility of different backends for computation. Keras is slower than other deep learning frameworks because of this, yet it is incredibly user-friendly.

Keras lets you to swap back and forth between several back ends. Keras is compatible with the following frameworks:

- PlaidML
- MXNet
- Theano
- CNTK (Microsoft Cognitive Toolkit)
- TensorFlow

TensorFlow is the only one of these five frameworks that have accepted Keras as its official high-level API. Keras is a deep learning framework that is built on top of TensorFlow and has built-in modules for all neural network calculations.

At the same time, you can use the TensorFlow Core API to create custom computations using tensors, computation graphs, sessions, and so on, giving you complete freedom and control over your application and allowing you to execute your ideas in a short amount of time.

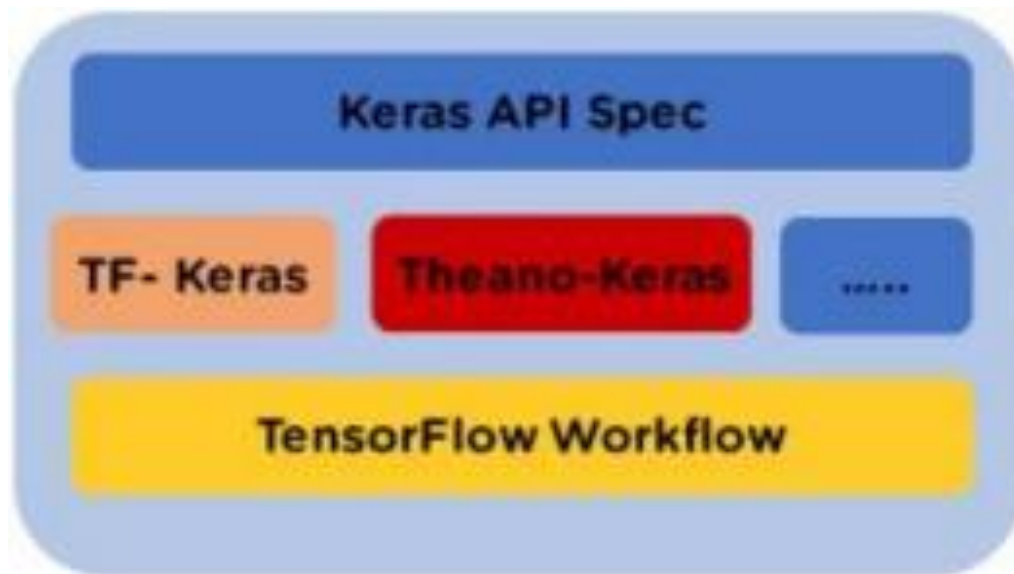


Fig. 4.5: KERAS

4.7.3 Scikit-learn

Scikit-learn is a Python package that includes a variety of supervised and unsupervised learning techniques. It's based on NumPy, pandas, and Matplotlib, which you may already be acquainted with.

The following are some of the features provided by scikit-learn:

- Preprocessing, including Min-Max Normalization
- Model selection
- Classification, including K-Nearest Neighbors
- Regression, including Linear and Logistic Regression
- Clustering, including K-Means and K-Means++

4.8 Hardware Details

We have various hardware components being used in this system. The details of each component are as follows

4.8.1 Raspberry Pi

The Raspberry Pi is a low-cost computer the size of a credit card that connects into a computer display or TV and utilizes a conventional keyboard and mouse, as seen in Figure 4.6. It's a powerful small gadget that allows individuals of all ages to learn about computers and programming languages like Scratch and Python.

It can do everything a desktop computer does, including accessing the internet and watching high-definition video, as well as spreadsheets, word processing, and gaming.



Fig. 4.6: raspberry pi

The Raspberry Pi is powered by an ARM CPU, which does practically all of the heavy lifting. The Raspberry Pi's main purpose is to collect data from various nodes, such as Arduino, and post it to the Firebase database. Raspbian is a Linux based operating system.

Installation of Raspbian OS

1. Format the SD card—During formatting, anything on the SD card will be overwritten. If the SD card on which you intend to install Raspbian presently has any

files on it, such as from a previous version of Raspbian, you should back them up beforehand to avoid losing them forever.

2. NOOBS (New Out of Box Software) - The quickest approach to install Raspbian on your SD card is to use the NOOBS software.

- Visit the Raspberry Pi downloads page to get NOOBS.
- NOOBS must be extracted from the zip archive.
- Next, Extract the files from NOOBS zip Folder which was downloaded from Raspberry Pi website
- To extract the files, double-click it and keep the resultant Explorer/Finder window open.
- To copy the files to the SD card, select all of the files in the NOOBS folder and drag them into the SD card window.

