TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS PULCHOWK,

LALITPUR

A Project Report on

FLORAL IDENTIFICATION

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INTRODUCTION

Detecting image and classifying them is a technology in the field of computer vision_for finding and identifying objects in an image or video sequence. Computer vision is a discipline that studies how to reconstruct, interpret and understand a 3D scene from its 2D images in terms of the properties of the structures present in the scene. It has been studied since late 1970s and has lot more to go. Humans recognize a multitude of objects in images with little effort, despite the fact that the image of the objects may vary somewhat in different views point, in many different sizes and scales or even when they are translated or rotated. Human can identify the objects by extracting its various features like: shape, color, texture, dimension etc. Objects can even be recognized when they are partially obstructed from view. This task is still a challenge for computer vision systems.

Here, we have used the Computer Vision in the field of Plant Leaf Classification. The project seeks to develop a system having travelling bot embedded with camera and the travelling bot is controlled manually from the remote access using mobile controlled by the user .The bot is connected to mobile using Bluetooth module. And, secondly there will be pi-camera connected to the raspberry pi so the user can observer the path and objects infront of it. Thus, the camera used on the bot help to take image of desire species of leaf ,which is used as input image to the program and are processed to classify the plant using the captured image of its leaf. It can detect any plant leaf for which the system is trained. After detection and recognition, it displays the various information of the plants that are helpful for the users and also can access to particular information if they want to know in more details about that flora through the reference link present there.

PROBLEM STATEMENT

Different flora species can be found everywhere. There are different species of different categories. Many of them possess similar characteristics. However one flora species is always different from others by some ways or characteristics. We can identify plants using its size, leaf, trunk, roots, environment etc. In most of the cases, classification of plants using its leaf is the best, cheap and effective way. The leaf of different plant species varies on shape, vein structure, colour etc.
There are numerous flora species found in Nepal. However we cannot identify all of them. Thus, our system is made to use as for research purpose for finding the available species in the forest, for identifying whether the available species is endangered or poisonous or the new medicine typed species.

SIGNIFICANCE AND SCOPE

The main purpose of this system is to learn and help to develop this system using the knowledge from previously built project ideas and new concepts.

This project can be found useful in large scale from Botany Research to General Information tool. The project can also be used as a easy tool to explore the flora that are most commonly in Nepal. Similarly the algorithm that this project uses can also be derived or modified to build other images comparing or recognizing system.

OBJECTIVE

The objective of our system are enlisted below:

- To utilize the opportunity for minor project by creating a useful system.
- To make a system which can be used for the research purpose in the deep forest.
- To test and explore possible methods for object detection and classification.
- To detect the plant species from plant leaf.
- To provide the details about the plant after recognizing it.
- To be familiar with the way of building Convolutional Neural Network.
- To fulfill the requirements of the "Minor Project" subject of sixth semester

LITERATURE REVIEW

Many approaches have been used in image detection and recognition. Some of them are Geometry-based approaches, Appearance-based approaches, Feature-based approaches, etc. These approaches use different algorithms for object detection. They are generic algorithms for object recognition.

RECENT DEVELOPMENT

With more reliable representation schemes and recognition algorithms being developed, tremendous progress has been made in the last decade towards recognizing objects under variation in viewpoint, illumination and under partial occlusion. Nevertheless, most working object recognition systems are still sensitive 1to large variation in illumination and heavy occlusion. In addition, most existing methods are developed to deal with rigid objects with limited intra-class variation. Future research will continue searching for robust representation schemes and recognition algorithms for recognizing generic objects. We can see major promising projects going on like ImageNet, Microsoft COCO and many more.

RELATED WORK

There has been various works in the field of plant classification by leaf detection. Scholars from various universities in the world has done some great works in this field. Researchers from three different institutes of Cairo, Egypt has done classification approach based on Random Forests (RF) and Linear Discriminant Analysis (LDA) algorithms for classifying the different types of plants. Scholars from two different universities in India has tried to detect plant leaf diseases using image segmentation and soft computing techniques. There are 1598 teams competiung for the project of leaf classification in Kaggle, which is the world's largest community of data scientists.

