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Computer Vision Based Toll System

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Abstract: *Many highway toll collection systems have already been developed and are widely used in India. Some of these include Manual toll collection, RF tags, Barcodes, Number plate recognition. All these systems have disadvantages that lead to some errors in the corresponding system. The system is based on Computer Vision vehicle detection using OpenCV library in Embedded Linux platform. The system is designed using Embedded Linux development kit (Raspberry pi). In this system, a camera captures images of vehicles passing through toll booth thus a vehicle is detected through camera. Depending on the area occupied by the vehicle, classification of vehicles as light and heavy is done. Further this information is passed to the Raspberry pi which is having web server set up on it. When raspberry pi comes to know the vehicle, then it access the web server information and according to the type of the vehicle, appropriate toll is charged. This system can also made to count moving vehiclesThe number plate of the vehicle is captured and the image is converted into text form. The vehicle can be checked whether it is registered or not by comparing the captured image with the database from the RTO that contains details about the registered vehicles.*

I. Introduction

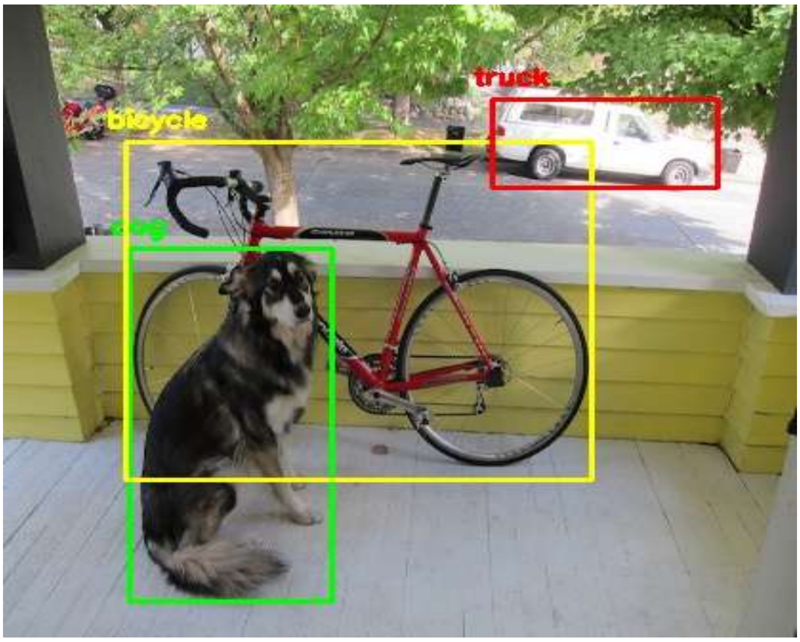
Overview

India is a nation where we get the opportunity to watch most broad national interstates. Government designs different stages to finish the undertakings under development. The administration consents to arrangement with the privately owned businesses who manufacture the framework like street, port and other stuff for a specific traverse of time and large in years. The contributed sum is charged from the vehicles passing on the recently constructed parkway. This charged sum is called as tollimpose. Individuals must choose between limited options to pay, toll charge for utilizing the foundation. The private organization required in the assembling of the foundation is allowed to charge subjects. PC vision is an imperative field of counterfeit consciousness where this choice about true scene having high dimensional information istaken. Many highway toll collection system have already been developed and are widely used in India. Some of these include Manual toll collection, RF tags, Barcodes, Number plate recognition. To capture the number plate image, image processing is required. This can be done using Open CV technology.

Open CV

Open CV stands for Open Source Computer Vision Library and is designed in C & C++ specifically for increased computational efficiency, supported by most Operating Systems. Open CV for providing effective solutions for complex image processing and vision algorithm for real time application. Computer Vision (CV) applications require extensive knowledge of digital signal processing, mathematics, statistics and perception. Open CV library include the

- Object Identification.
- Segmentation and Recognition.
- Face Recognition.
- Gesture Recognition.
- Camera and Motion Tracking.