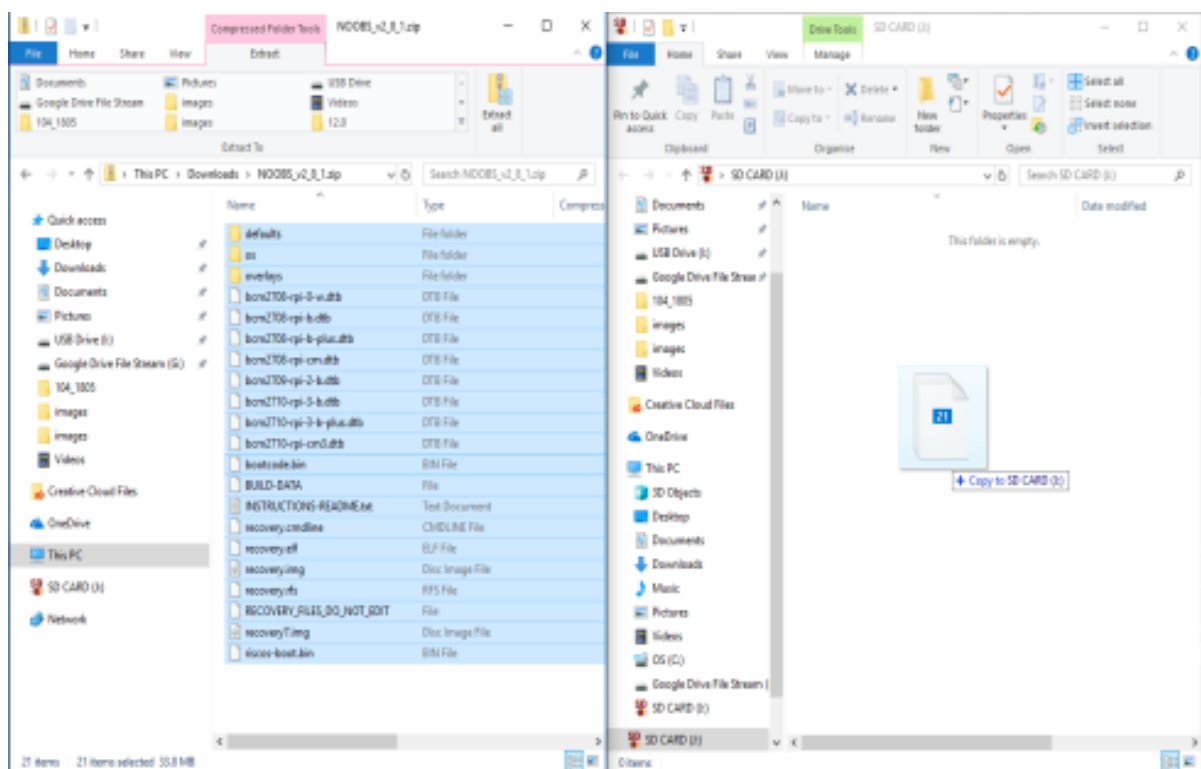


Fig. 4.7: Copying to Sim Card

3. Connect your Raspberry Pi to your computer.

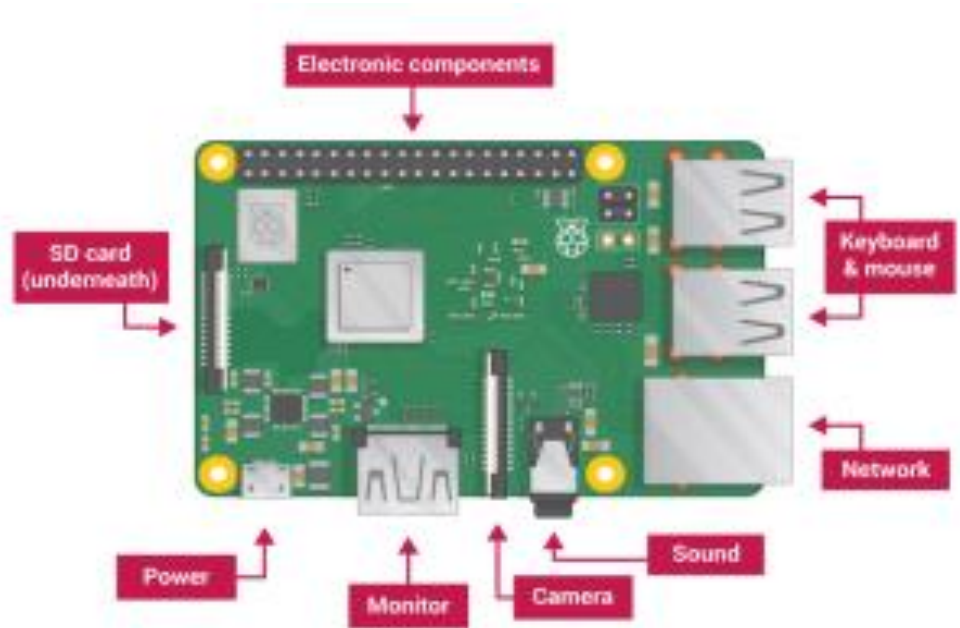


Fig. 4.8: Raspberry Pi

- In the slot 14, insert the SD card with Raspbian (through NOOBS).
- Connect the keyboard and mouse to the Raspberry Pi's USB interface.
- Connect a screen to the Pi's HDMI interface using a cable - an adaptor may be required.
- Connect a micro-USB power supply to the Raspberry Pi's power port to boot up.
- The Raspberry Pi's red LED illuminates when it is connected to power supply. Raspberries will appear in the top left-hand corner of the screen when it starts up.



Fig. 4.9: Powering Raspberry Pi

The Raspbian Desktop will appear in a few seconds.



Fig. 4.10: Raspbian Desktop

4. Complete the setup.

The Welcome to Raspberry Pi programme will appear when you boot up your Raspberry Pi for the first time and walk you through the basic setup.



Fig. 4.11: Raspberry Pi Welcome Screen

- Click Next to start the setup.
- To complete the setup, click Done or Reboot.

Working directly on the Raspberry Pi is not always easy, since we may need to work on it remotely from another device. VNC (Virtual Network Computing) is a graphical desktop sharing technology that allows us to control the desktop interface of one computer (running VNC Server) from another computer or mobile device

(running VNC Viewer). VNC Viewer sends keyboard, mouse, and touch events to VNC Server, which gets updates to the screen in return.

VNC viewer and VNC server

VNC is a graphical desktop sharing technology that lets you control the desktop of one computer (running VNC Server) from another computer or mobile device (running VNC Viewer).

VNC Viewer sends keyboard, mouse, and touch events to VNC Server, which gets updates to the screen in return.

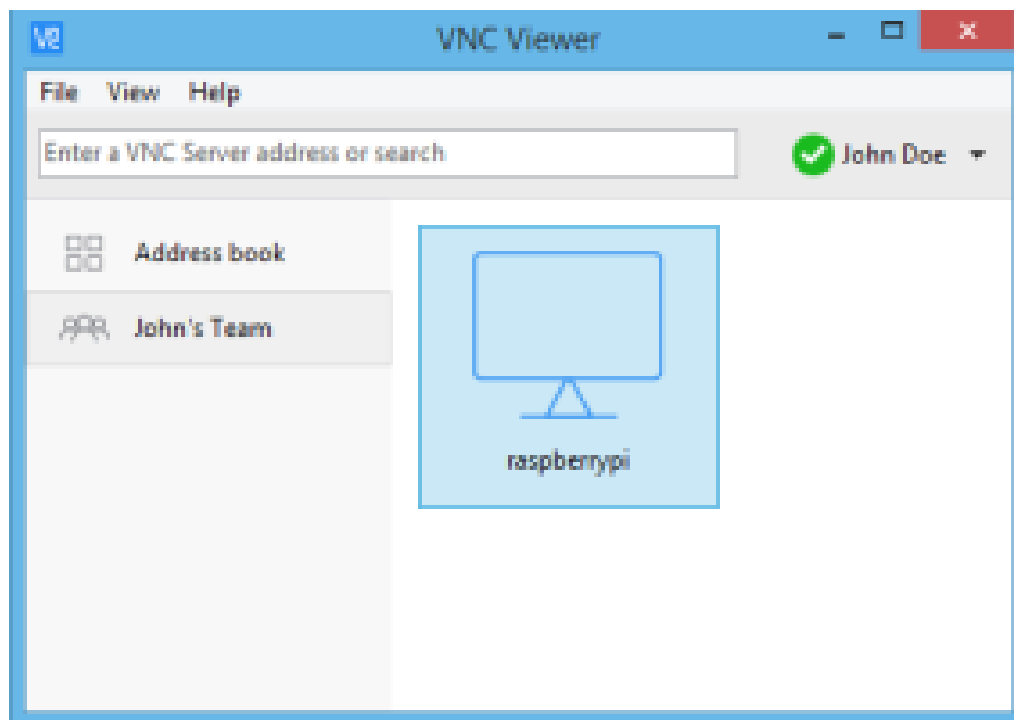


Fig. 4.12: VNC Viewer

Raspbian comes with VNC Connect from Real-VNC. It consists of two components: VNC Server, which enables us to remotely operate your Raspberry Pi, and VNC Viewer, which allows us to remotely control desktop PCs from our Raspberry Pi.

a. Switching on VNC Server

Run the following commands on the Raspberry Pi to ensure that the most recent version of VNC is installed. Follow the instructions below:

Enter the following commands in the Terminal.

- `sudo apt-get update`
- `sudo apt-get install realvnc-vnc-server realvnc-vnc-viewer` Now you may use VNC server. This may be done either visually or through the command line.
- Using a visual interface to enable VNC Server
 - ✓ Boot into the graphical desktop on your Raspberry Pi.
 - ✓ Choose Menu > Preferences > Raspberry Pi Configuration > Interfaces from the drop-down menu.
 - ✓ Make sure VNC is turned on.

Use the command line to enable VNC Server

- You can enable VNC Server at the command line
 - Type “`sudo raspi-config`”
 - Next, activate VNC Server by following these steps
 - ✓ Select Interfacing Options from the drop-down menu.
 - ✓ Select VNC > Yes from the drop-down menu.

b. Connecting to your Raspberry Pi with VNC Viewer

There are two ways to connect to your Raspberry Pi.