METHODOLOGY

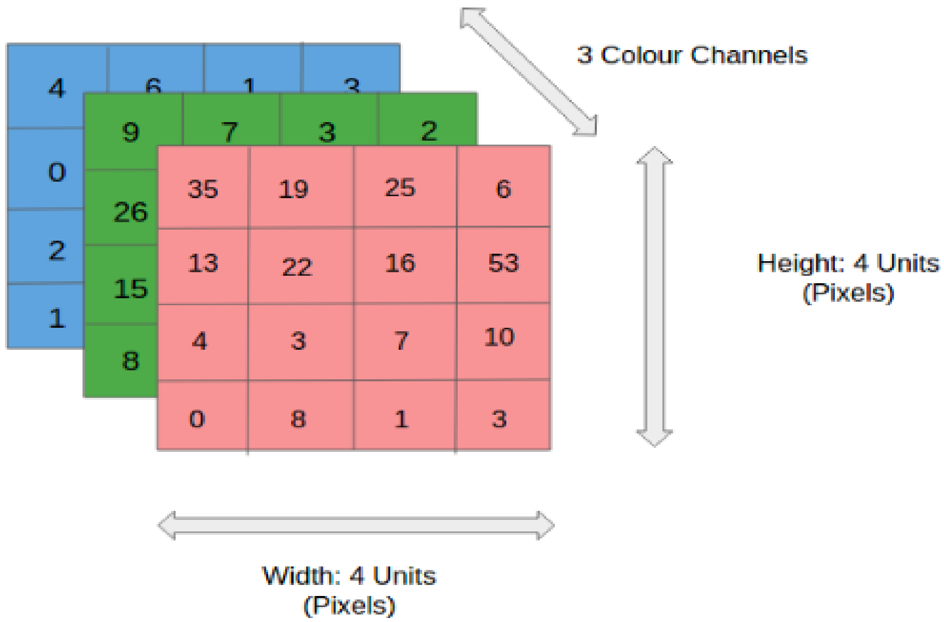
1. Software application in project

We have used Convolutional Neural network(CNN) for object recognition. For the implementation of CNN, we have use keras library on top of tensorflow. The language used is python. For designing the user interface, we have used Tkinter.

CNNs are biologically-inspired models inspired by research by D. H. Hubel and T. N. Wiesel. They proposed an explanation for the way in which mammals visually perceive the world around them using a layered architecture of neurons in the brain, and this in turn inspired engineers to attempt to develop similar pattern recognition mechanisms in computer vision.

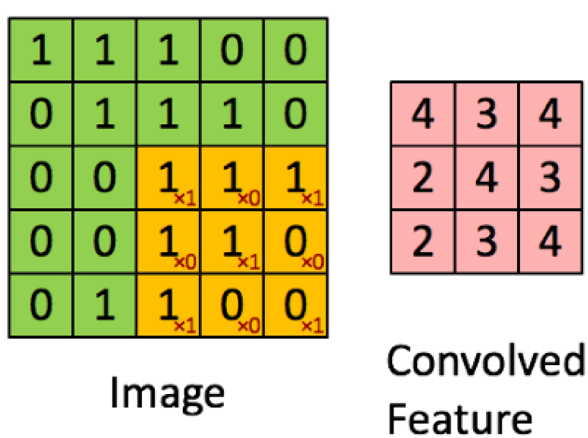
CNN receives the image as a matrix of pixel values. A sequence of convolution, maxpooling and normalization is done in several layers of CNN and is finally regularized. At the end of the network, probability is calculated for each class and prediction is made on the basis of probability.

Generally, we have a 8 bit pixels. Thus the possible range of values a single pixel can represent is [0, 255]. For a colored image(RGB), we will have three matrices associated for each color channels.



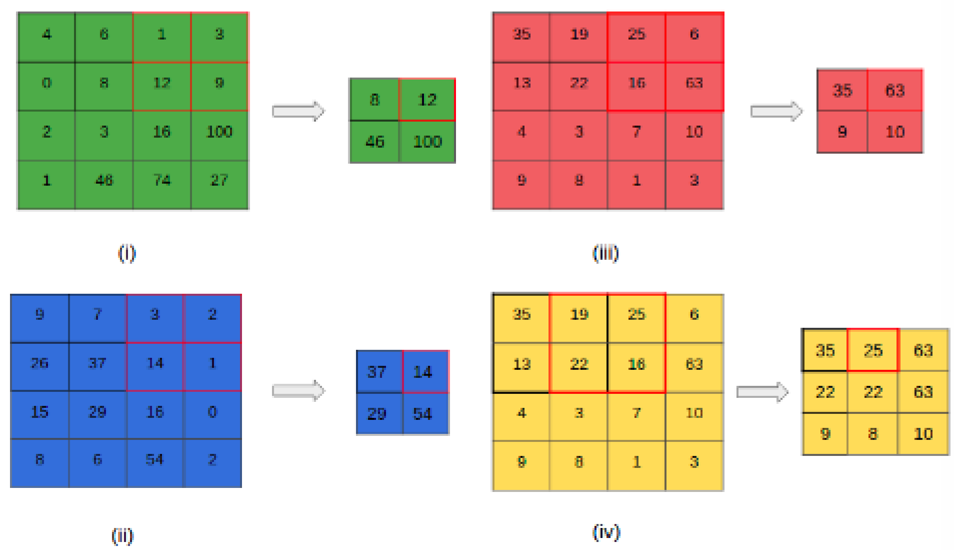
CONVOLTION

A convolution is an orderly procedure where two sources of information are intertwined. A kernel (also called a filter) is a smaller-sized matrix in comparison to the input dimensions of the image, that consists of real valued entries. Kernels are then convolved with the input volume to obtain so-called 'activation maps' (also called feature maps). We compute the dot product between the kernel and the input matrix. -The convolved value obtained by summing the resultant terms from the dot product forms a single entry in the activation matrix. The patch selection is then slided (towards the right, or downwards when the boundary of the matrix is reached) by a certain amount called the 'stride' value, and the process is repeated till the entire input image has been processed.