Training the Algorithm: First, training of the algorithm is required. To do so, use a dataset with the images of the people to be recognized. Set an ID (it may be a number or the name of the person) for each image, so the algorithm will use this information to recognize an input image and give you an output. Images of the same person must have the same ID. With the training set already constructed, let's see the LBPH computational steps.
Applying the LBP operation: The first computational step of the LBPH is to create an intermediate image that describes the original image in a better way, by highlighting the facial characteristics. To do so, the algorithm uses a concept of a sliding window, based on the parameters **radius** and **neighbors**.
Extracting the Histograms: Now, using the image generated,use the **Grid X** and **Grid Y** parameters to divide the image into multiple grids. Based on the image, we can extract the histogram of each region as follows:

- As there is an image in grayscale, each histogram (from each grid) will contain only 256 positions (0~255) representing the occurrences of each pixel intensity.
- Then, it is needed to concatenate each histogram to create a new and bigger histogram. Supposing we have 8x8 grids, we will have 8x8x256=16.384 positions in the final histogram. The final histogram represents the characteristics of the image original image.To perform these procedure, Embedded Linux is used which is an open source operating system.

II. Proposed Work

Embedded Linux

Numbers of commercial OSs are available, but using Embedded Linux is more beneficial as it is open source, stable and reliable, with broad hardware support and moderate requirement of resources. It also has excellent development tools, community supports. Linux is getting tremendous popularity because its open source and some other features like security, scalability, cost, robustness, rate of development. These features can be used in embedded application to make good quality and low cost product. There are lots of development boards available out there in embedded market. Raspberry Pi is one of the popular embedded Linux based development boards.

Generation Of Raspberry PI

The first generation (Raspberry Pi 1 Model B) was released in February 2012, followed by the simpler and cheaper Model A. In 2014, the Foundation released a board with an improved design, Raspberry Pi 1 Model B+. These boards are approximately credit-card sized and represent the standard main line form-factor. Improved A+ and B+ models were released a year later. A "Compute Module" was released in April 2014 for embedded applications. The Raspberry Pi 2, which added more random-access memory, was released in February 2015. A Raspberry Pi Zero with smaller size and reduced input/output (I/O) and general-purpose input/output (GPIO) capabilities was released in November 2015. By 2017, it became the newest mainline Raspberry Pi. On 28 February 2017, the Raspberry Pi Zero W was launched, a version of the Zero with Wi-Fi and Bluetooth capabilities. On 12 January 2018, the Raspberry Pi Zero WH was launched, a version of the Zero

W with pre-soldered GPIO headers .Raspberry Pi 3 Model B was released in February 2016 with a 1.2 GHz 64-bit quad core processor, on-board WiFi, Bluetooth and USB boot capabilities.

On Pi Day 2018 the Raspberry Pi 3 Model B+ was launched with a faster 1.4 GHz processor and a three-times faster gigabit Ethernet (throughput limited to 300 Mbit/s by the internal USB 2.0 connection) or 2.4 / 5 GHz dual-band Wi-Fi (100 Mbit/s). This proposed system uses Raspberry Pi 3B+ model as shown in the figure.

Characteristics Of Raspberrypi 3 Model B+

- 1.4GHz 64-bit quad-core ARMv8 CPU, 1 GB RAM
- 802.11n Wireless LAN, 10/100Mbps Lan Speed
- Bluetooth 4.2, Bluetooth Low Energy
- 4 USB ports, 40 GPIO pins, Full HDMI port, Combined 3.5mm audio jack and composite video
- Camera interface (CSI),Display interface (DSI), Micro SD card slot (now push-pull rather than push-push), VideoCore IV 3D graphics core

GPIO

A powerful feature of the Raspberry Pi is the row of GPIO (general-purpose input/output) pins along the top edge of the board. A 40-pin GPIO header is found on all current Raspberry Pi boards (unpopulated on Pi

Zero and Pi Zero W). Prior to the Pi 1 Model B+ (2014), boards comprised a shorter 26-pin header. Any of the GPIO pins can be designated (in software) as an input or output pin and used for a wide range of purposes.