- Establishing a direct connection-Direct connection is quick and simple providing you're joined to the same private local network as your Raspberry Pi. For example, this might be a wired or wireless network at home, at school, or in the office).
- On your Raspberry Pi (using a terminal window or via SSH) use these instructions or run `ipconfig` to discover your private IP address.
- On the device you'll use to take control, download VNC Viewer. For best results, use the compatible app from RealVNC.
- Enter your Raspberry Pi's private IP address into VNC Viewer:

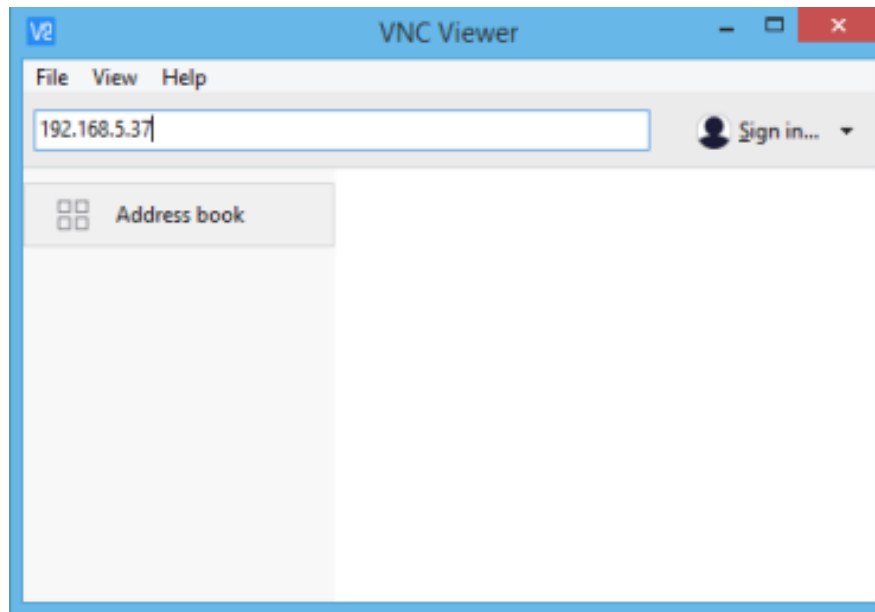


Fig. 4.13: VNC Viewer Address

- Establishing a cloud connection- Cloud connections are convenient and encrypted end-to-end. They are highly recommended for connecting to your Raspberry Pi over the internet.
- On your Raspberry Pi, sign in to VNC Server using your new RealVNC account credentials:

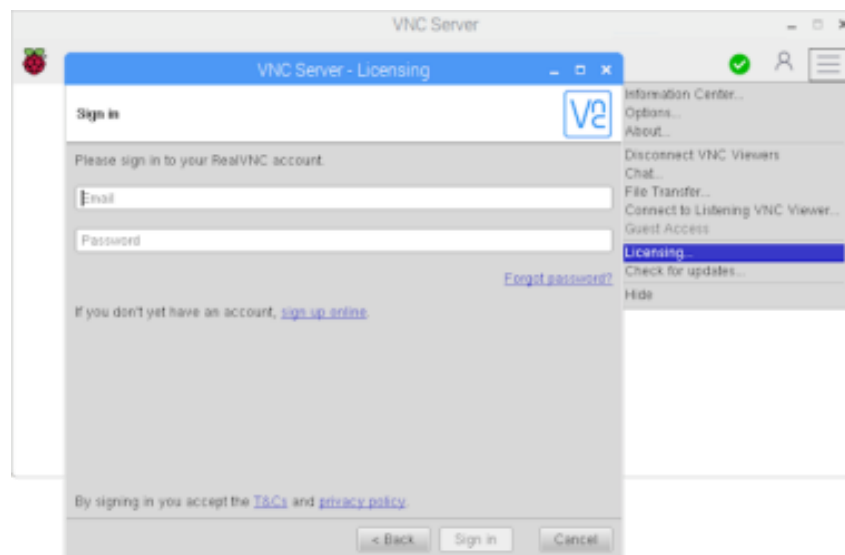


Fig. 4.14: VNC Server

- On the device you'll use to take control, download VNC Viewer.
- Sign in to VNC Viewer using the same RealVNC account credentials, and then connect to your Raspberry Pi or set up a new connection:

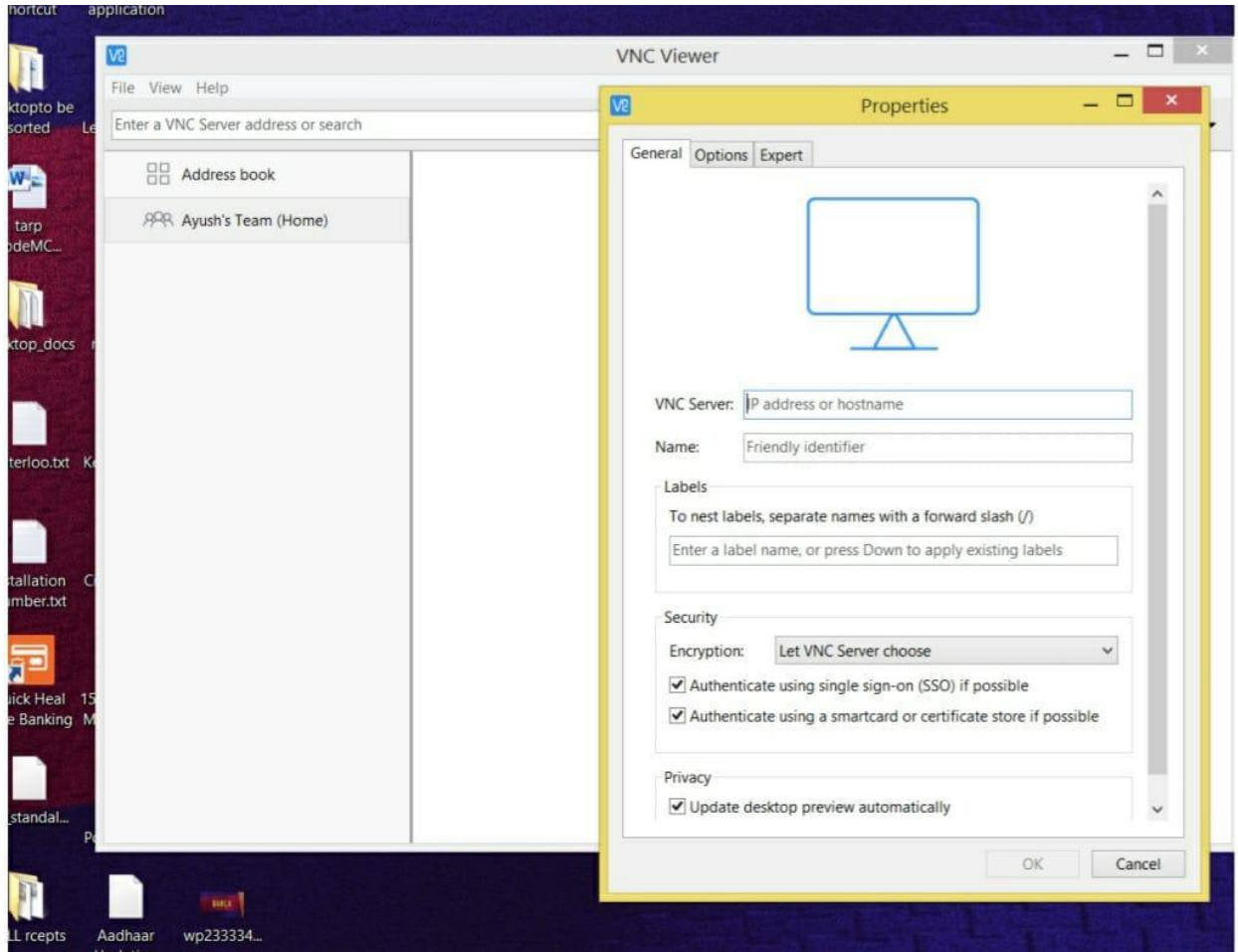


Fig. 4.15: VNC Properties Window

NOTE: IP address here is Internet IP address which is different from Ethernet IP (LAN) address as both Ethernet port and built in WIFI modules have different MAC addresses

4.8.2 Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a

USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your Uno without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