POOLING

Pooling reduces the spatial dimensions (Width x Height) of the Input Volume for the next Convolutional Layer. It does not affect the depth dimension of the Volume. The transformation is either performed by taking the maximum value from the values observable in the window (called 'max pooling'), or by taking the average of the values. Max pooling has been favored over others due to its better performance characteristics.



NORMALIZATION

Normalization turns all the negative values to 0 so that a matrix have no negative values. We have used ReLU activation in our case. A stack of images becomes a stack of images with no negative values.

REGULARIZATION

Regularization is a vital feature in almost every state-of-the-art neural network implementation. To perform dropout on a layer, you randomly set some of the layer's values to 0 during forward propagation. Dropout forces an artificial neural network to learn multiple independent representations of the same data by alternately randomly disabling neurons in the learning phase.

PROBABILITY CONVERSION AND PREDICTION

At the very end of our network (the tail), we'll apply a softmax function to convert the outputs to probability values for each class. Then the class with the highest probability is chosen as the predicted output.

2. Hardware application in project:

We proposed a wireless tracker to take live video which could be accessed wirelessly. The details have been described below:

1. <u>PHYSICAL DESIGN</u>
   For suitable design, we have used rocker bogie mechanism for our car. It is a suspension arrangement used in Mars Rover for Mars Pathfinders and also in Mars Exploration Rover(MER).The main purpose of this system is to develop a highly stable suspension system capable of operating in multi terrain surfaces while keeping all the wheels in contact with the ground. Right and left rockers can independently climb different obstacles. Theoretically this mechanism can sustain tilt of about 50° inclination without tipping.

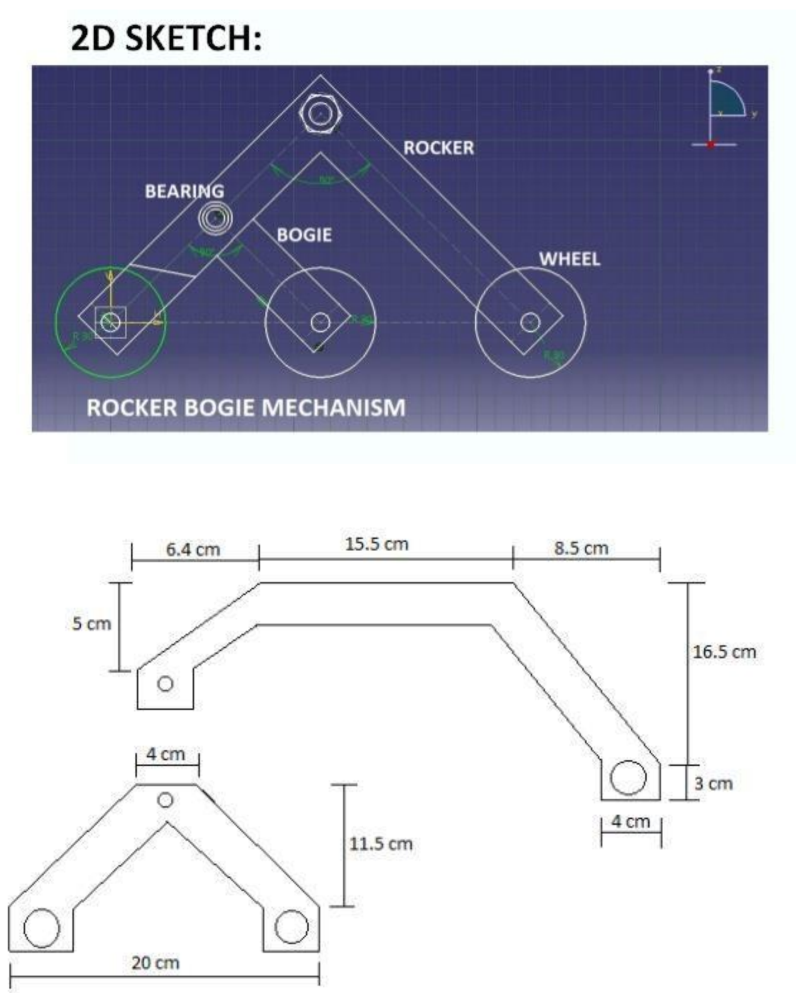
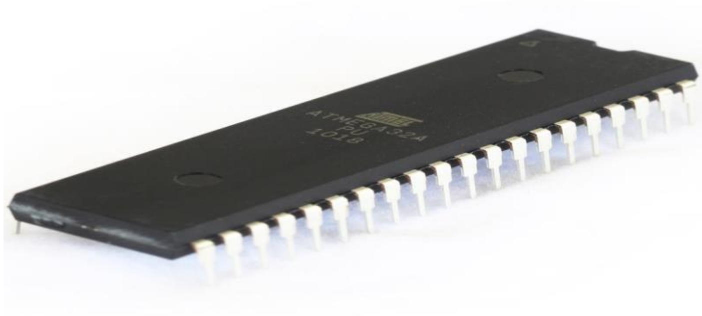


Fig: sketch 2D design for our car

Components:

- **ATmega32A:**



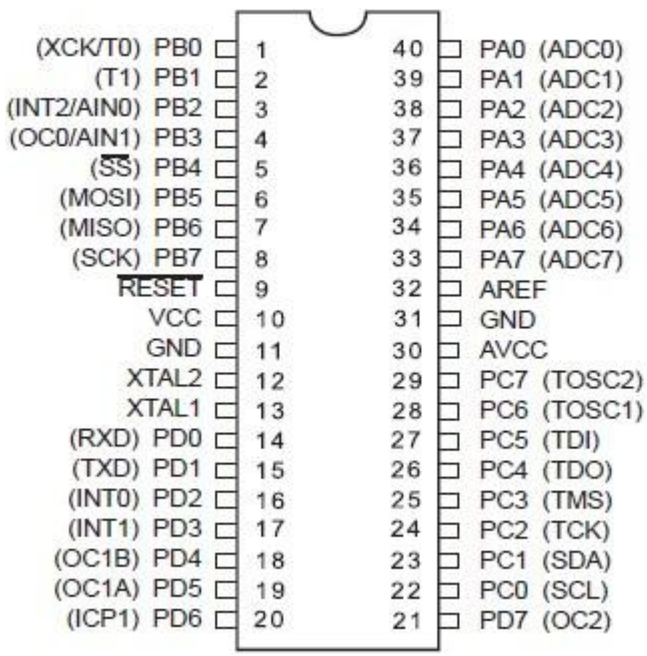


Fig: pin configuration

The Atmel® AVR® ATmega32A is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega32A achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

Features

• High-performance, Low-power Atmel® AVR® 8-bit Microcontroller

• Advanced RISC Architecture
– 131 Powerful Instructions – Most Single-clock Cycle Execution
– 32 × 8 General Purpose Working Registers
– Fully Static Operation
– Up to 16MIPS Throughput at 16MHz
– On-chip 2-cycle Multiplier

• High Endurance Non-volatile Memory segments
– 32Kbytes of In-System Self-programmable Flash program memory
– 1024Bytes EEPROM
– 2Kbytes Internal SRAM
– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
– Data retention: 20 years at 85□C/100 years at 25□C(1)
– Optional Boot Code Section with Independent Lock Bits

• In-System Programming by On-chip Boot Program

• True Read-While-Write Operation
– Programming Lock for Software Security

• JTAG (IEEE std. 1149.1 Compliant) Interface
– Boundary-scan Capabilities According to the JTAG Standard
– Extensive On-chip Debug Support
– Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface

• Atmel QTouch® library support
– Capacitive touch buttons, sliders and wheels
– Atmel QTouch and QMatrix acquisition
– Up to 64 sense channels

• Peripheral Features
– Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes
– One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
– Real Time Counter with Separate Oscillator
– Four PWM Channels
– 8-channel, 10-bit ADC

• 8 Single-ended Channels

• 7 Differential Channels in TQFP Package Only

• 2 Differential Channels with Programmable Gain at 1x, 10x, or 200x
– Byte-oriented Two-wire Serial Interface
– Programmable Serial USART
– Master/Slave SPI Serial Interface
– Programmable Watchdog Timer with Separate On-chip Oscillator
– On-chip Analog Comparator

• Special Microcontroller Features
– Power-on Reset and Programmable Brown-out Detection
– Internal Calibrated RC Oscillator
– External and Internal Interrupt Sources
– Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby

• I/O and Packages
– 32 Programmable I/O Lines
– 40-pin PDIP, 44-lead TQFP, and 44-pad QFN/MLF

• Operating Voltages
– 2.7V - 5.5V

• Speed Grades
– 0 - 16MHz

• Power Consumption at 1MHz, 3V, 25□C
– Active: 0.6mA
– Idle Mode: 0.2mA
– Power-down Mode: < 1µA

We have used the lower four pins of Port A (PA0-PA3) to input 4-bit data from HT12D into the microcontroller and the higher four pins are pulled up. The eight bit data at Port A is now compared with pre calculated values to determine a unique output to other ports. The output from Atmega is fed to motor driver L293D.

- **L293D:**

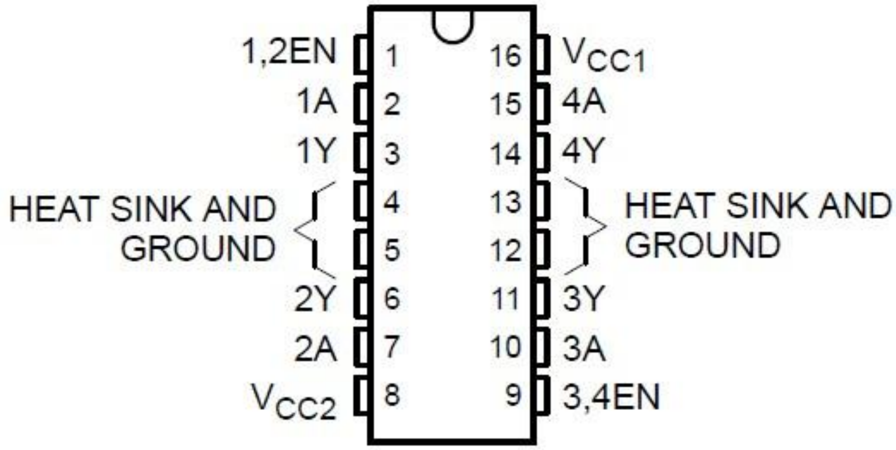


fig: pin configuration

The L293 and L293D devices are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, DC and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo- Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN.

