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Automatic License Plate Detection and Recognition

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***Abstract*--- An increasing demand for transport systems has made the world a better marketplace. But with the increasing number of vehicles, management of transport services has become tedious. Unsaved information about the vehicle and its owner tends to create ambiguity errors and encourages malpractices. To avoid such scenarios, techniques like 'Automatic License Plate Recognition' are used. Several number plates are pre stored in the system. The other number plates which do not match the system's database will be denied entry. Emerging technologies such as Computer Vision, play a very central role in such systems. OCR technique is used to convert images to characters and results are further saved for verification. These systems have a wide application in parking management systems, traffic control systems and theft recovery systems.**

***Index Terms*— Computer Vision, Image processing, OCR, Python, Raspberry Pi**

I. INTRODUCTION

The increasing demand for transport systems has led to an ever flourishing market place for many horizons. Although on the flip side, the never ending traffic lines, congestion and unexpected arrivals of viruses contribute to the inefficiency of transport media. To address this problem we designed a toll barrier system with automatic license plate detection and recognition. The system aims to detect and pass vehicles with a prepaid pass to ensure a faster commute.

Problem Statement

Tolling booths tend to have long lines resulting in traffic congestion and increase the travelling time. In certain situations where one has to follow social distancing norms and avoid crowding, a system should be in place to mitigate this scenario. Healthcare transport system collapses due to tedious manual process at the toll booth. Unsaved information about the vehicle and its owner tends to create ambiguity errors and in turn results in encouraging malpractices.

II. OVERVIEW

In this paper we are presenting the hardware and software architectural details of the ALPR toll booth system as well as the python programming required for the implementation. ALPR (Automatic License Plate Recognition) is a technique which uses OCR (Optical Character Recognition) system on images to create and manage vehicle information data. A system is set up using various image capturing techniques like cameras and is connected using breadboard and wired connections. It uses a Raspberry Pi 3B+ model on which a python code is loaded to execute the working of the system.

It also controls two infrared sensors through ports GPIO19 and GPIO26 respectively. The function of the first infrared sensor (IR1) is to trigger the Raspberry Pi camera to detect the images of the number plates of the vehicles approaching the barrier. The other sensor is used to detect the passing vehicle control the servo motor for the barrier movement. A servo motor is connected to the Raspberry Pi model through port GPIO13. A barrier, made out of lightweight materials usually hard plastic or acrylic of a rectangular shape is attached to the servo motor for the movement. The Raspberry Pi camera is attached to the barrier by drilling holes for placement of the components. A remote controlled car is made to move linearly towards the toll barrier which has a number plate attached to it. The image captured and processed is further compared with the one present in the database. A conditional loop is present for comparison between the obtained and the desired image. The barrier is made to lift if the condition is satisfied.

After the passing of the vehicle another sensor detects the movement and sends a signal to the barrier for closure.

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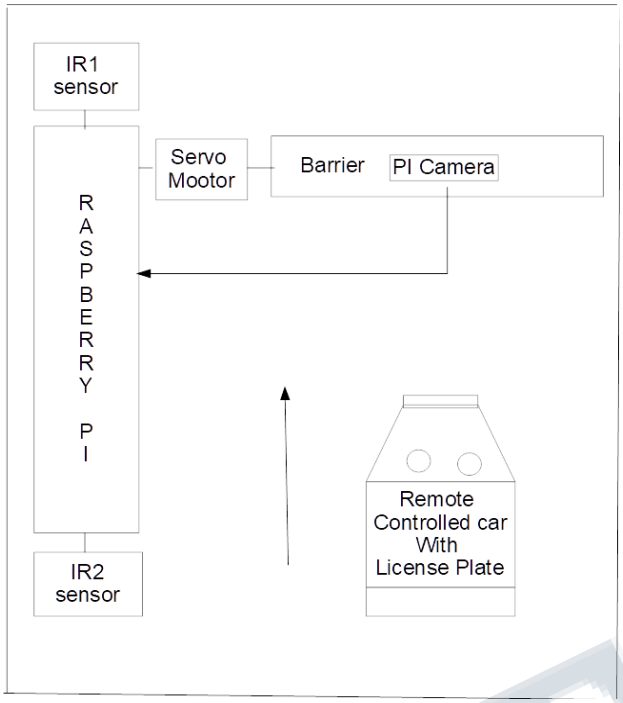
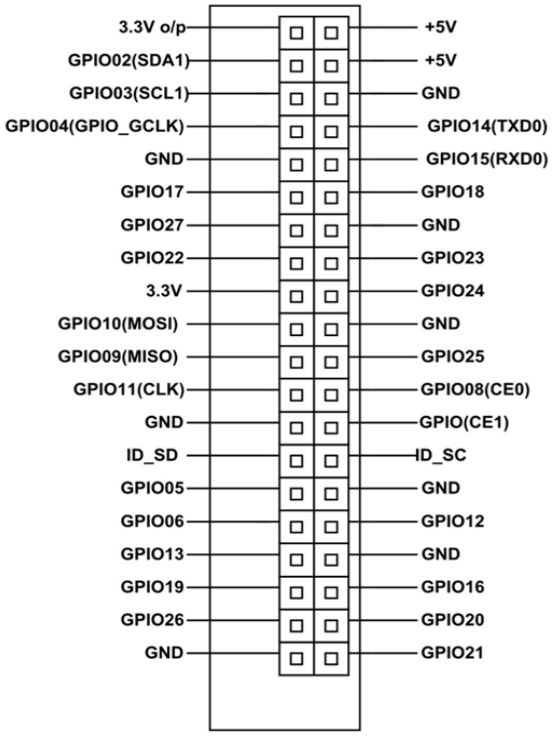