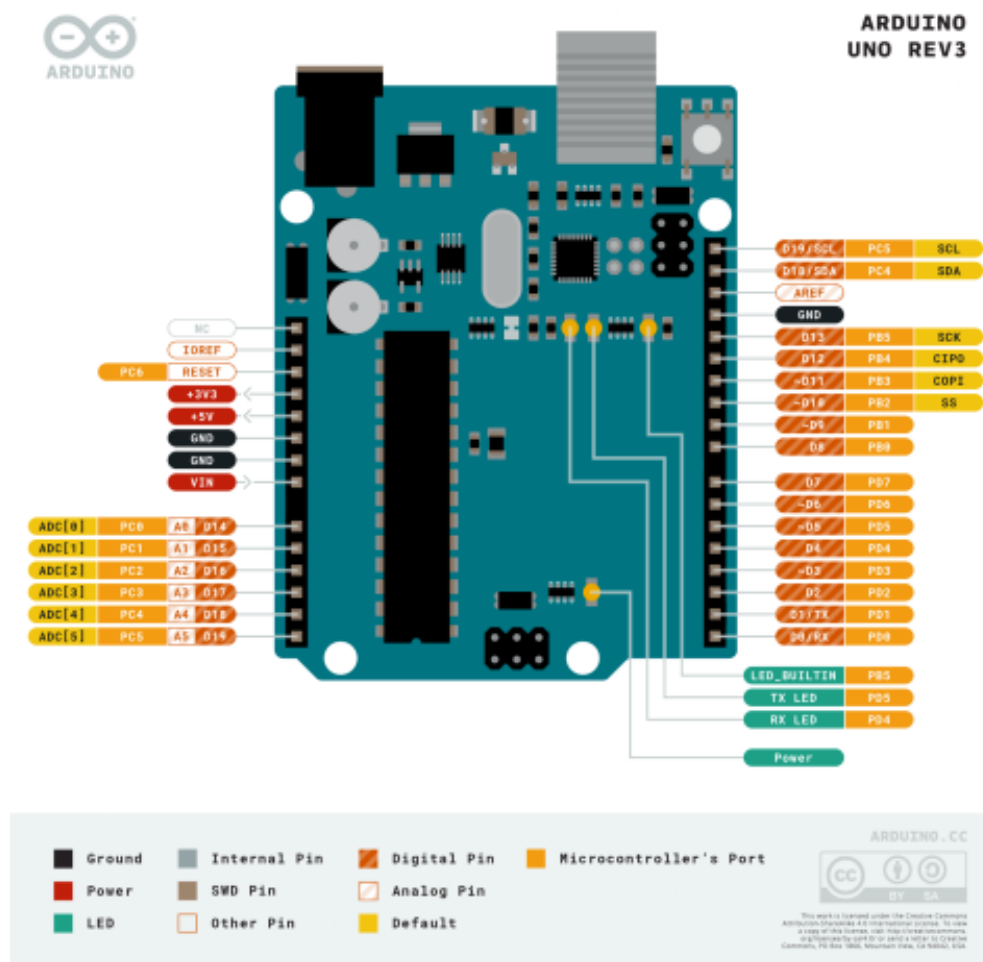


Fig. 4.16: Arduino

4.8.3 L298 MOTOR Controller

In order to have complete control over the DC motor, we have to control its speed and rotation direction. This can be achieved by combining these two techniques.

- PWM – For controlling speed
- H-Bridge – For controlling rotation direction

PWM – For controlling speed

The speed of a DC motor can be controlled by varying its input voltage. A common technique for doing this is to use PWM (Pulse Width Modulation)

PWM is a technique where the average value of the input voltage is adjusted by sending a series of ON-OFF pulses.

The average voltage is proportional to the width of the pulses known as Duty Cycle.

The higher the duty cycle, the greater the average voltage being applied to the dc motor (High Speed) and the lower the duty cycle, the less the average voltage being applied to the dc motor (Low Speed).

Below Fig. 4.17 illustrates PWM technique with various duty cycles and average voltages.

H-Bridge – For controlling rotation direction

The DC motor's spinning direction can be controlled by changing the polarity of its input voltage. A common technique for doing this is to use an H-Bridge.

An H-Bridge circuit contains four switches with the motor at the center forming an H-like arrangement.

Closing two particular switches at the same time reverses the polarity of the voltage applied to the motor. This causes a change in the spinning direction of the motor.

Below Fig. 4.18 illustrates H-Bridge circuit working.

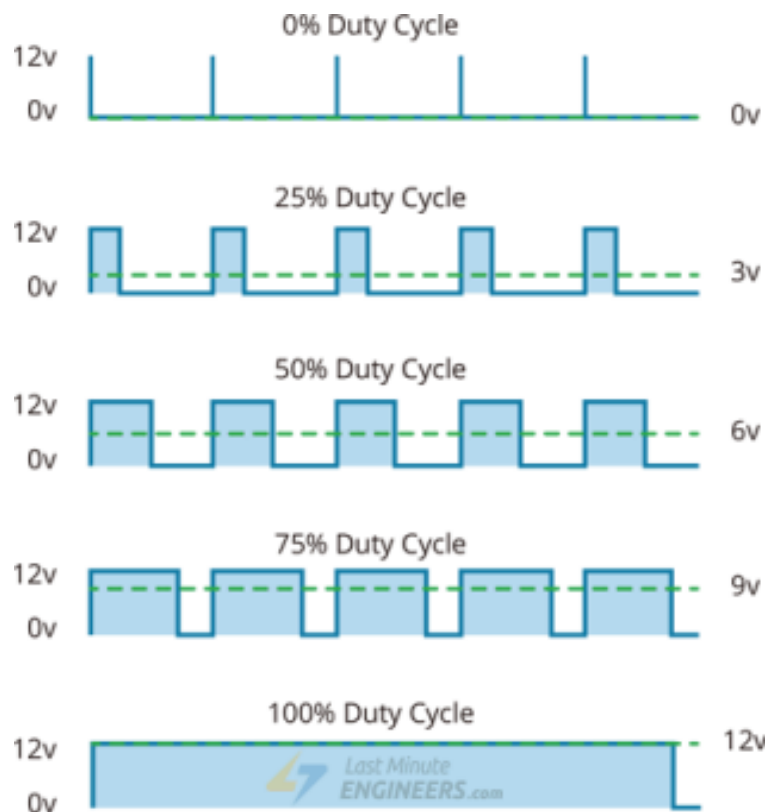


Fig. 4.17: Pulse Width Modulation (PWM) Technique

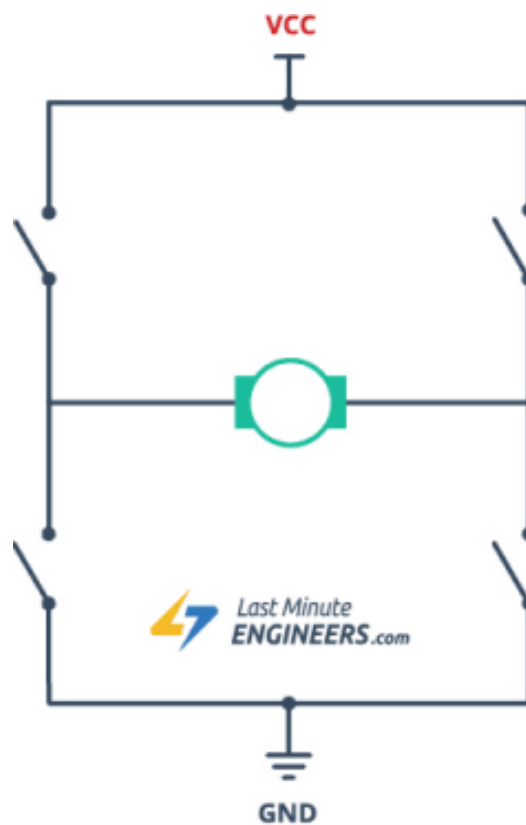


Fig. 4.18: Working of H-Bridge L298N Motor Driver IC

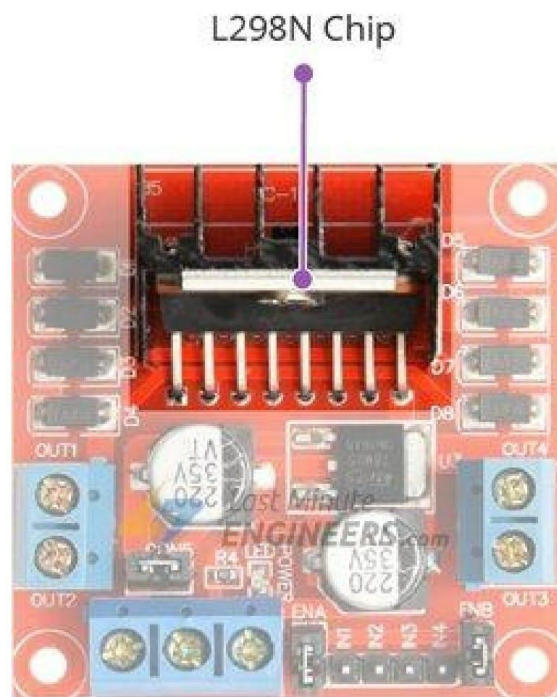


Fig. 4.19: L298N CHIP

At the heart of the module is the big, black chip with a chunky heat sink is an L298N.

