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Circuitry and Proof of Concept for an Adaptive Traffic Control System

M Vaishnavi[1], M M Sai Prakash[2], G Moulika[3], C H Lowkya[4]

[1,2,3] *Student, ECE, Sreenidhi Institute of Science and Technology, Ghatkesar, Hyderabad.*
[4] *Guide, ECE, Sreenidhi Institute of Science and Technology, Ghatkesar, Hyderabad.*

Abstract: This paper illustrates the circuitry and proof of concept of a novel density based traffic mitigating system for the vehicles. The intention of this paper is to make an adaptive signalling system, which can be optimally used in real-time. This project is accomplished with the help of NVIDIA Jetson Nano and utilizes python for image processing as open source in order to measure the size of the traffic on the road.
Keywords: GPIO, NVIDIA Jetson Nano, dynamic signalling

I. INTRODUCTION

The trend of purchasing automobiles has been increasing through years; this is due to adapting to the urban lifestyle. However, this adaptation has its own perks, people have become ignorant on the fact that this will cause more environmental damage. In addition, this demand of automobiles at every household has led to substantial increase in the traffic that we see on the roads.

Now, as we see that many countries cannot meet the demand of widening the roads, as that is a massive transformation and leads to a lot of demolishing of private property. Hence, an alternative fix for this problem is expected.

Traffic jams have become threatening day by day as they not only delay the process of our work but also block the movement of the vehicles that need immediate addressing. This will include any sort of emergency vehicle, a person who needs to catch a flight or a train or any other important deadline that must be followed.

This has become menacing by the day as people have started jumping the signals in order to avoid the long waiting and cops have been assigned at every signal in order to control this situation. Even though, tickets are being generated for every vehicle jump, it has not reduced the amount of people jumping the signal.

Experts have been working on this problem for the past few years and have come up various fascinating solutions such as dynamic signaling. In this method, the timer is at dispense with the lane that has the most traffic.

In this paper, a dynamic signaling method is proposed and the circuitry of the proposed system is explained as follows:

In section 2, all the existing systems for the dynamic signaling have been listed.

In section 3, the implementation of this system is illustrated with the help of a circuit diagram.

In section 4, the results of this project are displayed.

In section 5, the synopsis of the system is described followed by the future work.

II. LITERATURE SURVEY

One of the existing systems as described in [1] is by manual controlling i.e., when the cops are assigned for every traffic signal in order to control it. [1]

In [2], the author has executed an IOT based traffic control system in which the input image of the vehicles undergoes few pre-processing techniques so, as to separate the background and the foreground of the image. After this, the vehicles are counted and this data is dispatched to the cloud with the help of Bluetooth connection. [2]

III.IMPLEMENTATION

For this paper, the implementation can be divided into hardware execution and software execution. This project is performed and implemented with NVIDIA Jetson Nano and the demonstration of the traffic lights is accomplished with the tricolored LEDs with common anode. The software execution of this system will include finding the two wheelers and four wheelers and allotting them bounding boxes. We utilize deep neural networks for an effective execution. We are also processing the pictures so, as to find a plus sign that is the representation of a mobile hospital. After this, an intelligent signaling takes place according to the priority.

The circuitry of this system is described as follows:

The project deals with four lines or four roads with a traffic signal at the intersection hence there will be a requirement for a total of 8 signals each signal controlling one red and one green light per road.

As we have used a common anode LED for the demonstration, we will have to short all the anodes and give a positive supply to it for the LED to get into the forward bias condition and do its working.

The circuit will be a closed circuit and the LEDs will be in forward bias when any one of the cathode (RGB) is given a comparatively negative power supply, in our case grounding the power supply.

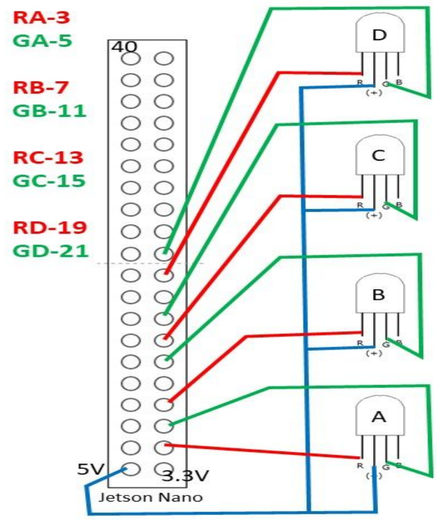

Figure 1. Displays the circuit diagram of the system

For the above mentioned circuitry to be in action, we've written Python program which uses an exclusive Jetson Nano GPIO library and gives us access to those 40 pins.

