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# SMART DETECTION OF TRAFFIC SIGNALS RED LIGHT RUNNING USING VEHICULAR CAMERAS

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**Abstract:-** The red visitors mild walking is a completely common areas with extra pedestrian glide, the sort and amount of site visitors violation. Nowadays, automobiles going for walks crimson site visitors lights are accidents, among others. The rule, in General, is the identical applied detected with the aid of sensors constant on the streets. However the very small along the main routes. Percentage of all traffic lighting fixtures are ready with such sensors. Is this reason, this paintings proposes the purple mild runner detection to be executed by means of the gadget that includes the camera and the computer embedded in the car. An set of rules is also proposed to method the recorded movies and the prototype changed into applied. The prototype's intention is to reveal work vehicles with none intervention in driving, acting best in as an educational tool. Tests are completed with video recorded within the streets of Belo Horizonte for the duration of the day and with the video benchmark using the carried out prototype. The consequences are as compared primarily based at the execution time and accuracy. The video processing took less one tenth of the video's period and the accuracy turned into about 95.8%.

**Keywords**-Component; VLC; CAN, Vehicle communication;Traffic light Detection; PD saturation

## I. INTRODUCTION

With the increasing quantity of motors. The most frequent violations logged in first half of 2013 in Belo Horizonte were advancing crimson mild and parking on site. The amount of infractions by way of development of crimson light suffered a superb discount of eighty% in the first half of of 2014 in over the equal duration of the previous year, from 123,878 to twenty-five,470. However, this discount in registrations not necessarily imply that the infractions no longer fined fell in the equal percentage. Drivers become doing a mapping the site visitors lighting fixtures which have advance registration and therefore, understand which disrespect with out being penalized. Currently, the metropolis has about 122 system enhance registration of red light. Devices feature incredible precision, every now and then coupled with human useful resource, as in. However, the value produced every yr, the automobile enterprise has the installation of such device on all invested in more wise transport systems with the objective of helping the driving force to make selections and thinking timely manner in conditions of chance, supporting to store lives and resources. A machine that gives the vehicle the ability to recognize and interpret what is

in your again can inside the short time period enhance the safety of those drivers immediately and the Middle term permit the improvement of self sufficient motors. The strengthen of crimson light is one of the infractions commonplace and is taken into consideration a severe infraction. However, neither all the lights are monitored by using enhance registration. Thus, there may be a want to monitor the automobiles in traffic lighting fixtures with out advance registration. A possibility, explored on this work, is to apply a gadget with a on-board digicam at the vehicle, which can accomplish. In locations wherein there's no constant radars or officials in thru. In addition, a equal digicam could be used for other functions (in a few towns, there are cameras on buses, as an instance). As the characteristics of the traffic and routes range from a course to any other, further to the issue of adapting the signaling on an entire city, diverse sensors along with cameras can carry out the challenge to assist the interpretation of signaling and sign up a possible awful behavior earlier than a purple light. Several radars and electronic sensors are set up in roads and strategic places of foremost towns inclusive of Belo Horizon, based on technical research that detect intersections with visitors lighting within the city makes the undertaking unfeasible before everything, that's why the intersections candidates are decided on based on statistical statistics, to acquire improve registration device. With an increase detection device of pink light embedded in the vehicle, the driving force may want to have higher conduct and admire symptoms no matter the existence of navy officers or of constant speed cameras on the street honestly by way of understanding you are being monitored. With this, there might be a reduction inside the facts and, mainly, of accidents. There are numerous works related to detection and site visitors sign reputation in General changing the traditional sensors for processing pix. Two commonplace ways to start the detection and recognition of traffic signs and symptoms thru pictures are based on shade segmentation and segmentation primarily based on edges. Techniques that use colorations tend to have better control over the lights. An example the usage of the HSV color space is defined through Fleyeh. Several papers have been published the use of Vision Computer to control or monitor the conditions visitors. The works of Cosmo, Salles and Ciarelli carry out pedestrian detection using a vector Machine Support (SVM) to educate and check Windows scanned the photo of being a sturdy classifier in pedestrian detection. Also use Histogram of oriented gradients (HOG), proposed with the aid of Dalal and Triggs, the excessive overall performance of the descriptor. The hit detection is around sixty three.Eight%. Fairfield jobs and Urmson and Levinson et al managing the detection and reputation of visitors lights with the resource of geospatial queries to locate intersections on the road, thru the Google Maps API, for discard remote pix of crosses. However, this rule does not observe in Brazil, wherein, in many places, is common meet traffic lights on a simple crossing of pedestrians. In addition, the gadget could end up tremendously dependent on the connection to the GPS. Images are categorized to from resources of