Ground Pins:
The extended header offers an additional 3 ground pins. So that's a total of 8.

Voltages:
Two 5V pins and two 3V3 pins are present on the board, as well as a number of ground pins (0V), which are unconfigurable. The remaining pins are all general purpose 3V3 pins, meaning outputs are set to 3V3 and inputs are 3V3-tolerant.

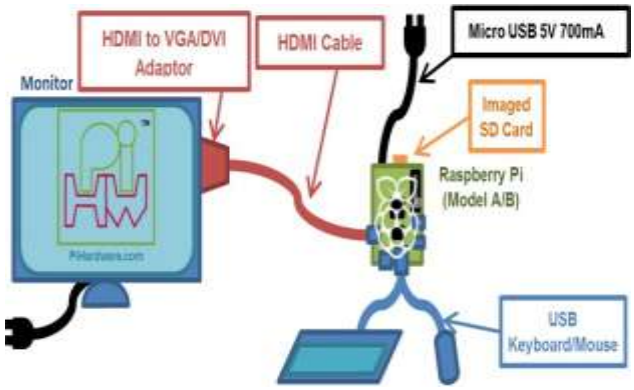
Outputs:
A GPIO pin designated as an output pin can be set to high (3V3) or low (0V).

Inputs:
A GPIO pin designated as an input pin can be read as high (3V3) or low (0V). This is made easier with the use of internal pull-up or pull-down resistors. Pins GPIO2 and GPIO3 have fixed pull-up resistors, but for other pins this can be configured in software.

As well as simple input and output devices, the GPIO pins can be used with a variety of alternative functions, some are available on all pins, others on specific pins.

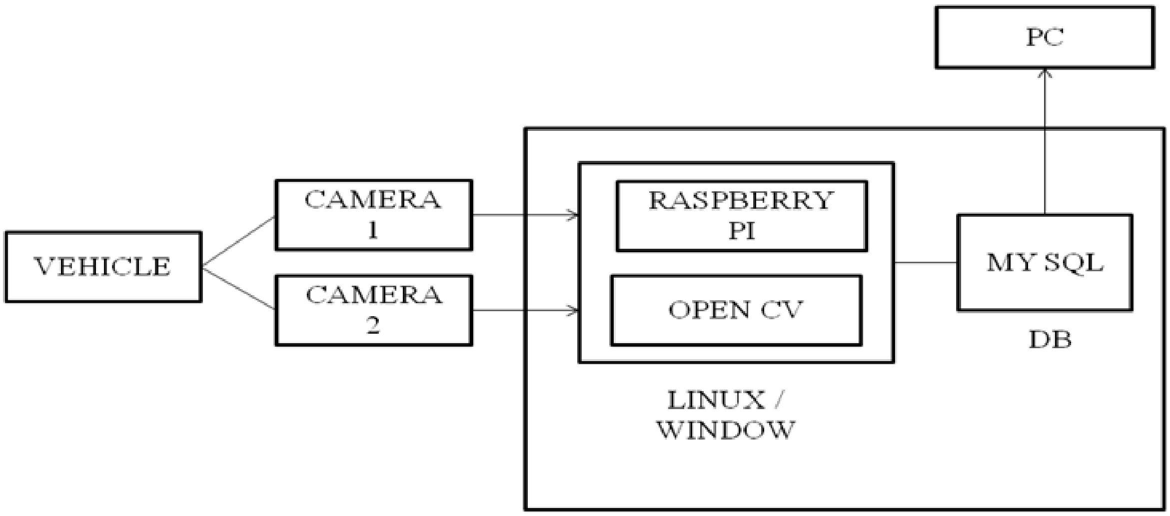
- PWM (pulse-width modulation)
  - Software PWM available on all pins
  - Hardware PWM available on GPIO12, GPIO13, GPIO18, GPIO19
- SPI
  - SPI0: MOSI (GPIO10); MISO (GPIO9); SCLK (GPIO11); CE0 (GPIO8), CE1 (GPIO7)
  - SPI1: MOSI (GPIO20); MISO (GPIO19); SCLK (GPIO21); CE0 (GPIO18); CE1 (GPIO17); CE2 (GPIO16)
- I2C
  - Data: (GPIO2); Clock (GPIO3)
  - EEPROM Data: (GPIO0); EEPROM Clock (GPIO1)
- Serial
  - TX (GPIO14); RX (GPIO15)"

Monitor
Raspberry pi has one HDMI port so that we can connect it to the monitor which is having HDMI cable. It is used to display Graphical User Interface (GUI) of raspberry pi. Also it is used to check the information list of toll collected vehicles. It will help administrator to check whether toll tax is entered correctly or not.