The LED terminals as discussed and shown in the circuit diagram are connected to the respective pins on NVIDIA Jetson Nano.

Each pin that is being used is declared and defined in the Python code as an output pin, these pins are given outputs of either high voltage or a low voltage level, and these voltage levels decide the positive voltage or the grounding voltage. As the required terminals of green and red colours are already connected to the GPIO pins, the common anode terminals being short and given to one pin, now the control of voltages is done with the help of the code as mentioned earlier with high and low voltage levels. As mentioned the common anode terminal needs to be given a positive supply i.e. a high voltage level to enable the LPD, the other terminals can be controlled as required with giving a high voltage level for that coloured light to turn off and a lowered his level for the colour of light connected to that terminal to turn on.

Our system intelligently allots an amount of time to a particular lane for it to have a green signal and also the order of the signalling, hence the command for these LEDs to glow either a green or red light is given by our system measuring the traffic density and the priority of emergency vehicles.

It is ensured that if one lane has a green signal all the other lanes will have the complementary, which is the red signal.

IV. PROOF OF CONCEPT

We are using four cameras for the real-time video input that will be processed and operated on frame by frame for all the above-mentioned tasks and implementation.

As a proof of concept for multiple camera interface, we have used OpenCV for the capturing and further processing on the image.

For four cameras, four camera objects are to be created with each having a different reference and each connected to an individual and independent camera recording or capturing a live feed. This camera object is used with the read function that returns the frames of the live video feed, these different frames are stored in different variables and are pre-processed then operated with the norms of the system as defined to work, calculate and control the traffic lights.

We have demonstrated the above with two cameras interfaced with the Jetson Nano via USB (Universal Serial Bus) port available on the board.

We have taken inputs from the camera and simultaneously displayed them that are readily available for the pre-processing and feature extraction from each frame they capture and are also benefitted with individual exclusivity.

The images for the proof of concept are given below with the USB cameras connected to the Jetson Nano in the initial figure and the output of the code with the multiple camera interface as the latter figure.

Two web cameras faced in opposite direction are shown connected to the board with the help of the USB ports on the board. The live video feed is displayed on the screen in two separate frame windows.

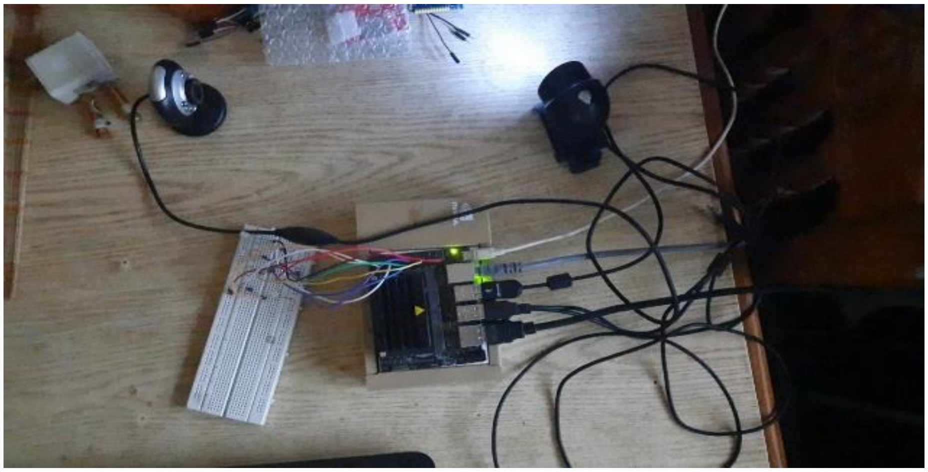

Figure 7. Two USB Cameras interfaced with NVIDIA Jetson Nano.