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light pink, yellow or inexperienced. The away from the visitors light is estimated on the idea of calculations concerning the real length of the gadgets. Shenetal endorse a modeling of hue and saturation (HSI area) based totally on 2D Gaussian distributions, in which the parameters are received from applicants labeled manualment. In addition, it's far proposed a technique to dispose of fake candidates primarily based on information in publish-processing of the picture. The quit result is a mixture of facts from the publish processing and a historical base. The results of this approach, in though, come to present an accuracy exceeding 99% for some videos. The scope of these works is limited to detection of traffic lights. On the other hand, feed detection methods of signal Red are proposed by Yung and Lai and Luo, Huang and Qin with the camera located at a fixed point of the via where are visible the semaphore, the retention range and the cars passing by. The method of Yung and Lai identifies the nearest traffic light (the higher the image) and uses the processing. The detection is done based on the color: white for retention range and red, yellow and green for the traffic light. The test results achieved 100% hit in the tests. Luo, Huang and Qin perform the tests on a intersection with free right, i.e. where the light is not valid for convergence to the right (only for vehicles that converge to the left or move on). The results feature slightly lower precision, around of the 90% for unmetered traffic lights, failure to signage still exists and remains unpunished. Aiming at the reduction of advances of traffic lights at intersections do not monitored, this paper proposes a methodology for detection of advancement with the on-board camera on the vehicle, uniting signal detection techniques and advance detection using computer Vision.

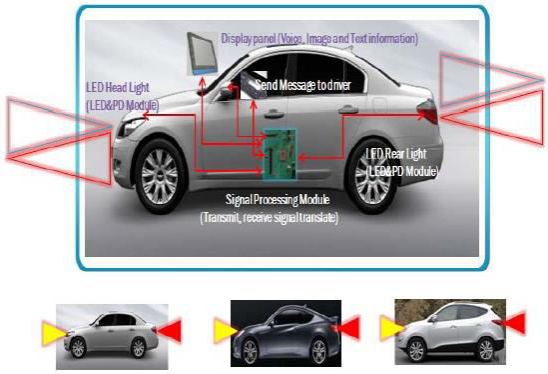


Fig1: Architecture of CAN Networks

| Protocol | Typical bitrate | Transmission medium | Topology |
|---|---|---|---|
| LIN | 19.2 kbps | Single wire | Point to point |
| CAN | 500 kbps | Twisted pair | Bus |
| FlexRay | 20 mbps | Optical fiber | Bus/star |
| MOST | 150mbps | Optical fiber | Ring |
| Ethernet | 100mbps | Optical fiber | Various |

## II. SYSTEM CONFIGURATION

### *A. Concept of vehicle VLC communication*

The concept of experiment is shown in Figure 1. Almost every car's control signals are made by CAN such as a light, engine control, air bag control, car speed, engine RPM signal and etc. Thus, if drivers receive a CAN signal, they can get information of near vehicle. For example, drivers can know how fast near vehicle, which direction they want to go, even they get some simple text message from other