III. HARDWARE ARCHITECTURE

A. *Raspberry Pi 3B+ Module*



The Raspberry Pi is a computational device that allows programming in various languages. It is a cheap and small device that can be transformed into a mini computer along with a standard keyboard and mouse. Raspberry Pi 3B+ provides a 64-bit Quad core processor with a speed of 1.4GHz. A Raspberry Pi 3B+ board contains a 40 pin header of which 28 pins are GPIO pins (General purpose input output). The 3V3 pins are used for components consuming low energy like LED's. The 5V pins are used to power more energy consuming parts, like servo motors or a strip of LED lights. The other pins are grounded.

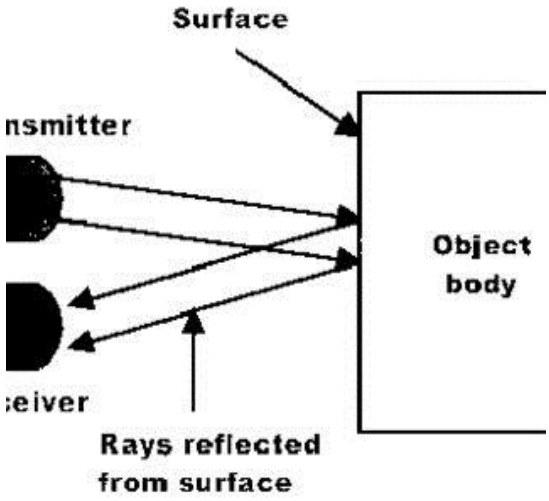
B. *IR Sensors (Object detection)*

IR sensor are devices which emit light in order to sense objects in the surrounding environment. The main application of an IR sensor is to detect the movement of on object and also measure the heat radiated by a component.

IR Sensor Working Principle

An IR sensor consists of a photodiode and an LED. When the light emitted by the transmitter reaches the object, a part of the light is reflected back to its receiver. The output of the sensor is defined based on the intensity of the received output. Two infrared sensors namely IR1 and IR2 are connected to the system through ports GPIO19 and GPIO26 respectively. The sensors provided are distance measuring sensor to detect objects ranging from 2 to 10cms. A level converter circuit is used between the sensor and the Raspberry board as Raspberry Pi cannot handle voltage higher than 3.3v on its GPIO pin. A resistor of value 1k is used for this purpose.

The figure depicts the working principle of IR sensor:



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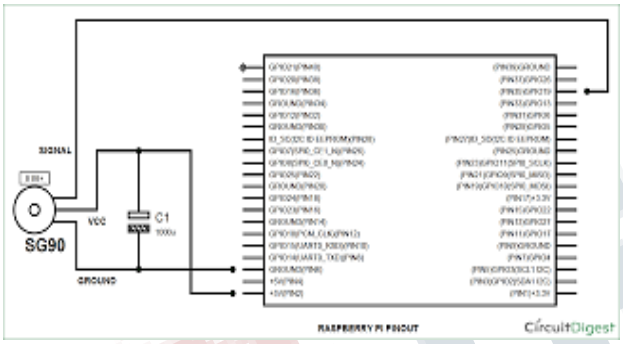
C. Servo motor (Barrier control)

Servomotor are actuators (rotary or linear) that that have application in precision control of angular or linear position. A servomotor is coupled with some sort of position encoder to obtain position and speed feedback. A servomotor is placed in the system to control the movement of the barrier by connecting it to the port (GPIO13). **SG90** is compact (22.2 x 11.8 x 31 mm) and a lightweight (Weight: 9g) server motor with a rotation of approximately 180 degrees (90 in each direction). A **servo** motor can be made to operate by programming using servo codes written in various programming languages, hardware or library. The servo motor is controlled by varying the length of a square wave pulse sent to the servo motor.



