Non-Intrusive Techonology to Its for BRT

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Abstract: - The Intelligent Transport Systems (ITS) is allowing that ubiquitous society use the ITS facilities to conducting their activities, so this research studied the use of LPR (License Plate Recognition) as a tool for ITS BRT operation. The use of Optical Character Recognition (OCR) to identify the vehicles will permit to monitoring several items, like: localization of bus, non-authorized vehicles and so on. This research considers the use of existing ITS infrastructure and technology and the main advantage of LPR is the ability to identify vehicles without disrupting the normal flow or even cause a decrease in speed and to be non-intrusive in perspective of vehicles owners.

Key-Words: - ITS, BRT, Operation, OCR, LPR, Mobility, Transportation

I. INTRODUCTION

The opportunities are central to bringing of diverse and substantial social and economic benefits to world, however, these decisions affect the design, accessibility and use of these technologies could open wrong ways [1]. This mobility permit to have information in anywhere, then the ITS systems can be more effective permitting to have real-time information. Also the accessible cost of devices and communications channels permit to use in more services in order to inspect the road and supply chain.

The operation purpose determine whether a particular technological solution will be used to trace the statistical analysis of evidence of irregularities or if tracking systems & monitoring will be combined with other technologies to support the BRT operations in real time. As for the object, different solutions and technologies are used for tracking and monitoring of vehicles (bus).

Technologies and solutions adopted are also influenced by the type of operation to be monitored:

- Operational purpose:
  - Statistical analysis of routes, location, time and business with real time monitoring (bus);
  - Non-authorized vehicles.
- Object: Vehicles

This paper presents an effective solution for the surveillance of vehicles through the use of LPR (License Plate Recognition) and integration with the ITS, allowing in real-time to identify which vehicles are using the BRT Lane. The LPR is one of most important component of ITS.

II. PROPOSED SOLUTION

An possible solution to problem presented in the anterior topic is necessary to use an integrated solution, consisting of vehicle identification, means of communication and integration with ITS. For this purpose, this paper proposes the solution presented in this topic.

LPR Technologies

The LPR (License Plate Recognition) has been implemented through a combination of sensors, cameras, software and other equipment for the recognition of characters on the plates, using OCR (Optical Character Recognition) algorithms on images captured on the road or street, as shown in Figure 1.

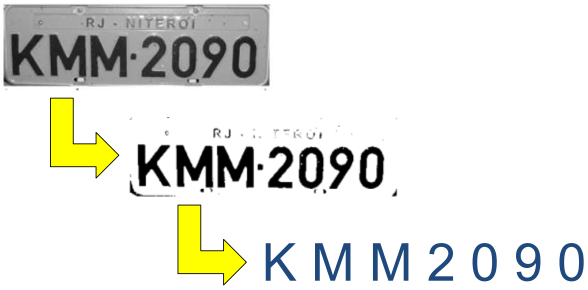

Figure 1: License Plate Recognition

LPR system usually requires that each lane (road, avenue or a toll plaza, for example), figure 2, is equipped with a sensor that detects the presence of vehicles and then shoot one infrared camera, as shown at figure 3.

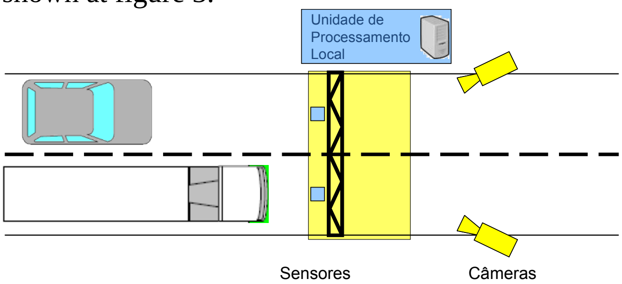

Fig. 2: Overview of LPR

Sensors and cameras of all stripes are usually connected to a local processing unit, whose main component is a computer that captures or select the images generated by cameras, processes the OCR algorithm, stores and / or send plates for later recognized processing.