driver. So drivers should be more convenience and get more safety driving. As you can see in Figure1, head and rear LED light of center car transmits signal to near car's receiver module. Transmitted signal is received from receiver module. And it signal is processed by processing module. That processed signal is sent to display panel or dash board for driver. Recently, a range of approaches have been developed to model the behaviour of these types of networks, notably by Lim et al. [2,3] , Hintermaier et al. [4] and Alderisi [5] . A review of these approaches can be found in [6] . The focus of this paper is on introducing and analysing a novel simulation technique and platform for the evaluation of automotive networks, rather than on proposing novel topologies or scheduling algorithms. We propose that the integration of real time automotive video network streams into the simulated testbed (for the purposes of this work we use the term testbed to mean a hybrid network simulation platform which integrates both virtualised and simulated nodes) allows for more realistic and useful simulations. We do this by simulating, using a hybrid approach and the integration of traditional traffic generators and real video network streams onto a novel simulation platform.For experiment, we made transmitter and receiver. It is shown in Figure 2, 3. We used a commercial head and rear light. On the right side is transmitter part and on the left side is receiver part. To generate a digital signal, we used CAN signal generation device (PEAK, NI). It generates CAN low (1.5V~2.5V) and CAN high (2.5V~3.5V) signal. These signals are changed by CAN transceiver. And CAN transceiver make differential signal using CAN high and CAN low signal. As we know, LED can modulate digital signal '1','0'. When current is supplied LED, it modulate digital signal '1' and current isn't supplied LED, it modulate digital signal '0'. In our transmitter, when digital signal '1' of transceiver was passed to switch IC, switch IC was changed open state and at the same time LED was off. In another case, LED was on. We already said that VLC can use a communication and lamp simultaneously. This is the reason why we used this way. In our receiver, PD detected the luminance change. At this time, PD converted photon to current. This current was passed to Trans impedance Amp (TIA). TIA converted current to voltage. Because almost every ICs are voltage driving. After that, we used limiting amplifier. Because the received signal power was changed by distance, light power and input current power.Limiting amplifier had a constant output value regardless of input signal power (VPP). This means when received signal was high, it was decreased by limiting amplifier. In another case, when received signal was low, received signal was increased by limiting amplifier. So it maintains almost the same value.This output of limiting amplifier was passed to bias control circuit. For using CAN transceiver, we used bias control circuit. This circuit controlled input DC level of CAN transceiver. CAN transceiver can divide into CAN high and CAN low signal. We detected this CAN signal using Digital Phosphor Oscilloscope (DPO). It can measure Q-Factor. Thus, we can get a reliability of our system.

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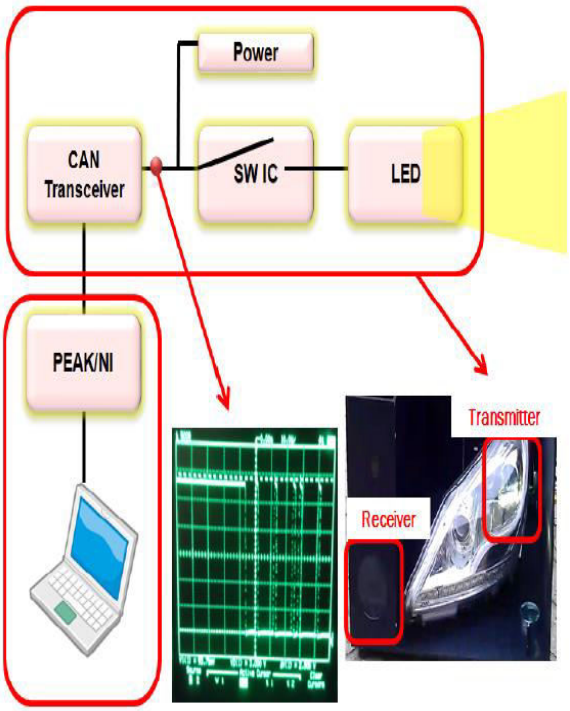


Figure 2. Transmitter circuit design and transmitted signal

In this paper, we assume, as other authors in the literature have done, that Ethernet will be used to carry all automotive traffic, with the exception of a separate CAN based legacy system which is modelled as operating over Ethernet through a CAN - Ethernet bridge. It is likely that CAN systems will remain in vehicles for some time, as pointed out in the literature [6] , however data on the CAN bus may also be useful in some Ethernet ADAS applications and so in our simulations we also include it on the Ethernet network.As described in this section and in Section 1 , the primary focus of this platform is to examine automotive video traffic for a number of purposes. However, in order to remain as faithful as possible to real automotive networks, we include in our simulation all traffic types whilst our results focus on those which are relevant to video traffic..

## III. ETHERNET AS AN AUTOMOTIVE COMMUNICATION TECHNOLOGY

Ethernet [22] has been a dominant networking standard in mainstream computing for almost 30 years. Its combination of high speed, low cost and flexibility provides a powerful backbone for many different network types.There are a number of real advantages to using a general purpose networking standard such as Ethernet over certain automotive specific standards. The popularity of Ethernet ensures that it is an extremely cost effective solution. The automotive industry is acutely sensitive to cost considerations and thus using standard widely available components allows equipment costs to be kept as low as possible. The 802.3 working group has the responsibility for continually improving the performance of the Ethernet standard.From the inception of Ethernet in 1973, the technology has been iterated several times, with the latest revision capable of providing 100 Gbps over optical fibre or twisted pair copper cable. This allows automotive systems to keep pace with developments in audio visual technology and demands for higher bandwidth. For in-vehicle networks it is common to find 100 Mbps Ethernet solutions utilising twisted pair copper cable to reduce wiring harness size. Currently the automotive and other industries through the Institute for Electical and Electronic Engineers (IEEE) are standardising a 1 Gbps solution with reduced wiring size. This standard is IEEE P802.3bp. Their work is anticipated to be completed in 2016 [6] . Several networking technologies may currently be in use concurrently in a single