The L298N is a dual-channel H-Bridge motor driver capable of driving a pair of DC motors. That means it can individually drive up to two motors making it ideal for building two-wheel robot platforms.

Power Supply

The L298N motor driver module is powered through 3-pin 3.5mm-pitch screw terminals. It consists of pins for motor power supply (V_s), ground and 5V logic power supply (V_{ss}). The L298N motor driver IC actually has two input power pins viz. ' V_{ss} ' and ' V_s '.

From V_s pin the H-Bridge gets its power for driving the motors which can be 5 to 35V. V_{ss} is used for driving the logic circuitry which can be 5 to 7V. And they both sink to a common ground named 'GND'.

The module has an on-board 78M05 5V regulator from STMicroelectronics. It can be enabled or disabled through a jumper.

When this jumper is in place, the 5V regulator is enabled, supplying a logic power supply(V_{ss}) from the motor power supply(V_s). In this case, the 5V input terminal acts as an output pin and delivers 5V 0.5A. You can use it to power up the Arduino or other circuitry that requires 5V power supply.

When the jumper is removed, the 5V regulator gets disabled and we have to supply 5 Volts separately through the 5 Volt input terminal.

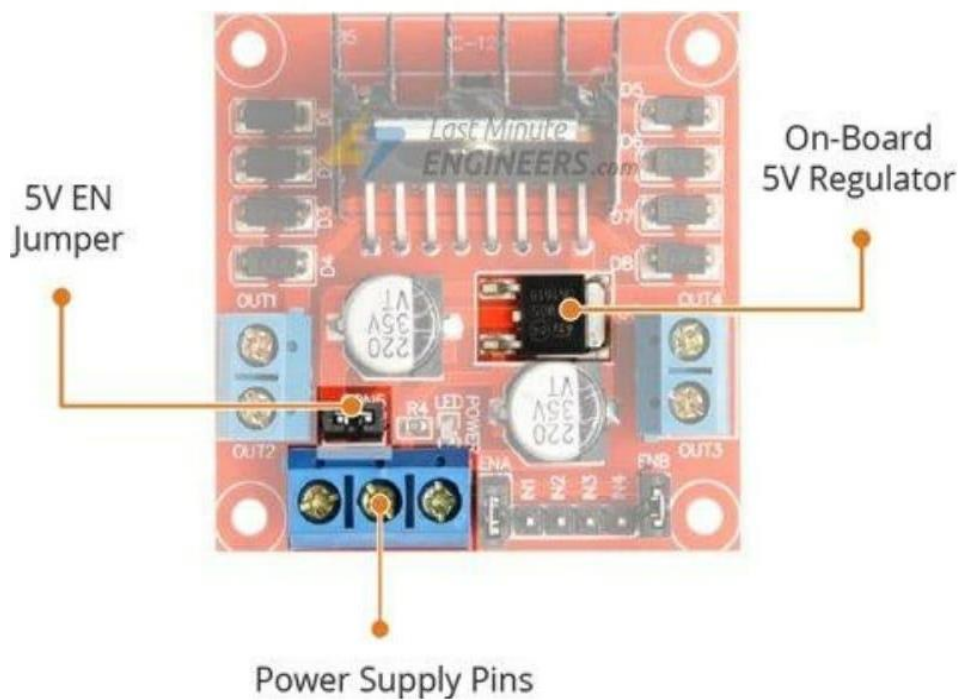


Fig. 4.20: JUMPER POWER SUPPLY PINS IN L298N CHIP

Warning:

You can put the jumper in place, if the motor power supply is below 12V. If it is greater than 12V, you should remove the jumper to avoid the onboard 5V regulator from getting damaged.

Also DO NOT supply power to both the motor power supply input and 5V power supply input when the jumper is in place.

Voltage Drop of L298N

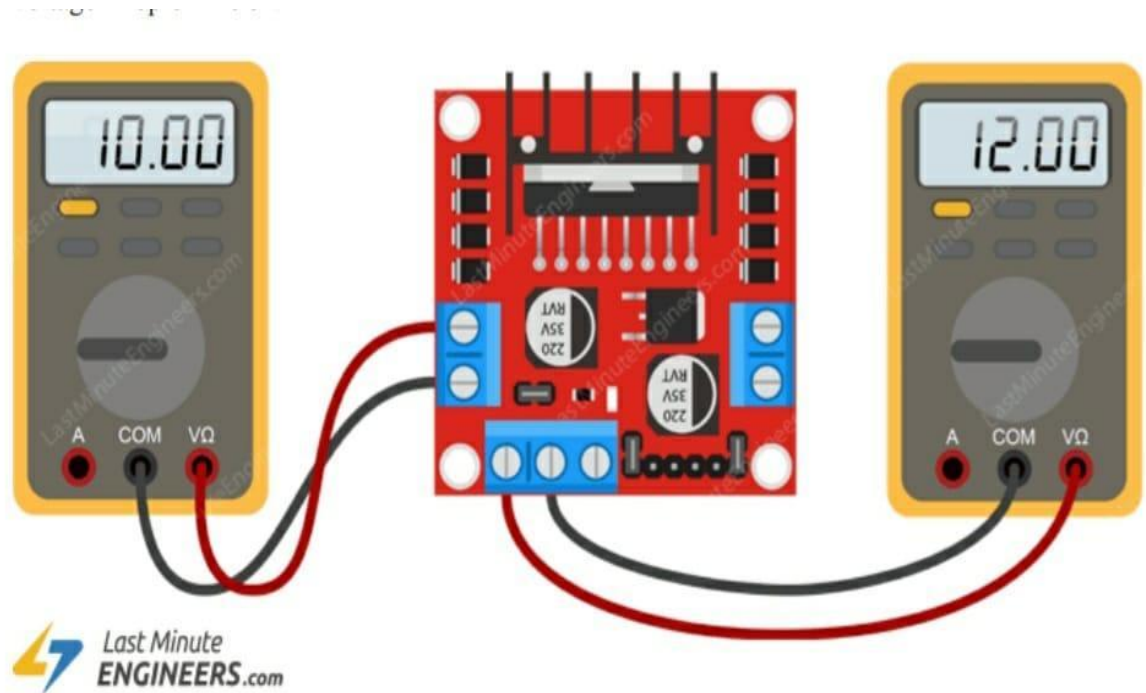


Fig. 4.21: Multi-Meter

The voltage drop of the L298N motor driver is about 2V. This is due to the internal voltage drop in the switching transistors in the H-Bridge circuit.

So, if we connect 12V to the motor power supply terminal, the motors will receive voltage around 10V. This means that a 12V DC motor will never spin at its maximum speed.

To get maximum speed out of the motor, the motor power supply should be a bit higher voltage(2V) than the motor's actual voltage requirement.