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

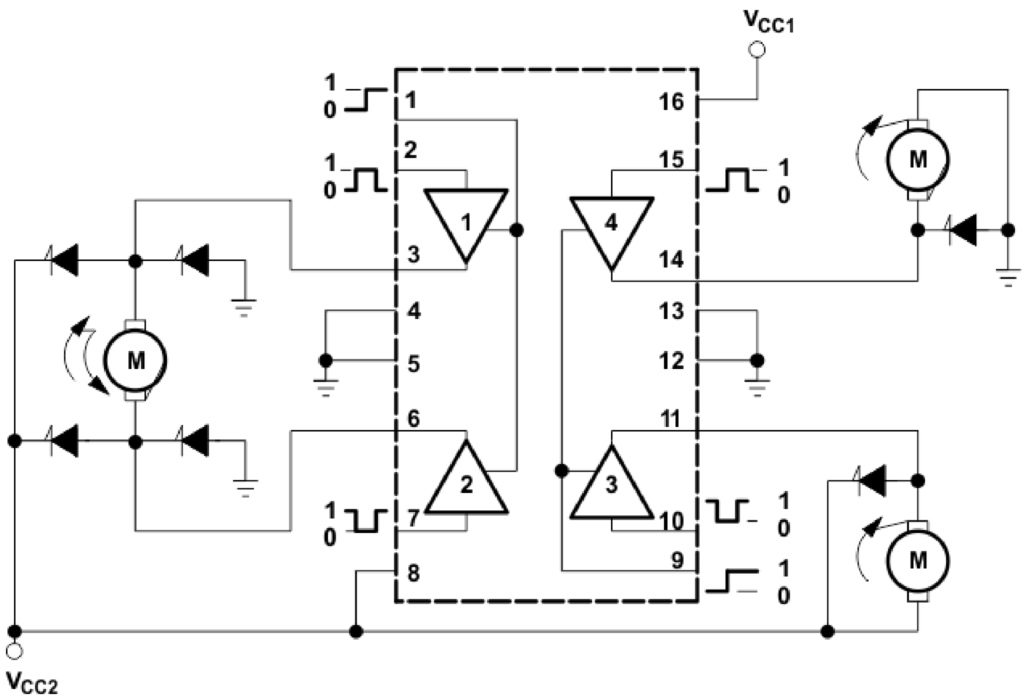


Fig: functional diagram

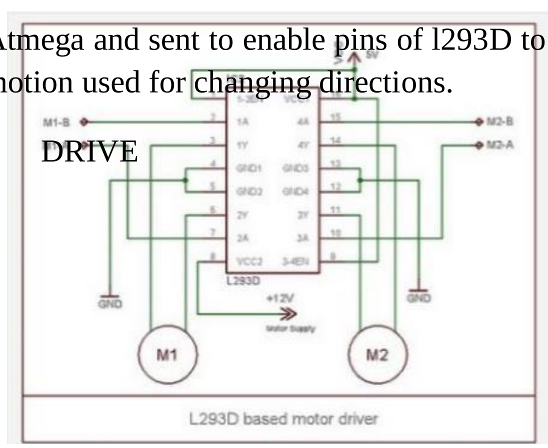
Features

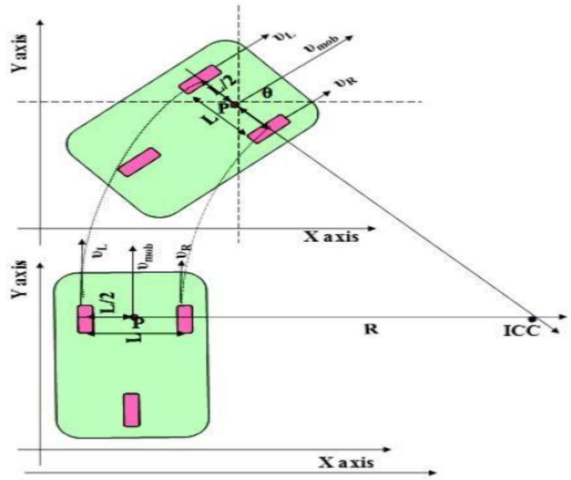
- Wide Supply-Voltage Range: 4.5 V to 36 V
- Separate Input-Logic Supply
- Internal ESD Protection
- High-Noise-Immunity Inputs

Three L293D motor drivers are used to drive the six dc motors placed to move six wheels of our car. The input signal for the input pins of L293D and for the enable pins are taken from the output ports of the microcontroller. Each motor driver having four output pins can drive two motors in both clockwise and counter clockwise direction. The pin diagram of L293D is given:

PWM is used in Atmega and sent to enable pins of l293D to control speed of the car and differential drive motion used for changing directions.