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in-vehicle network, and Ethernet could alleviate this complexity due to its universality and flexibity. While Ethernet may not immediately be able to replace certain network sub systems within a vehicle such as CAN or FlexRay due to their deterministic nature, the advantages of Ethernet for high bandwidth applications are obvious.

### III.1. OPEN alliance special interest group

The One Pair Ethernet Alliance Special Interest Group (OPENSIG) [23] is an organisation formed to encourage adoption of in-vehicle Ethernet systems. Its stated goals are as follows:

- Enable wide scale adoption of Ethernet-based automotive connectivity
- Establish industry standards for Ethernet connectivity over single pair unshielded cable
- Enable migration from closed applications to open, scalable Ethernet-based networks.

The OPEN Alliance SIG has a number of high profile industry members including Broadcom, BMW, Hyundai, Jaguar, Land Rover and Bosch.

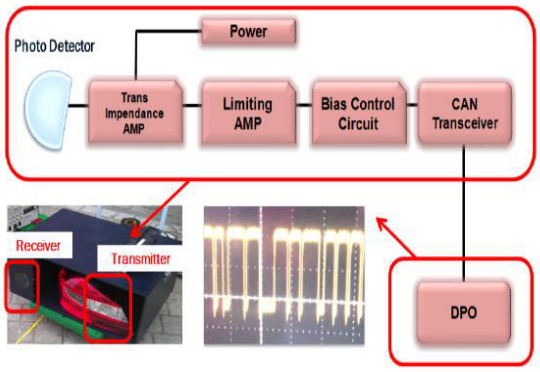


Figure 3. Receiver circuit design and received signal

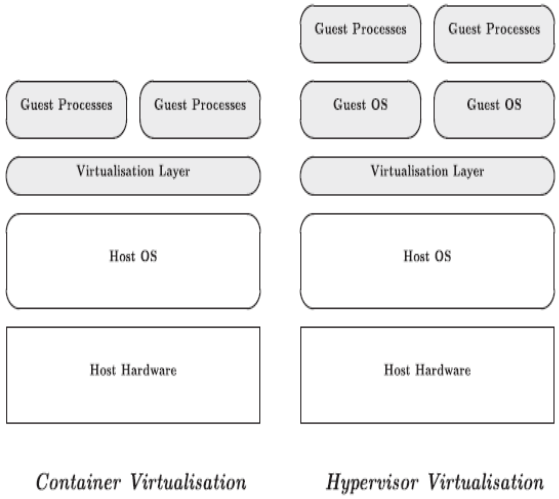


**Fig. 4.** Illustration of container based virtualisation compared to hypervisor based virtualization

## IV. LINUX CONTAINER BASED TESTBED

It is important when creating simulations that they mirror real world performance as closely as possible and for this reason our platform employs a hybrid approach. This differs from traditional network simulation in that the system integrates real world traffic across a simulated network. This approach allows simulations to utilise accurate and realistic network traffic flows and removes reliance on in-built traffic generators of the particular simulation platform in use. This concept is not novel and is conceptually similar to cluster simulation as demonstrated by Karfich et al. [34] as well as residual bus simulation as demonstrated by Bartols et al. [35] . Many well known virtualisation systems such as Xen [36] , VMWare [37] and KVM [38] use a hypervisor approach to virtualisation, that is, a guest operating system runs on top of a hypervisor application which handles translation of system calls to the underlying host operating system. Container based

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visualisation instead uses the kernel of the host operating system directly and separates processes from the host operating system through namespaces [39] . Due to the nature of this type of virtualisation and the requirement for the virtualised containers to use the same kernel as the host operating system, this limits the supported execution environments to Linux hosts and Linux based guests. This limitation is a disadvantage of this approach over the use of a hypervisor based virtualisation solution, however, it offers performance and other advantages [40] . This virtualisation technique allows for less flexibility in the guest operating system that may be used, but makes containers much more lightweight than hypervisor based solutions. The difference between these two approaches is illustrated in Fig. 2 . For the purposes of this research, the ns-3 network simulator was chosen. ns-3 allows integration between a simulation network and Linux containers through the use of tunnel and tap devices (TUN/TAP). The TUN/TAP device driver provides packet reception and transmission for user space programs [41] . It can be thought of as a software network interface. An illustration of this functionality can be seen in Fig. 3.

