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An IoT based smart traffic control system

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ABSTRACT

An automated Pi based traffic control system using webcams and sensors that help in reducing traffic density in busy traffic junctions. The design of this traffic infrastructure can help to avoid traffic congestions. This paper describes a system where webcams are integrated with the Raspberry Pi to operate the lanes of traffic junction based on the count of traffic and RFID Sensors for emergency vehicles to be prioritized for the safety of passengers. As a result, the improvement in the traffic system can be exponentially improved, which can lead to progressive in the overall traffic system.

Keywords— *Internet of Things (IoT), Raspberry Pi, Web Cam, RFID, Traffic Control*

1. INTRODUCTION

IoT has evolved from the convergence of wireless technologies, Micro Electro Mechanical Systems (MEMS), micro-services and the internet. The convergence has helped tear down the silos between Operational Technology (OT) and Information Technology (IT), enabling unstructured machine-generated data to be analysed for insights to drive improvements.

A prototypical traffic system consists of four lanes each having a signal with a fixed time interval that operates clockwise or anticlockwise. The problem with previously designed ultrasonic sensor based system and conventional system is that it cannot detect the traffic accurate on each lane because of miscalculation in traffic densities. Therefore, time is elapsed even during an empty lane condition thus causing a bottleneck condition.

There are several traffic control system using methods such as GPS tracking [1], RFID (radio frequency identification) technology [2], image processing using CCTV cameras [3], VANET (Vehicular Ad-Hoc Network) [4], Ultrasonic Sensor based.

A Raspberry Pi microcomputer and multiple webcams are used in each lane to calculate the count of traffic and operate the lane based on that calculation. While automating the lanes, the webcams are used to calculate vehicular density and updates the signals at their respective lane. The motivation behind this approach was to create an image processing system that will be effective and very simple to implement. The system design, components and operation used to build and control the system are discussed in the following sections.

2. SYSTEM DESIGN

Fig.1 shows the overall design of the system. In this intersection, each outgoing lane has four webcams that calculate and update the traffic conditions of each lane signal of the Raspberry.

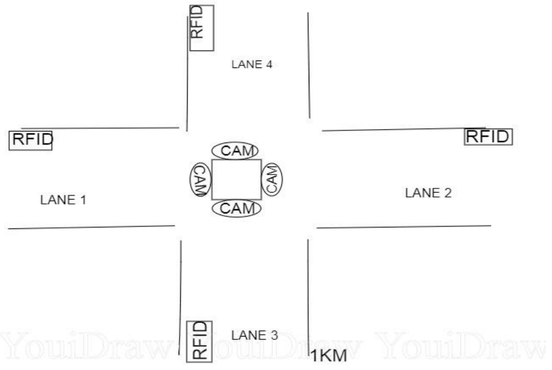


Fig. 1: Model of the system

And also the RFID'S placed at each lane will detect any incoming emergency vehicles and updates the signal

3. COMPONENTS

The components used in this system are listed below:

3.1 Raspberry Pi 3 B+

Raspberry Pi is just a credit card size motherboard of a mini computer, there are many versions of Raspberry Pi some of them is even smaller than a credit card. So just connect a mouse, keyboard, Screen (with HDMI Cable), instead of hard disk it has SD Card in which one can install an Operating system Good thing about Raspberry Pi is that once it's set up it can run without external peripherals so you can disconnect mouse, keyboard and even Screen too. Along with peripherals, It has GPIO pins to which you can attach sensors or LED or other electronics hardware.

3.2 MCP23S17

MCP23S17 is a 16-bit I/O extender integrated circuit (IC) using a serial peripheral interface (SPI). This IC enables the addition of more devices to the system if necessary.

3.3 Light Emitting Diode (LED)

LED is used for traffic light operation.

3.4 Webcam

It is a high mega pixeled camera used to detect vehicles. which operate through connecting through its USB.

3.5 EM-18 RFID Sensors

Radio-frequency identification sensors refer to a technology whereby digital data encoded in **tags** or smart labels (defined below) are captured by a reader via radio waves.

4. ASSEMBLY

Table 1: Number of components and I/O pins

Component name	Number of components used	Number of I/O pins required for each unit of component
LED	12	1
EM-18	4	4
MCP23S17	2	4
Total	36	

MCP23S17 expand the number I/O pins in the system. Each MCP23S17 can add an extra 16 I/O pins to the system. The designed system consists of four RFID sensors in each lane, which requires two MCP23S17s to balance the number of I/O pins needed. The Raspberry Pi 3 checks the 3-bit control address of an MCP23S17 before communicating with.