DIFFERENTIAL DRIVE MOTION:





By changing the velocities of left and right wheel, ICC of rotation is changed and the wheels will follow different trajectories. This is called as differential drive motion. Angular velocity is given as

$$\omega = \frac{V_R - V_L}{L}$$

The curvature radius of trajectory is given as

$$R = \frac{V_R + V_L}{V_R - V_L} * \frac{L}{2}$$

Pulse width modulation (PWM) is used to vary velocities. PWM varies the duty cycle of the input pulse reaching the motors of the wheels.

DC Motor: A DC motor is any class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic to change the direction of current flow in part of motor.

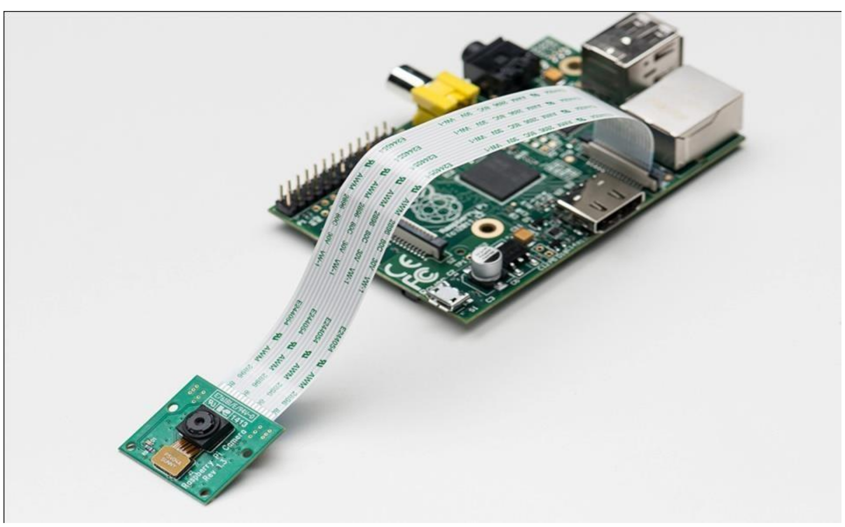
Here, we have made use of 6 DC motors. One for each tyres which are 12 V motors of 350

Rpm. Tyre motors are driven and controlled by a L293D chip(described later).

- **Live video streaming**:

Fig: raspberry Pi 3

Raspberry Pi is a credit card sized computer that plugs into our computer and keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that our computer does, like spreadsheet, word processing, browsing the internet etc. It also plays high definition videos.



So the main information which is a video, can be remotely streamed is different ways. One of the best way is using Wi-Fi technology which is wireless. As video is huge information we need a hardware that is fast enough to capture the frames and send it wirelessly to the local machine. Our local machine (where we view the video) and the device should be connected wirelessly. Our best hardware platform is using no other Raspberry PI which is robust reliable, fast, cheap, and small in size. Raspberry Pi can handle huge amount of data and can fit our requirements. A newer version of Raspberry Pi has built in WIFI Technology which we can use to connect to our local router. So our hardware problem is tackled. Now what about controlling the raspberry pi remotely for video feedback? It can be using MATLAB, great software for program prototyping, robust and fast capable of performing complex processing like Image Processing, computer vision, etc. MATLAB can easily establish a connection to Raspberry Pi and access its hardware components. We will write programs in MATLAB that can remotely access the camera board of Raspberry Pi and stream it in local machine. Not only that we use image processing to extract information from the video and apply computer vision to the robot.

4. WORKS COMPLETED AND WORKS REMAINING

4.1 TIME SCHEDULE

The time allocation for this project estimated at the beginning of the project was:

1) Research 2 week
2) System Design 1 weeks
3) Implementation 2 weeks
4) Training and Testing 1 weeks
5) Interface Design 1 week
6) Documentation 1 weeks

4.2 WORKS ACOMPLISHED

We started our project with the aim of completing every task in the allocated time frame. But most of the works are done in parallel fashion, rather than the sequential fashion. Till now, we have completed following tasks:

- We did a research on leaf detection and recognition and tried to find the best algorithm for the purpose of our project. We also designed the system in the same time.
- We made a bot which carry raspberry pi and all other project material.
- We design a well compact pcb board for the avr microcontroller, Bluetooth module and motor driver.
- We collected the data of leaves needed for our project.
- We implemented the algorithm into code. At the same time, the system design was improvised as per the need.
- We work to interface Bluetooth module with microcontroller to move the bot.
- Training and testing of data are done alongside the implementation.
- We created a database to store the various information of the leaf recognized.
- We made a simple interface for the software to facilitate the user.