Camera
In this project we have to use high image capturing digital camera to get the clear images of vehicles. For practical purpose, we have used following camera just for demonstration

Block Diagram

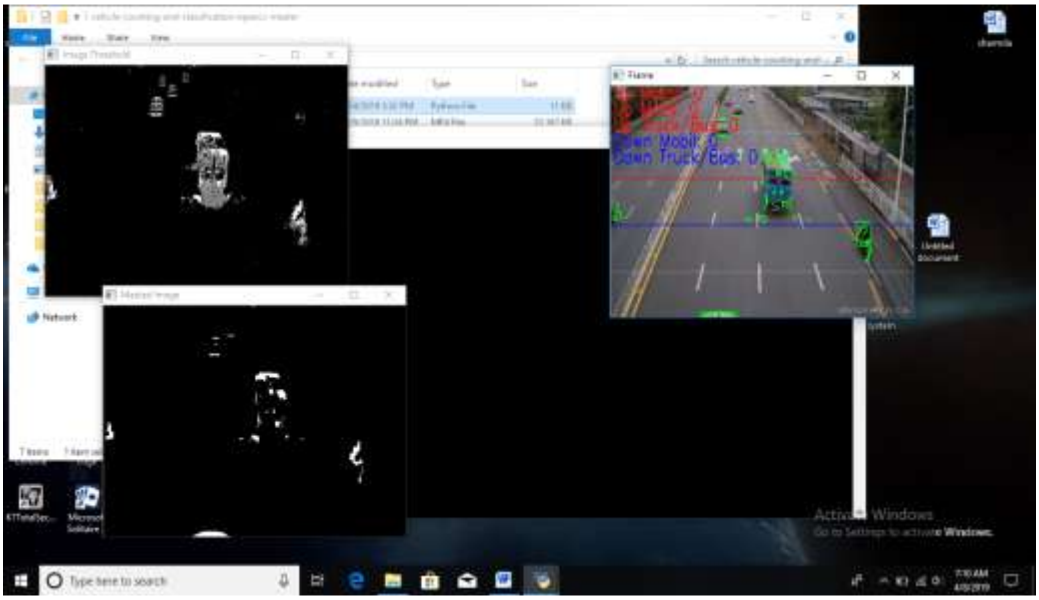


Algorithm:

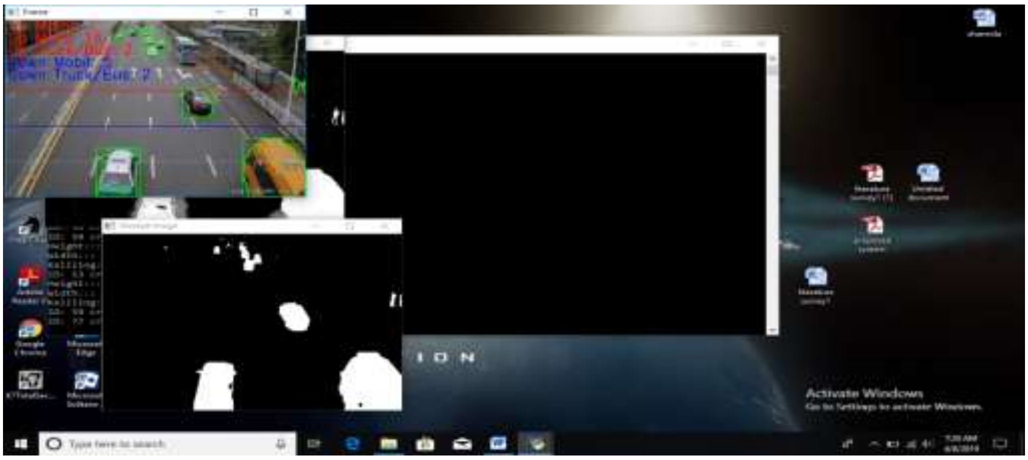
Step 1: The variables such as width and height for vehicles are declared.
Step 2: The vehicles' image is captured using camera.
Step 3: The background image is obtained and is taken as reference image.
Step 4: Background image which is a reference is subtracted from the current image which is captured using camera.
Step 5: The result is converted into binary form.
Step 6: A border or contour is drawn to indicate the detected vehicle image