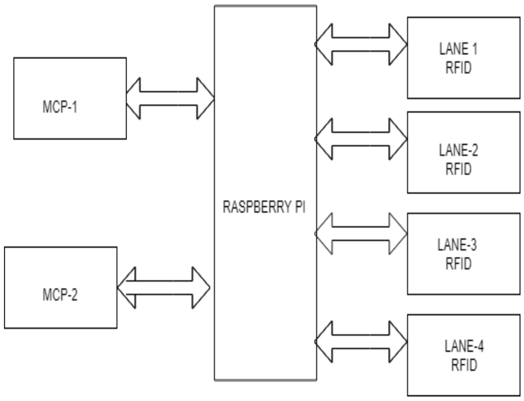


Fig. 2: Connection of port extender to the raspberry pi

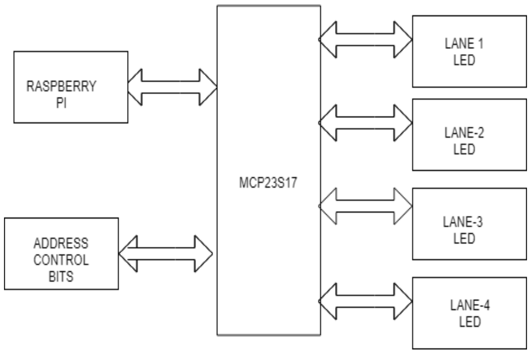


Fig. 3: connection from mcp23s17 to LED of each lane

5. OPERATION

5.1 Web Cam detection and Counting

The main idea of background subtraction algorithms used for foreground detection. There are many different algorithms for background subtraction, but the main idea of them is very simple.

Foreground_objects = Current_frame-Background_Layer.

We will use MOG algorithm for background subtraction. Some noise on the foreground mask which we will try to remove with some standard filtering technic.

5.2 Filtering

In our case we will need these filters: Threshold, Erode, Dilate, Opening, Closing. We will use them to remove some noise on the foreground mask. First, we will use closing to remove gaps in areas, then Opening to remove 1–2 px points, and after that dilation to make object bolder

5.3 Object detection by contours

We will use the standard cv2.findContours method. On the exit, we add some filtering by height, width and add centroid. Finally merge together out BG subtraction, filtering and detection parts. Detected objects on different frames and will create paths, and also will count vehicles that got to the exit zone.

5.4 Algorithm

The code for this System is Written in Raspberry pi 3 Using Python Programming Language. figure 4 displays a basic flow chart of the program

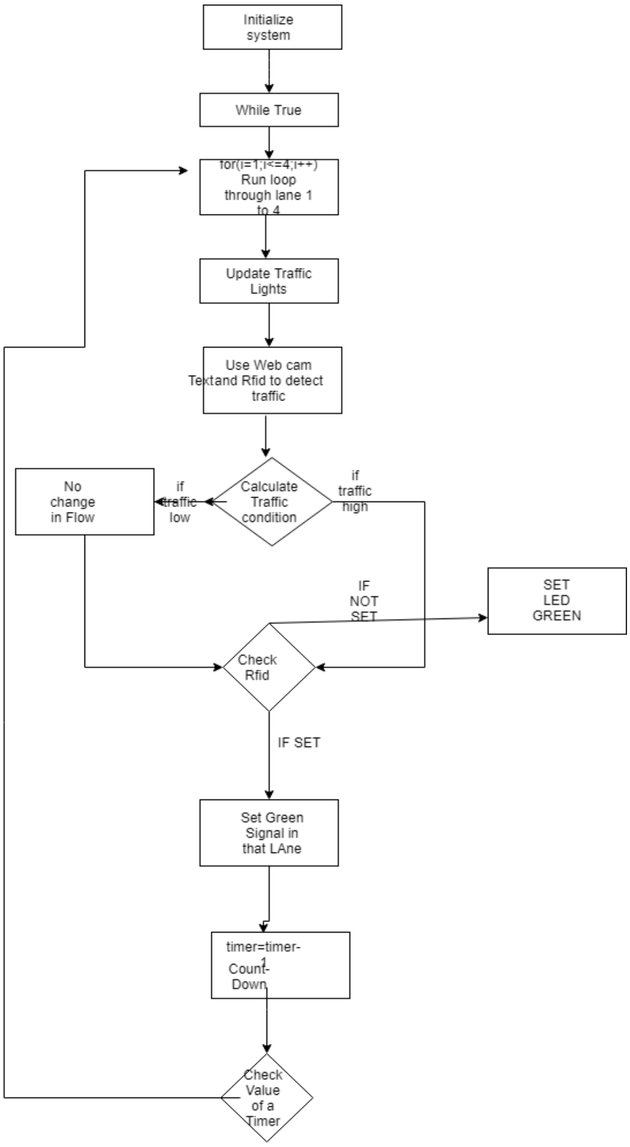


Fig. 4: Basic flow chart of the algorithm

6. RESULTS AND DISCUSSION

There’s a huge fault in Ultrasonic sensor-based traffic analysis since it cannot accurately detect a moving vehicle, thus it is only possible through USB cam which captures frames and counts vehicular density and updates the signal without any manual work.