Considering the voltage drop of 2V, if you are using 5V motors you'll need to provide 7V at the motor power supply terminal. If you have 12V motors then your motor supply voltage should be 14V.

Output Pins



Fig. 4.22: OUTPUT PINS OF L298N CHIP

The L298N motor driver's output channels for the motor A and B are broken out to the edge of the module with two 3.5mm-pitch screw terminals.

You can connect two DC motors having voltages between 5 to 35V to these terminals.

Each channel on the module can deliver up to 2A to the DC motor. However, the amount of current supplied to the motor depends on the system's power supply.

Control Pins

For each of the L298N's channels, there are two types of control pins which allow us to control speed and spinning direction of the DC motors at the same time viz. Direction control pins & Speed control pins.

Direction Control Pins

Using the direction control pins, we can control whether the motor spins forward or backward. These pins actually control the switches of the H-Bridge circuit inside L298N IC.

The module has two direction control pins for each channel. The IN1 and IN2 pins control the spinning direction of the motor A while IN3 and IN4 control motor B.



FIG. 4.23: CONTROL PINS OF L298N CHIP

The spinning direction of a motor can be controlled by applying either a logic HIGH (5 Volts) or logic LOW (Ground) to these inputs.

Speed Control Pins

The speed control pins viz. ENA and ENB are used to turn the motors ON, OFF and control its speed.

Pulling these pins HIGH will make the motors spin, pulling it LOW will make them stop. But, with Pulse Width Modulation (PWM), we can actually control the speed of the motors.

The module usually comes with a jumper on these pins. When this jumper is in place, the motor is enabled and spins at maximum speed. If you want to control the speed of motors

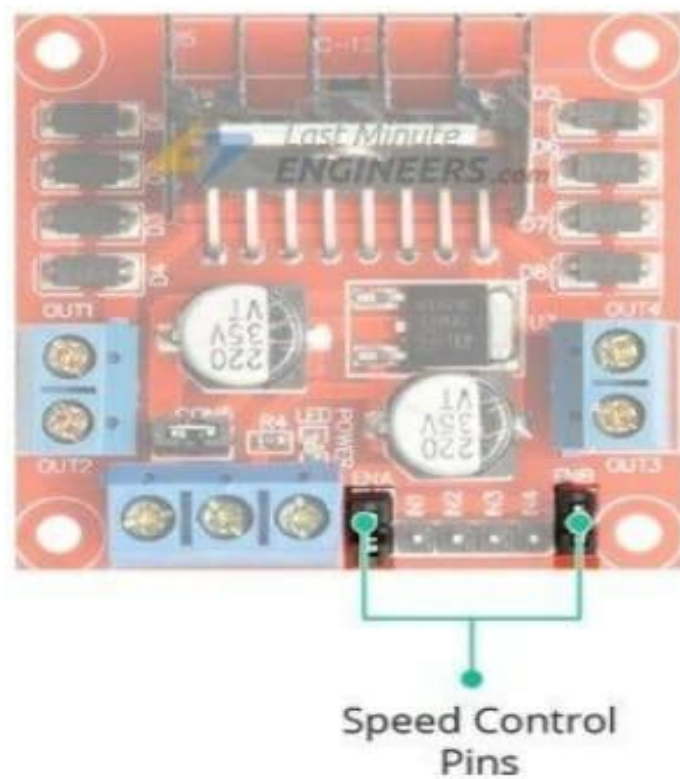


Fig. 4.24: SPEED CONTROL PINS L298N CHIP

programmatically, you need to remove the jumpers and connect them to PWM-enabled pins on Arduino.

L298N Motor Driver Module Pinout

Before diving into hookup and example code, let's first take a look at its Pinout.

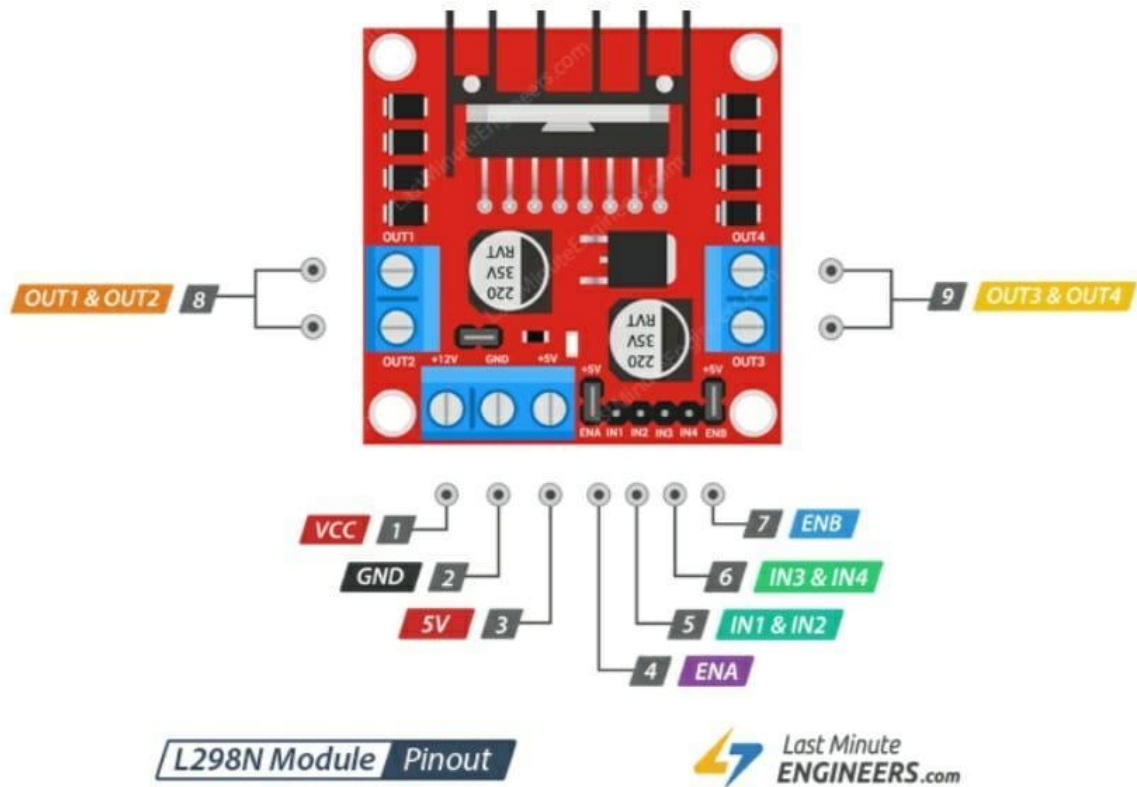


Fig. 4.25: L298N Motor Driver Module

VCC pin supplies power for the motor. It can be anywhere between 5 to 35V. Remember, if the 5V-EN jumper is in place, you need to supply 2 extra volts than the motor's actual voltage requirement, in order to get maximum speed out of your motor.

GND is a common ground pin.

the 5V pin supplies power for the switching logic circuitry inside the L298N IC. If the 5V-EN jumper is in place, this pin acts as an output and can be used to power up your Arduino. If the 5V-EN jumper is removed, you need to connect it to the 5V pin on Arduino.

ENA pins are used to control speed of Motor A. Pulling this pin HIGH(Keeping the jumper in place) will make the Motor A spin, pulling it LOW will make the motor

stop. Removing the jumper and connecting this pin to PWM input will let us control the speed of Motor A.

IN1 & IN2 pins are used to control the spinning direction of Motor A. When one of them is HIGH and other is LOW, the Motor A will spin. If both the inputs are either HIGH or LOW the Motor A will stop.

IN3 & IN4 pins are used to control the spinning direction of Motor B. When one of them is HIGH and other is LOW, the Motor B will spin. If both the inputs are either HIGH or LOW the Motor B will stop.