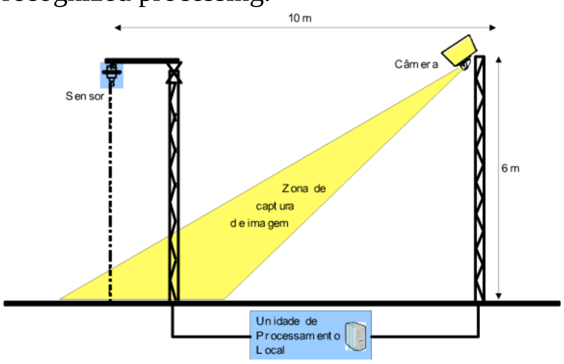

Fig.3: Typical Infrastructure of LPR

Recent advances in computing performance with reduced costs, the OCR algorithms and communications channels (mobile, internet, etc..) enable LPR system evolve in terms of reliability (accuracy more than 90% of plates), operation facilities, maintenance and cost. LPR systems operate with the vehicle stationary or moving (depending on the detection equipment) in inside or outside areas, but its performance is influenced by adverse weather conditions such as fog or heavy rain. Still, these systems can be used in various situations, even with vehicles traveling at high speed.

The detection of vehicles can be performed by sensors embedded in the lane, such as inductive loops, detector optics, among others. There more sophisticated LPR systems that rely on sensors, the cameras capture multiple frames per second (as in a movie) continuously and LPR software selects the most relevant images automatically - that is, vehicles license plates. Although relying on cameras and processing software, or more expensive, this option is the lower cost of installation and operation.

Telecommunications Channels

Appropriate communication channels are required for the interconnection between the equipment that will make the identification of vehicles on the lane (LPR), the checkpoints (mobile or fixed), the ITS. The telecommunications industry provides several technologies for data transmission, with different profiles of cost, speed, mobility and availability. This work is being considered transmission via mobile.

In Brazil there are technologies available for data transmission via mobile, usually (GPRS) from second and third generation (3G), which are available along the main road, see figure 4. The main advantages of mobile technology are the mobility and wide availability of equipment and operators that offer such services. Moreover 3G technologies offer nominal speeds of up to 7 Mbps (the speed of business systems in real conditions, however, rarely exceed 1 Mbps). [14]

Figure 4: Communications Channel by Mobile

Operational Process using LPR

This scenario assumes that the vehicles are traveling on a lane at speeds usual permitted by law.

Automatic readers license plates (vehicle detectors and cameras) are installed in bus stop or passage.

When the vehicle passes through the detector, a photo of the board is captured and a system that uses an image processing algorithm for OCR (Optical Character Recognition) and get the license plate in question. It is possible to verify that a vehicle passed or was present at the site where the LPR equipment is installed, without the same need to stop or even slow down. At scenario described can be made are the following, see figure 5:

1. Sensors detect the passing or stopped vehicles;
2. The cameras capture images of vehicles detected;
3. The local processing unit processes the OCR algorithm at image to recognize the license plate;
4. The local processing unit sends the identified plate to central control through communication channel, to find the information of the vehicle in question. At central control is installed the ITS;
5. Central control query default of ITS to identify the authorized bus;
6. Central control sends back plate of vehicles that need to be investigated;
7. The local processing unit displays message at electronic board with the vehicle plate, notifying him. The message also is sent to the fiscal at the inspection post.

A wide range of devices and systems for detection of vehicles for use in conjunction with LPR, which can range from the popular inductive links to systems via microwave for multiple purposes (including weighing) as described in Table 1. This table presents a comparison between detection systems. The more complete detection system is the optical scanner, however the maintenance is tricky because it requires that the sensors are always clean.

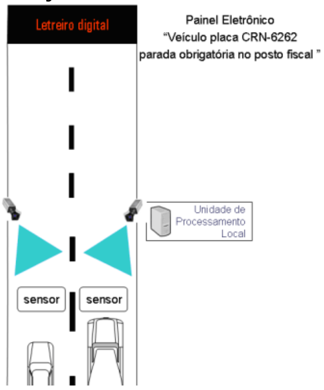

Figure 5: Identification Process through LPR

The more traditional sensors such as inductive loops, while popular and lower cost of acquisition, have higher operating cost, lower precision and high failure rate, partly explained by the fact that they are intrusive, or engaged at lane.

Alternatively, there are LPR systems that do not require sensors, because image capture is continuous as in a video camera, around 30 frames per second. But this solution requires most sophisticated LPR system, due to the necessity to select the image which containing vehicles and their license plate, without repetition and in real-time, before processing of OCR algorithm.