Below are the Circuitry and Peripherals connection of our model

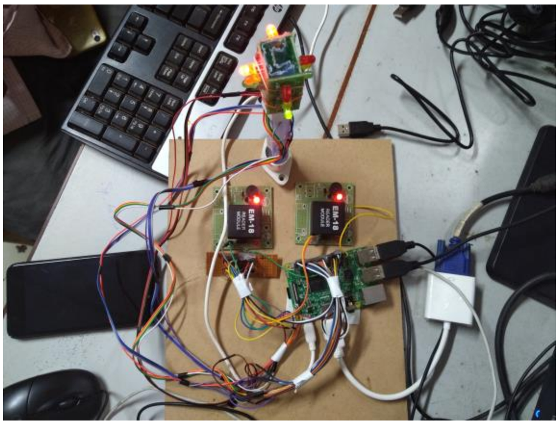


Fig. 5: Prototype of the model

The above figure is the top view of the traffic model which is a basic prototype where Two RFID’s attached to two different Lanes and These are inturns connected to the PI through GPIO pins

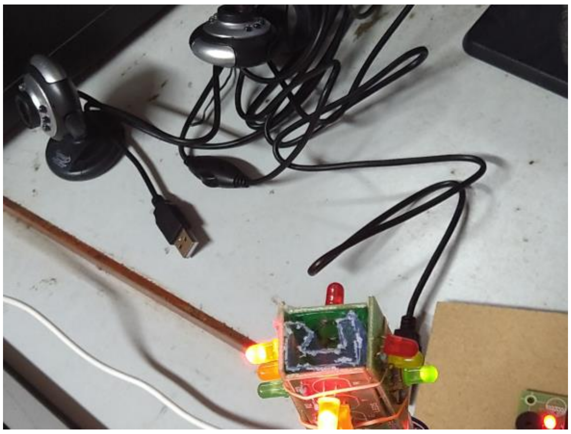
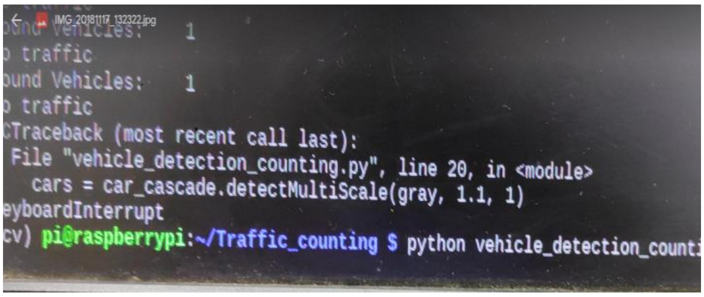


Fig. 6: Prototype of the model

Two Qualcomm USB Webcam is also integrated into the Pi. Thus by placing any video frame of a traffic intersection, it can easily calculate the Vehicular counting and updates the traffic accordingly.



```
ound Vehicles:    1
o traffic
ound Vehicles:    1
o traffic
CTraceback (most recent call last):
 File "vehicle_detection_counting.py", line 20, in <module>
   cars = car_cascade.detectMultiScale(gray, 1.1, 1)
eyboardInterrupt
cv) pi@raspberrypi:~/Traffic_counting $ python vehicle_detection_counti
```

Fig. 7: Code for the proposed system

Working from terminal to execute the Python code to count the traffic in a junction.

7. FUTURE WORK AND CONCLUSION

But if you run the python script it might have little problem with foreground objects overlapping, also it doesn’t have vehicles classification by types. But still, with good camera position (above the road), it gives pretty good accuracy. And that tells us that even small & simple algorithms used in the right way can give good results.

One way is to try adding some additional filtration trying to separate objects for better detection. Another is to use more complex algorithms like deep convolution networks. Also High Mega Pixel and a Fast booting Minicomputer or microcontroller can achieve more accuracy to the system

8. ACKNOWLEDGEMENT

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