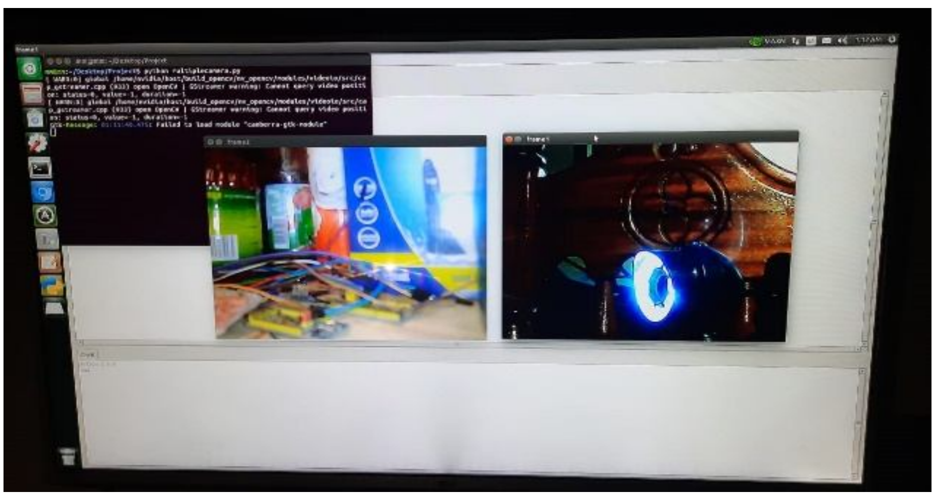

Figure 8. Output for live video with two cameras interfaced.

V. EXPERIMENTAL RESULTS

The outputs are produced for this system and are displayed as follows:

Figure 2. Displays output image containing an ambulance

Figure 3. Displays output image containing a two wheeler

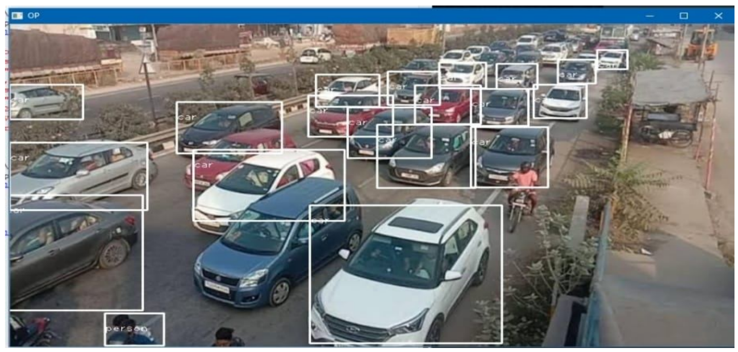

Figure 4. Displays output image with huge traffic.

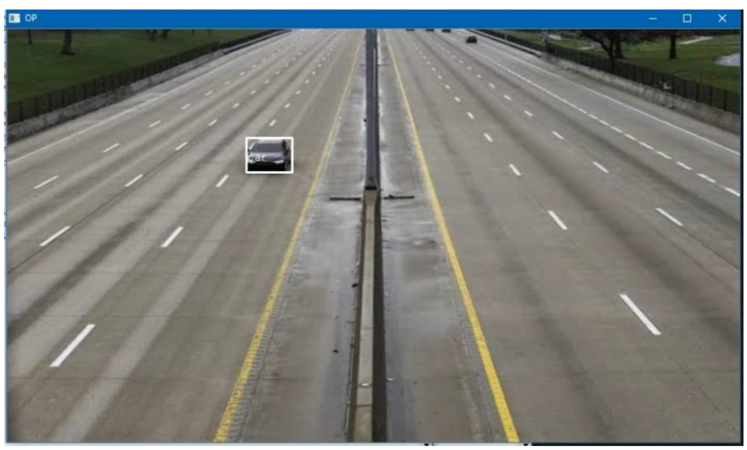

Figure 5. Displays output image with nary traffic.

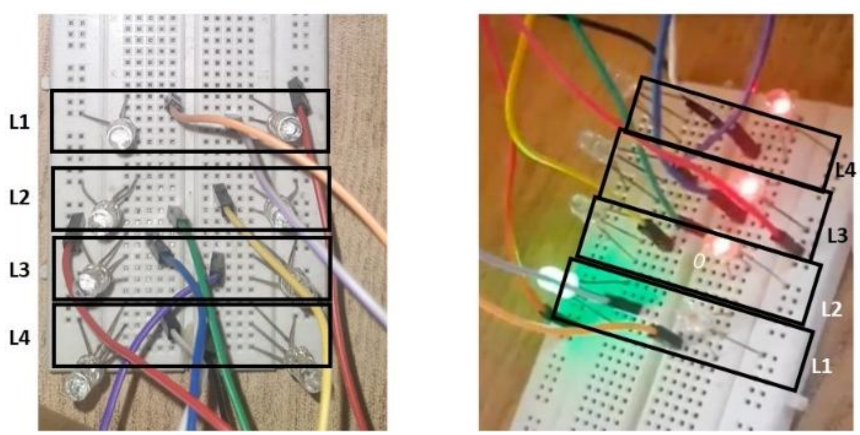

Figure 6. Hardware output image.