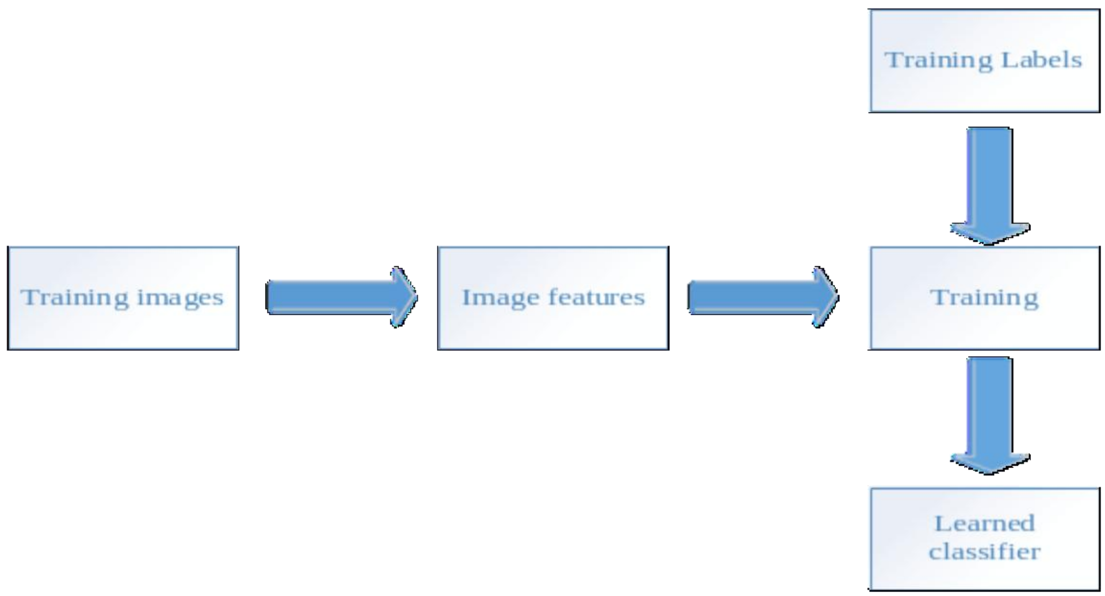
4.3 WORKS TO BE OPTIMIZED

- Collecting various information of the collected plant leaves and adding it to the data created.
- Fixing servo motor to pi cam for the movement of camera in different direction.
- Adding more samples of leaf.

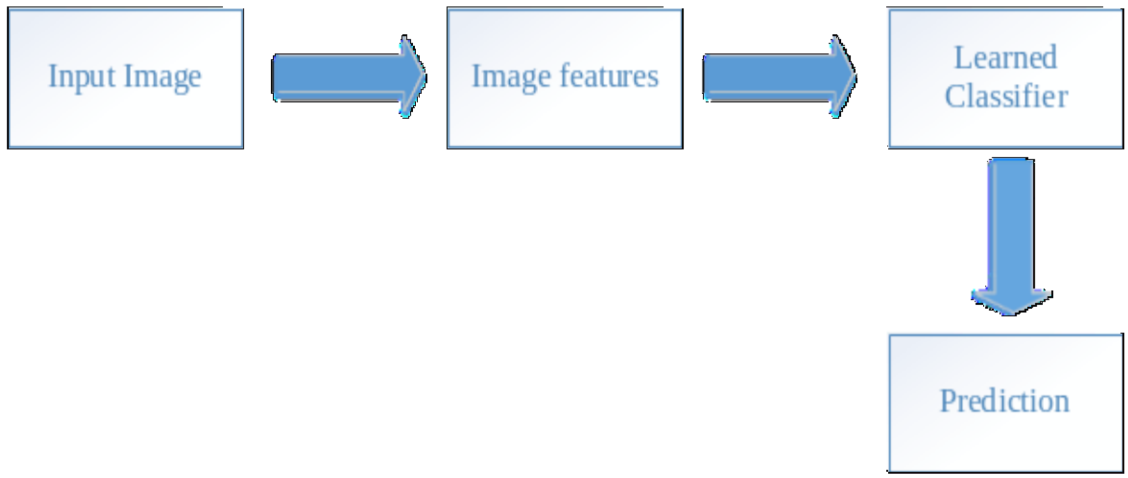
- Improvising the code so that our system predicts the leaves with maximum accuracy.
- Improvising the user interface.
- Provision to add unidentified species.