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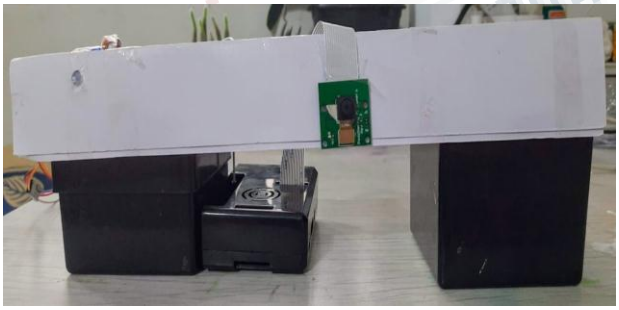
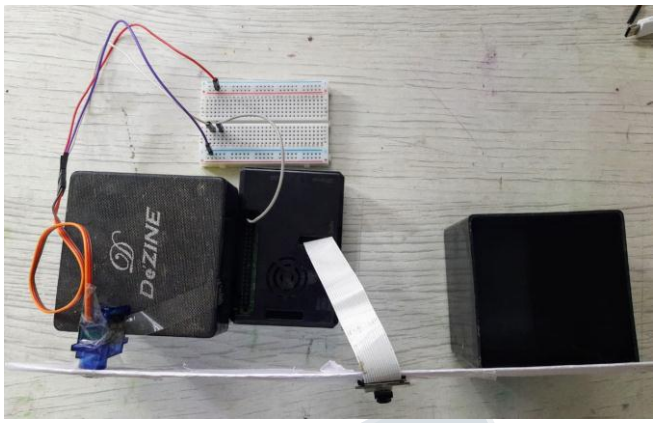
Remote controlled car for linear motion

A remote controlled car is used to approach the barrier. The car is made to run towards the barrier slowly in a linear motion. A license plate is attached to the front panel of the car. The plate consists of the vehicle number in a black and white format.





IV. SOFTWARE PROGRAMMING

Image Processing

Image processing are methods carried out on an image, for enhancing an image or for extraction of information of various types. It comprises of using various tools for modifying signals in which input is an image and output may be image or features associated with that image. Images are obtained using various image obtaining tools like cameras. The images obtained are further analyzed using various computer based software by preprogramming the system. Output is obtained based on image analysis. The project predominantly revolves around the image processing of the captured image. Built in libraries like Open-CV has to be imported.

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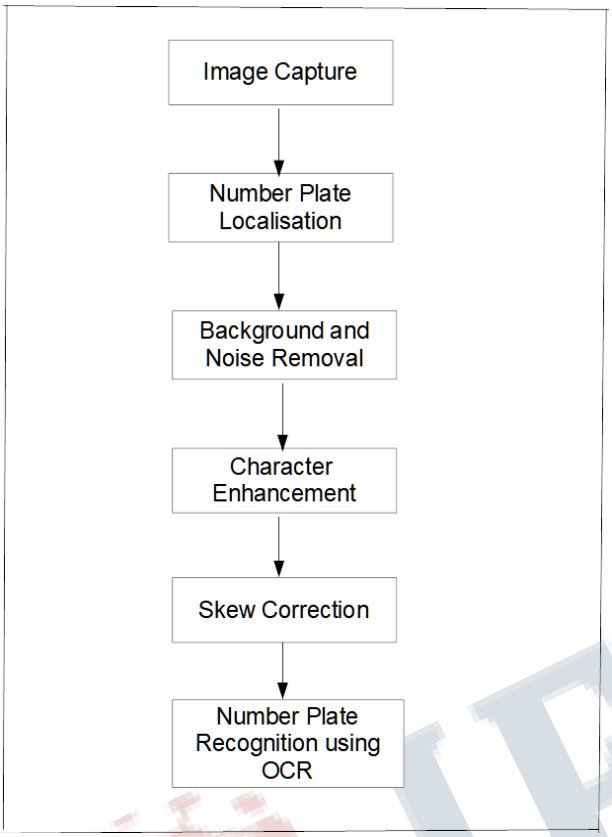
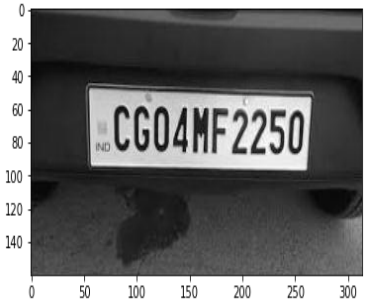