VI. CONCLUSION AND FUTURE SCOPE

The proof of concept shows us that this method is very much eligible for real time execution and is a very good replacement for the existing systems. This method compared to all the previous methods can be said has more accuracy as it will take into account all the lanes at a cross road for regular instances.

This method for intelligent signalling can be further extended by giving importance to other automobiles that need quick attention.

Additionally, we can also create an algorithm so as to capture pictures from the same cameeras as used in this system of the vehicles that tend to jump the signal. This will automate the most of the transportation department because the fines will be generated from the images captured with the help of an algorithm.

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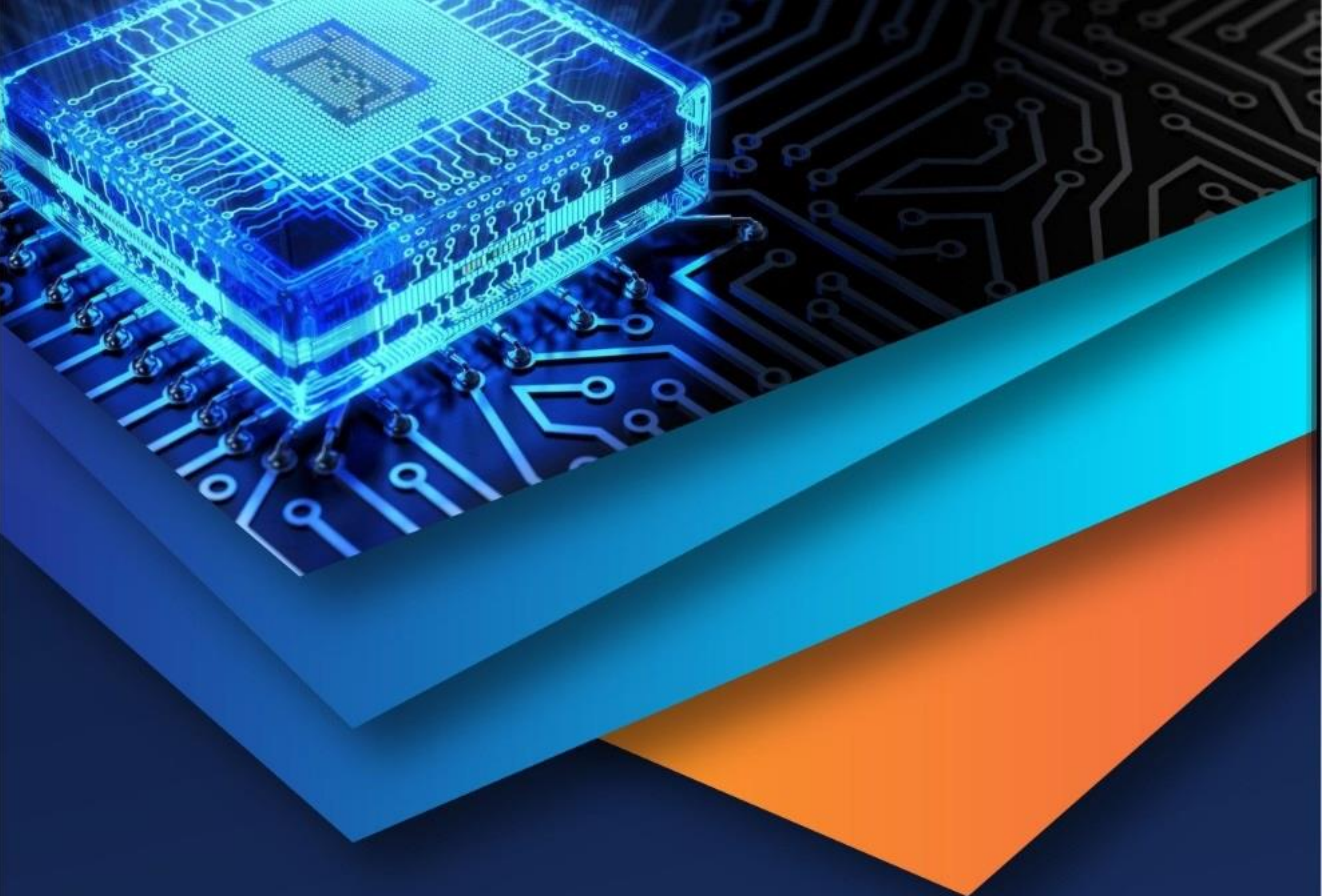

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