There are other network simulators which offer similar functionality such as OmNeT++ [42] , however ns-3 was selected for this work for a number of reasons, primarily concerned with performance. Weingartner et al. [43] as well as Lacage [44] have clearly shown that there are performance benefits to the use of ns-3. [44] in particular focuses on the performance and suitability of ns-3 for interfacing with real devices.

## VI. TRANSMIT DISTANCE

Even though we solve many outdoor VLC problems, if the signal doesn't reach the receiver, this signal couldn't recognize. To solve this recognize problem, we tried to design an optical lens. So we designed transmitter and receiver's optical lens which is shown in Figure 5. In case of transmitter lens which is shown in Figure 5's (A), (B) was attached in head of transmitter. And to find a proper lens position for receiver, we tried to change distance between lens and PD. This experiment is shown in Figure 5's (E), (F). After that we applied this lens design to our transmitter and receiver module which is shown in Figure 5's (C), (D). Because of this lens design, we improved communication distance to 20 m in the daytime outdoor situation.

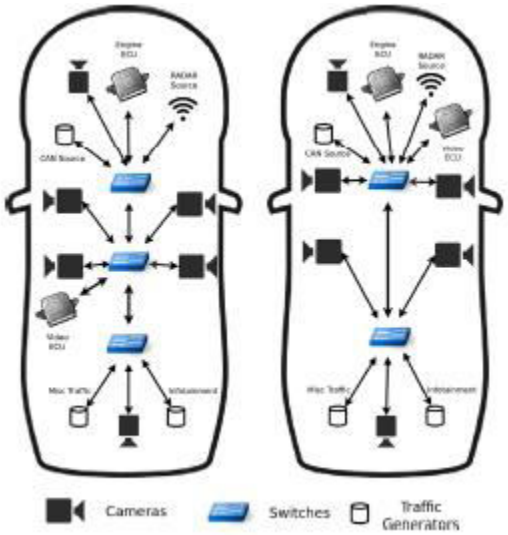


**Fig. 5.** Tested Network Architectures containing cameras, radar, infotainment and CAN sources as well as receiver ECU devices. **Left** - Daisy Chain topology. **Right** - Double Star topology.

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Figure 6. Outdoor VLC experimental setup

## VII. THE EXPERIMENTAL SETUP AND ANALYSIS OF RESULTS

### *A. The experimental setup*

Figure 6 is my outdoor VLC experimental setup. It was in the daytime outdoor condition. Direct sun light luminance was almost 20000 lux. The other case of sun light was about 3000 lux. CAN signal was generated from CAN signal generation devices (PEAK, NI). These devices were connected to computer using USB. Transmitter module was supplied by 18~20 voltage. And 245mA was applied to LED from switch IC output. Receiver module was supplied by 5V and bias control voltage was 1.4V at that time driving current was 260mA. Transmitter and receiver height was 20 cm from the ground. And communication distance was 20 m between transmitter and receiver.

### *B. Measure of changing performance according to experimantal setup*

For performance evaluation, we tried to measure of our system. Transmitter was fixed in our Experimental setup. And we changed distance between transmitter and receiver. We checked four cases. First, we used head light module with lens and second, head light module without lens and third, rear light module with lens and last, rear light module without lens. Performance evaluation was measured by Q-Factor of DPO 33 device. We got a different performance from our experimental cases. It is shown in Figure 7. In case of head light and back light with lens, its transmission performance has been verified Q-factor of 10 in 20 m. Q-factor of 6 is almost the same as BER 10-9.[8] In case of head light and back light without lens, it transmission performance has been verified Q-factor.