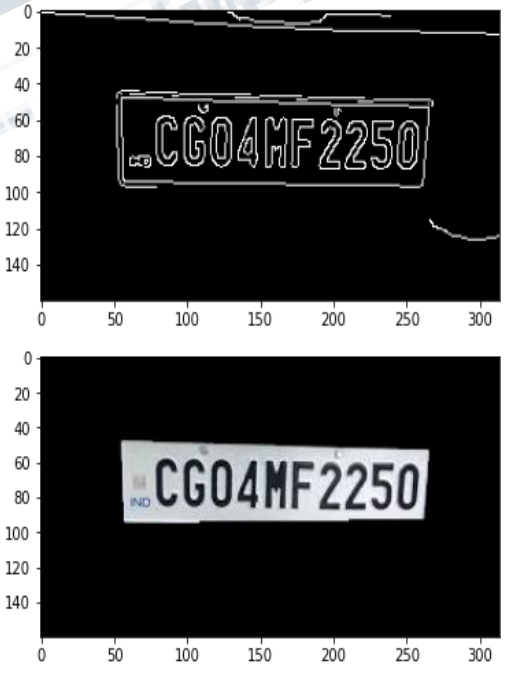
Image Capture

A Raspberry Pi camera is configured with the model to capture images along with a Pi Camera library that is to be imported and initialized. A python code is executed for the implementation of Pi camera. A sleep time of 2 seconds is introduced to give the time to the set light levels of the sensor. The image is captured in **RGB format and converted to a gray scale image.**



Number Plate Localization and Background Removal

The License Plate have the form of a rectangle and algorithms are designed taking rectangular shapes of predefined proportion (dimensions) into consideration. The edges of the image is the boundary between two regions having different gray level properties. For edge detection a histogram is taken into account and the morphed image is subtracted from equalized image. Several **histograms** are constructed for different regions. Certain **edge detection** techniques are taken into consideration for successfully removing the background. Kernels are created after dilation of the edges. The positions of the four corners of the number plate are obtained for completing the number plate localization.



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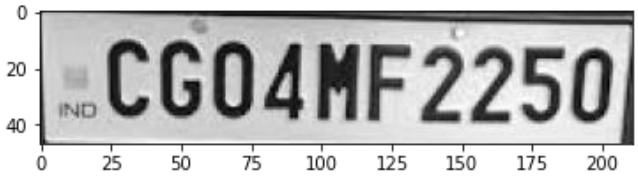
Skew correction

A text skew correction method is put in place to correct the angles in which the image is distorted. This is achieved by detecting the block of text in the image, computing the angle of the rotated text and rotating the image.



Number Plate Recognition

The project applies the concept of Optical Character Recognition (OCR) for which the OCR engine is used. This feature makes it possible to convert the characters from an image form to a text format. This method proves to be helpful to compare the obtained number placed with the one stored in the database and check whether the characters are identical. If so, the vehicle is given permit to pass through the toll booth. The illegal license plates are denied entry through the station.

V. CONCLUSION

During the implementation of the project, the system provides sufficient data to state algorithms that are suited for implementation of Automatic License Plate Detection system. Certain predefined libraries are available in Python for image processing which makes the execution of the setup easier to implement on the Raspberry Pi model. Each stage in the image processing demands a distinct technique to achieve the desired output. Number Plate Localization technique is carried out using the Contour Tracing Algorithm. The algorithm detects the number plate from the image provides output as an optimized number plate with different patterns effectively. Canny Edge Detection algorithm is required for detection and enhancement of the edges. This in turn enhances the quality of image by filtering the output of previous stage. Skew correction algorithm is carried out to correct the rotation by altering the angle. Optical Character Recognition (OCR) is used to convert the image of the obtained result to the character form for further comparison with the existing database.

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