ENB pins are used to control speed of Motor B. Pulling this pin HIGH(Keeping the jumper in place) will make the Motor B spin, pulling it LOW will make the motor stop. Removing the jumper and connecting this pin to PWM input will let us control the speed of Motor B.

- OUT1 & OUT2 pins are connected to Motor A.
- OUT3 & OUT4 pins are connected to Motor B.
- Wiring L298N motor driver module with Arduino UNO

Now that we know everything about the module, we can begin hooking it up to our Arduino!

Start by connecting the power supply to the motors. In our experiment we are using DC Gearbox Motors (also known as 'TT' motors) that are usually found in two-wheel-drive robots.

They are rated for 3 to 12V. So, we will connect an external 12V power supply to the VCC terminal. Considering internal voltage drop of L298N IC, the motors will receive 10V and will spin at slightly lower RPM. But, that's OK.

Next, we need to supply 5 Volts for the L298N's logic circuitry. We will make use of the on-board 5V regulator and derive the 5 volts from the motor power supply so, keep the 5V-EN jumper in place.

Now, the input and enable pins (ENA, IN1, IN2, IN3, IN4 and ENB) of the L298N module are connected to six Arduino digital output pins (9, 8, 7, 5, 4 and 3). Note that the Arduino output pins 9 and 3 are both PWM-enabled. Finally, connect one motor to terminal A (OUT1 & OUT2) and the other motor to terminal B (OUT3 & OUT4). You can interchange your motor's connections, technically, there is no right or wrong way. When you're done you should have something that looks similar to the illustration shown below.

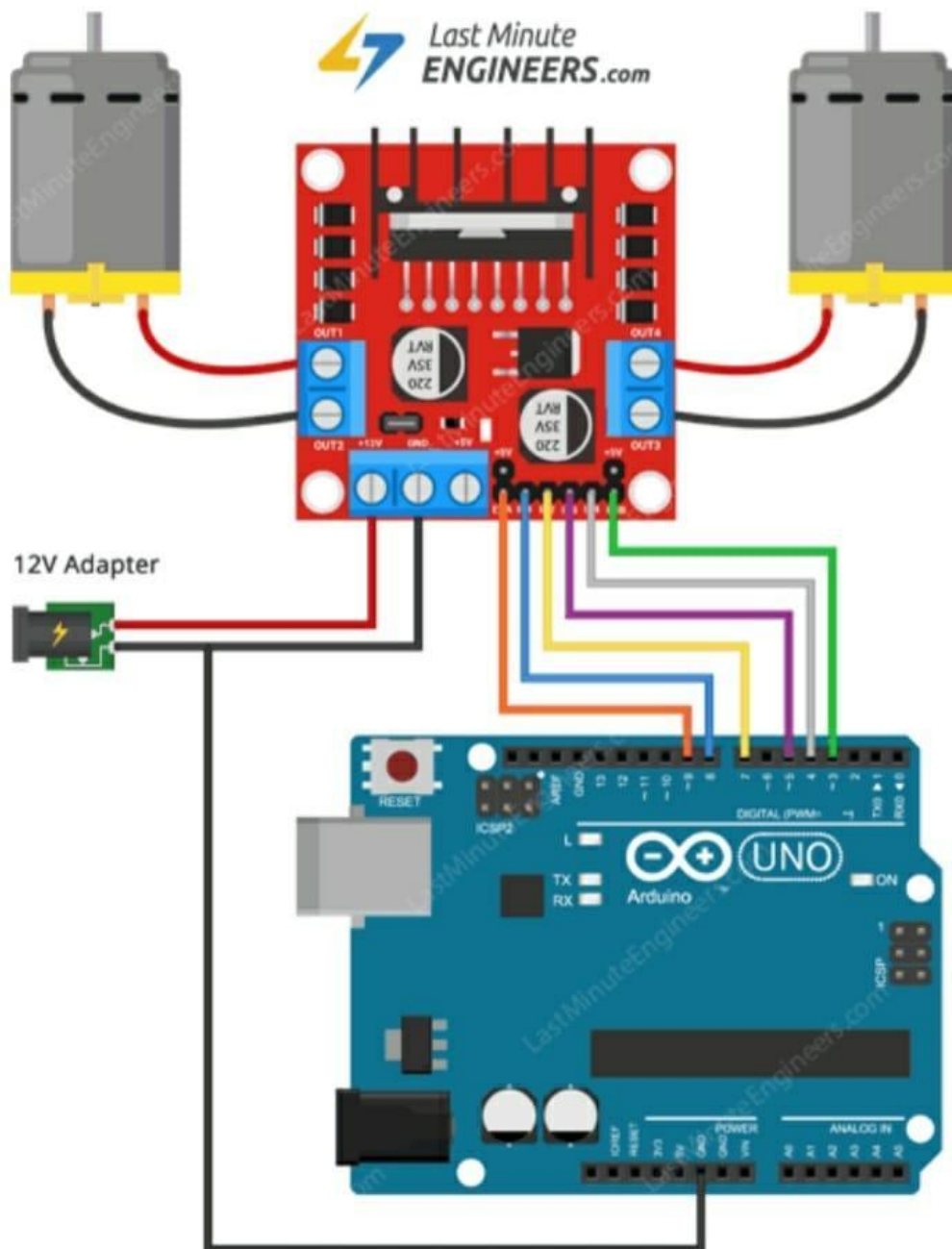


Fig. 4.26: Circuit Diagram

4.8.4 Ultrasonic Sensor

The ultrasonic distance sensor HC-SR04 is seen here. This inexpensive sensor has a range of 0.02 m to 4 m of non-contact measuring capability and a ranging accuracy of up to 0.3 cm. An ultrasonic transmitter, a receiver, and a control circuit are all included in each HC-SR04 module.

On the HC-SR04, you just need to care about four pins: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground) (Ground). You'll find it simple to set up and utilize this sensor for your next range-finding project!

Depending on the application, this sensor contains extra control circuitry that can avoid inconsistent "bouncy" data.



Fig. 4.27: ULTRASONIC SENSOR

4.8.5 Camera

A camera is a visual image-capturing optical equipment. For a variety of imaging applications such as machine vision or machine automation, cameras are employed to collect images of things or places being studied. Cameras are imaging

components that work with lenses to produce images. They have sensors that photograph the light that is focused by the imaging lenses.



Fig. 4.28:camera

4.8.6 SD card

The Secure Digital Association (SDA) established a proprietary non-volatile memory card format for use in portable devices, which is formally abbreviated as SD. A popular and compatible flash memory card family used largely for storage in electronic devices. A Secure Digital card is roughly the size of a postage stamp and weighs two grams



Fig. 4.29:SD CARD

4.8.7 DC Motor

Any rotary electrical motor that transforms direct current electrical energy into mechanical energy is referred to as a DC motor. The most popular varieties rely on magnetic fields to create forces. Almost all DC motors contain an internal mechanism, either electromechanical or electronic, that changes the direction of current in a section of the motor on a regular basis.

Because they could be supplied by existing direct-current lighting power distribution networks, DC motors were the first type of motor to become widely employed. The speed of a DC motor can be varied across a large range by varying the supply voltage or adjusting the current intensity in the field windings. Tools, toys, and appliances all employ small DC motors. The universal motor is a lightweight brushed motor that can run on direct current and is used in portable power tools and appliances. Larger DC motors are being employed in electric vehicle propulsion, elevators and hoists, and steel rolling mill drives. With the introduction of power electronics, it is now possible to replace DC motors with AC motors in a variety of applications.



Fig. 4.30: DC motor

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 COST ANALYSIS

List of components and their cost

The costs of the various components used in this project are given below in Table 5.1.

Table 5.1 List of components and their costs

COMPONENT	COST
Raspberry Pi	₹ 4000
Arduino UNO (1 nos.)	₹ 500
Motor(4 nos)	₹ 1200
Camera(1 nos.)	₹ 700
UltraSonic Sensor(1 nos.)	₹ 50
Motor Shield(L298N)	₹ 200
Miscellaneous	₹ 500
TOTAL	₹ 7150

5.2 Output



Fig. 5.1: INPUT

The above screenshot shows how the input is given to rover.