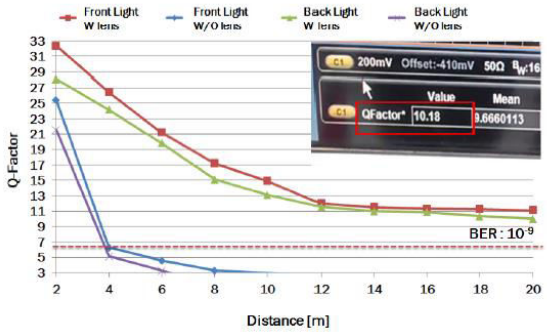


Figure 7. Changing performance according to experimental setup

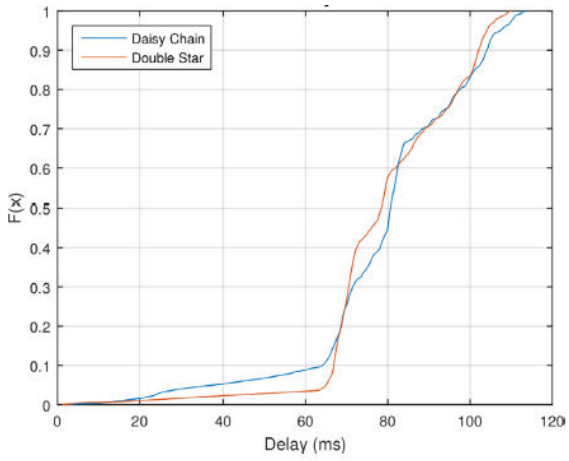


Figure 8. Changing performance according to experimental setup

## VIII. CONCLUSION

In Belo Horizonte, less than 1% of site visitors lighting has equipment for detection of enhance of red light. With the huge quantity of infractions by way of advancing all semaphore 12 months, wished a brand

new way to become aware of these advances in non-suitable system lighting for the report. For this cause, this paper proposed that the monitoring is performed from interior paintings cars, not at the intersections of the street. The idea part of the use embedded cameras and processing techniques photo. The photos are recorded with vehicular and digital camera movies processed later. The precision has been pleasant for motion pictures recorded for the duration of the day for the reason that camera was nicely located, further to the runtime had been greatly decreased, leading less than 250 seconds to render 24 minutes video at five fps with accuracy exceeding 95.8%. The implementation calls for changes and a higher definition of parameters for managing better lights and different factors within the photograph which can confuse the algorithm. The runtime is less than the period of the motion pictures for processing with decreased frame charge/second, establishing opportunity for actual-time processing. For the benchmark, there have been many false positives by using putting the digicam. With that, using a usual camera (used for different functions) has grow to be a problem, because the mild comes out of the field of view with the automobile still very far from the traffic mild. Even with many false positives, the hit price became 64% of traffic lighting rendered successfully. Due to the impossibility of transferring lighting fixtures legally and capture motion pictures of assessments with these actual advances, testing have been performed with strengthen simulation based totally on motion of the digital camera in front of the purple mild. The tests had higher results for the video from five fps, but nevertheless haven't detected all simulated, advances have other Red elements rose to the top the image and mistook the set of rules. The hit fee on simulation reached ninety five.Eight%, inspite of the alternative problem lighting and Red gadgets they put in area of the site visitors lights. This paintings brings a brand new perspective as a contribution of boost detection of mild with the camera on board, regardless of whether or not the visitors mild is monitored by using different strengthen registration forms. Related jobs determined managing afixed point of the route. Although less accurate than a fixed feed detector on the road, yet the solution appears to be feasible for the flexibility of record of advancement in any unmonitored semaphore. There are several possibilities of technical improvement proposal. Based on the results, shows up viable processing in real time with a computer embedded in the vehicle connected directly to the camera. It is recommended, in this case, assessing your performance in a low-power system, as a minicomputer based on Intel Mini-ITX or Raspberry Pi, for example, since this work has adopted a Core i3 processor computer. Another proposal includes tests with recorded videos with a better camera quality that reduces the distortion of colors, to compare the aspect of accuracy. There is also a need to deal with videos recorded at night and with traffic lights dinning arrows bright which restricts the movement only to certain vehicles, because this type of approach was Treaty within the scope of this work. Another possibility is the parallel processing, which would make better use of

the features of a low-power system. Although the benchmark video used in testing not be adequate for the placement of the camera, tests with other benchmark videos should be conducted. Tests with registry systems of similar progress can be made by evaluating, in addition to accuracy and processing time, mobility, the cost of implementation and deployment.

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