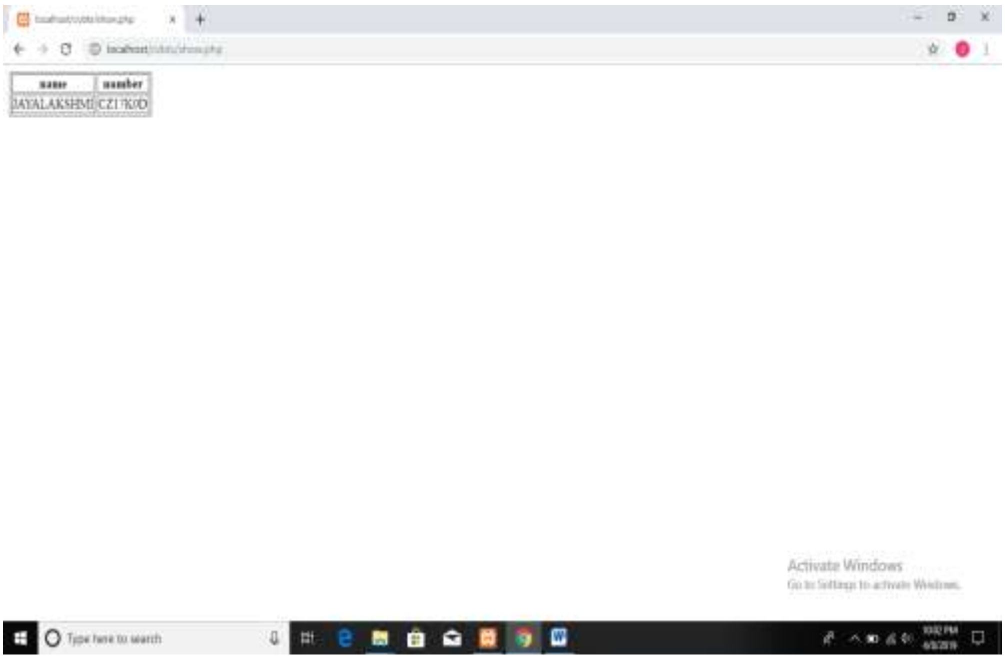
Output

Step 1: The count of vehicles before entering the toll is given.



Step 2: The vehicles entering and leaving the toll is classified into light and heavy and their separate count is taken.





III. Conclusion

Vehicle detection and number plate recognition is highly essential in the toll system. Traditional method for detecting the vehicle and separating them into heavy and light based on the area occupied, includes manual intervention, RFID tags, barcodes which are time consuming. It is also impossible to fix RFID tags in all the vehicles. Hence an automation in toll system is opted.

In order to overcome wastage of time in detection and categorization, the proposed system potrays a method like the images of the vehicles entering the toll are captured by extracting their images using OpenCV technology. Based on the area occupied by the vehicles, an algorithm is used to separate them into light and heavy vehicles. This information is stored in the database. Here an SQL database is used to store all the possible informations that can be fetched from the source. Furthermore, the number plate of the vehicle is captured by camera, to check if the vehicles are registered or not. Sometimes, the captured image can experience blur or lack of clarity due dust or any other natural hazard. To avoid this drawback the image is passed to Google Vision app, so that it will get converted into text format and is stored in database.