Related Diagrams

Block diagram

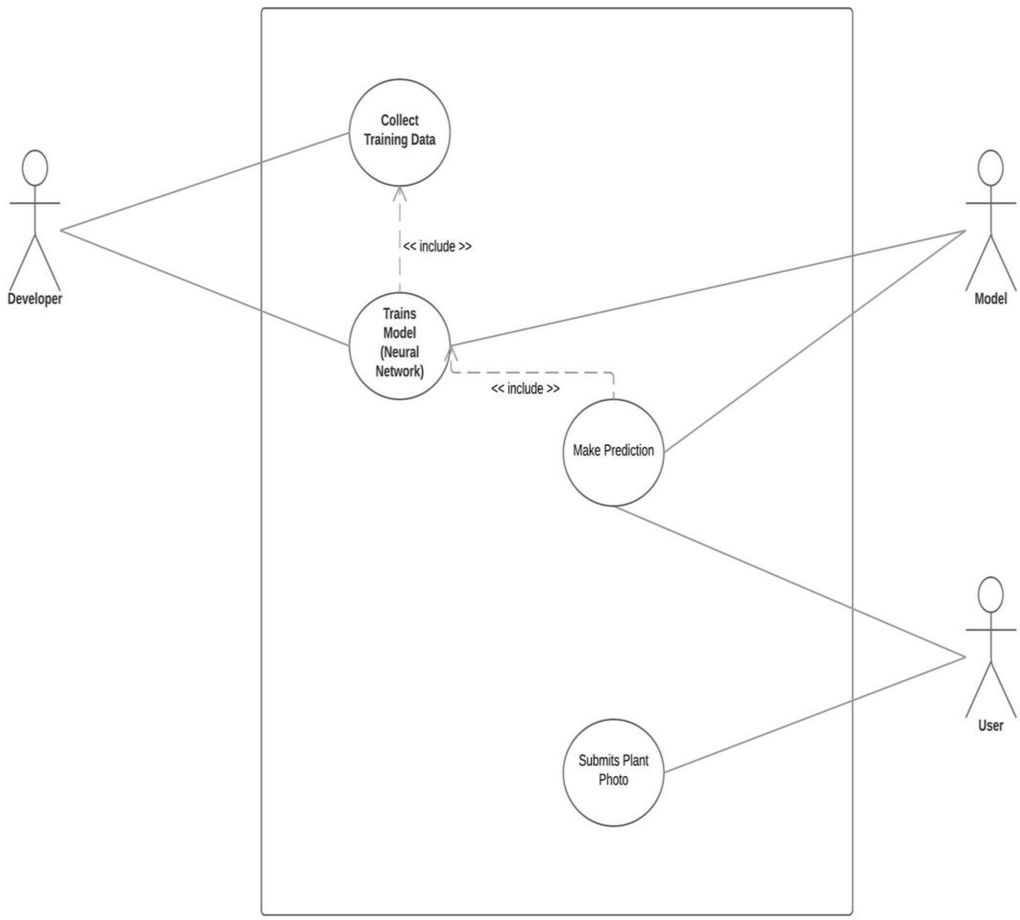


Block diagram for training

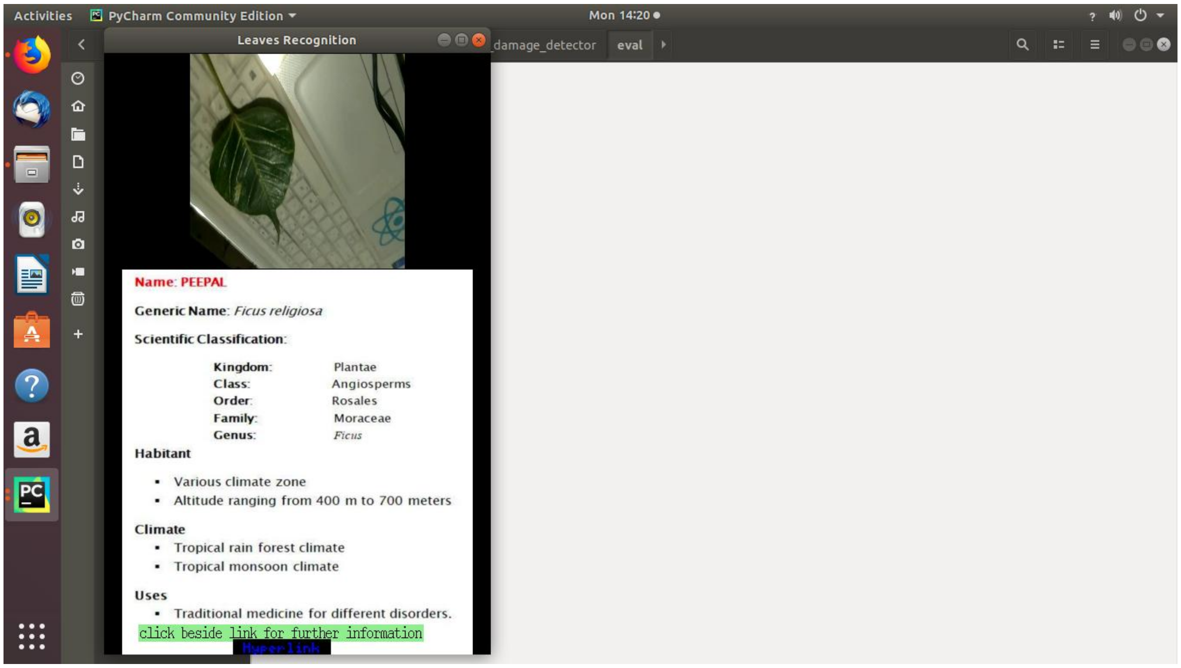


Block diagram for testing

Case diagram:



Output:



CONCLUSION

This project is our first step in ‘Computer Vision’ and ‘Artificial Intelligence’ field. We have tried to realize the practical implementation of concepts we learned in ‘Artificial Intelligence’ course. We have implemented Convolutional Neural Network (CNN) to train our test objects.

Our software can detect leaves on the basis of training datasets and localizes them with an estimated accuracy of more than 70 per cent. We have completed most of the works of the project and we will be completing the remaining works within the project deadline.

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