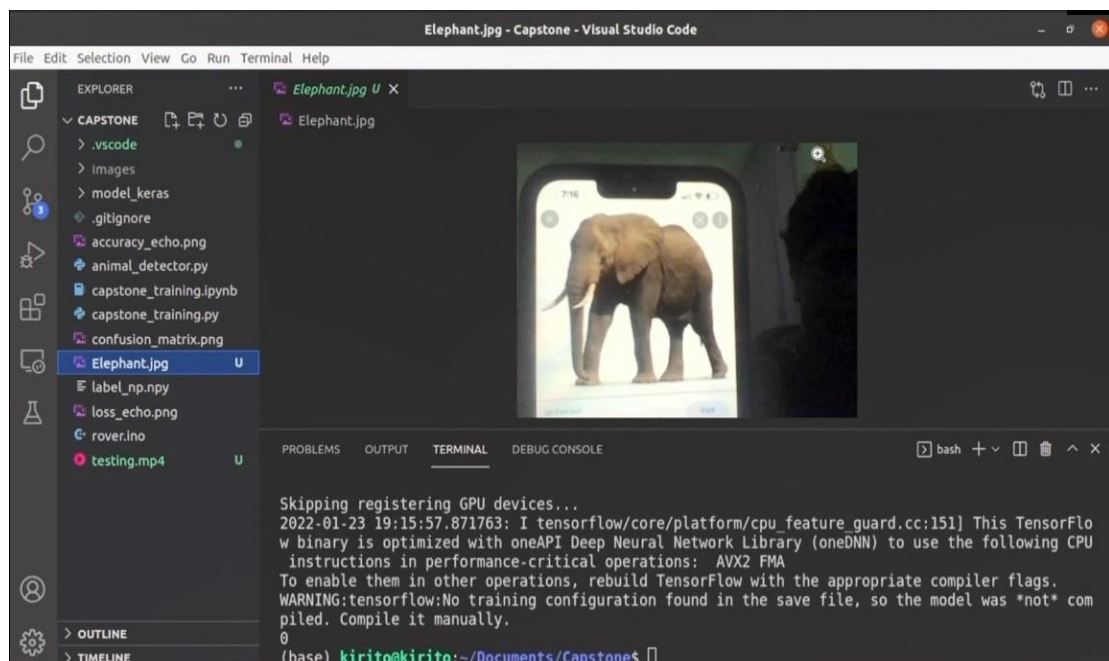


Fig. 5.2: OUTPUT

The Above Screenshot show the processed result after executing the python code. Here, Once The animal (Image from smartphone is used for simulation) is detected in the camera it is tagged by its name and stored in the SD-Card.

5.3. Final prototype



Fig. 5.3: FRONT VIEW

The front view has the camera which detects the animal that comes along the way also it has ultrasonic sensor that used to detect the obstacle in the path.

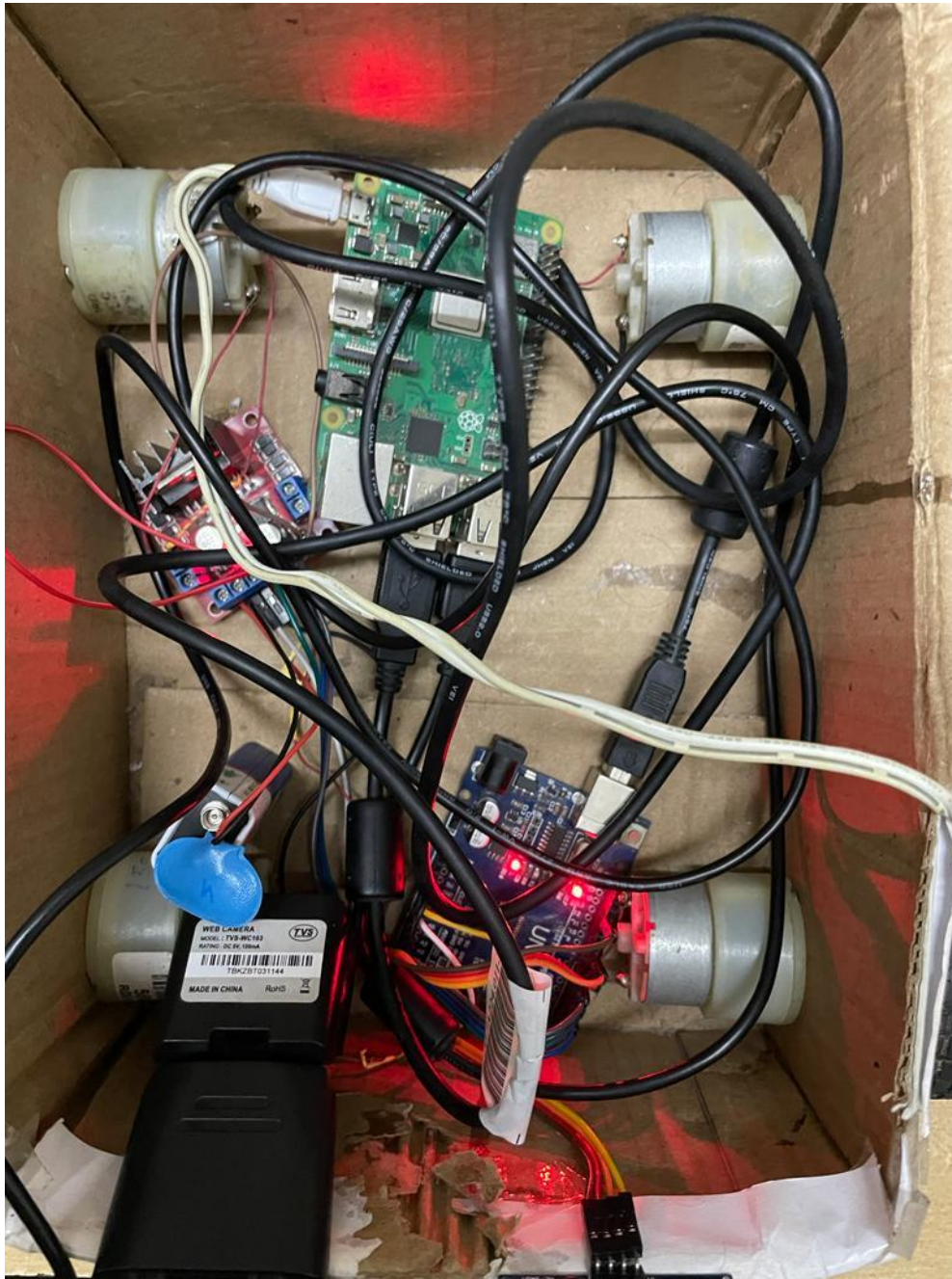


Fig. 5.4: TOP VIEW

The top view we can see the total circuit connection which consist of the main central neural system (Rpi) and Arduino UNO which controls the motor system of the rover. The Arduino Uno gives it commands to the motor drive which controls the motor for the rover.

CHAPTER 6

CONCLUSION AND FUTURE WORK

The project's future scope includes increasing the battery life and making it more of an off-road mechanic system, which will allow us to enter deep forest areas with tough terrain. Also planned is the preparation of swarms that will communicate with one another via an AI system that monitors and tracks their activities. This aids in broadening the search and wildlife landscape, allowing for a far more extensive trip and better data on the area's flora and fauna.

Finally, we may equip each rover with a little drone that can inspect the ground from above, allowing us to obtain better 3D imaging of the area as well as better imaging of the fauna. These drones can also capture predators that hide well in the tree tops, which could aid the future human team in avoiding them while researching those places in person. For better navigation, radar systems and GPS are being considered for determining the paths of the given terrain, as well as assisting in the development of a better route for human exploration.

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