Table 1: Comparison between main vehicle detection systems

System	Detection Precision	Classification Precision	Installation Facility	Maintenance Requisites	Mounting Lane
Inductive Loop	Good	Good	Poor	Poor	Intrusive
Magnetic Sensor	Good	Poor	Good	Good	Intrusive
Pneumatic Tube	Good	Poor	Excellent	Poor	Intrusive
Optical Scanner	Excellent	Excellent	Excellent	Poor	Non Intrusive
Passive Infrared	Good	Poor	Excellent	Excellent	Non Intrusive
Microwave Radar	Good	Poor	Excellent	Good	Non Intrusive

Requirements for Information System

This item presents the requirement for information system necessary to implement the proposed solution.

Lane Requirements

For each lane, it is necessary the following equipment:

- Detection Equipment (optical scanner, inductive loop or other);
- Infrared Camera;
- Post to mounting the cameras - in the case of roads or streets with three or more lane, it is recommended to build a portal, or a set of cameras in signaling structures, bridges, or toll plazas;
- Cabling and devices for interconnection of equipment's and power suppliers.

Independently of amount of role, it is required:

- Local unit processing with computer to execute OCR algorithm to automatic license plate reading, communication channel with central control and sending messages to electronic board;
- Electronic board (optional item) installed after the detectors and cameras infrastructure in order to notify the drivers to stop in the next inspection post. The board must be installed a distance ahead that is sufficient to identify them by LPR /

OCR, cross-checking the license plate by the central control and notify the driver to stop the vehicle at electronic board;
- Power supply;
- Communication channel with the inspection post to sending the vehicles to being stopped.

Alternatively, the scenario may include:
- Mobile System - Installation of the system in to a box, containing camera, processing system, communication channel through mobile technology, power supply (batteries). This box could be installed anywhere on the road or street;
- Embedded System - Installation of the system inside a police car, which own camera, processing system, communication channel through mobile technology and power supply.

LPR Systems Requirements

The LPR system must meet the following requirements:
- It should be possible to identify the characters of license plate for at least 90% of the stored images, regardless of the situation or lighting;
- The rate of false positives (plates whose reading differs from the real characters) must be less than 2% of the plates read by LPR, except cases of fraud. A high rate of false positives implies higher cost of operation of the LPR, depending on required processing;
- The maximum speed for image recording should be greater than 160 km / h;
- Each system must be able to record the images and perform LPR in following condition: a road or street with at least 4 lanes with traffic of 500 vehicles per minute, traveling at 120 km / h.

Infrared Cameras Requirements

References [8] and [9] provide examples of cameras dedicated to LPR, and the minimum requirements for the cameras to meet the proposed scenarios are:
- The camera's shutter must have exposure time of 1ms or less (this feature typically allows capture of vehicles at speeds up to 190km / h) and auto-iris;
- They must be used cameras that have a gun led's that emit infrared light, since there are tricks and illegal devices that makes it possible for cameras with flash commit mistakes and errors, mainly. Cannon and infrared filter must operate close to the range of 850 nm, which is in reference to this type of application, with sensitivity of 0 lux for night capture;
- The camera should have a mechanism for correction of intense illumination (DSP or other method);

Another important factor in the choice of camera in use is the resolution that can be expressed by number of lines of horizontal sweep circuit that the camera has. The camera must have a minimum of 480 lines for LPR;

The cameras capture images and LPR should be cameras fixed sized (30 cm long or less), ie, the cameras are generally classified by the size of the CCD (charge coupled device or charge-coupled device) that is the camera sensor that captures images, typically 1 / 3 '1 / 4' inch for the application in question, with lenses 18-50mm;

The camera should be resistant to external conditions and adhering to the IP66 specification [18], which is the classification standard for equipment resistant to external environment.

Detection Systems Requirements

The equipment for the detection and classification presented in Table 2 should be taken into account the following general requirements:
- The system should offset any adverse weather and reflective effects (track and other areas not related to vehicles) automatically;
- The maximum speed for detection and classification must be inferior to 160 km / h;
- Each system must be able to detect and classify all vehicles in following condition: a road or street with at least 4 lanes with traffic of 500 vehicles per minute, traveling at 120 km / h.
- The equipment and external components must be resistant to external conditions and adhering to the IP66 specification.

Electronic Board Requirements

The electronic board considered in this article must meet the following requirements:

Technology emitting diodes (LEDs);

Use outdoors, being adherent to the IP66 specification;

Control visibility day and night;
- Minimum of 2 lines with 12 characters each;
- Alphanumeric characters with a minimum

height of 50 cm (which generates a maximum visibility of about 200 m);

- Display of messages received by serial interface;
- In the scenarios proposed, if only a hypothetical situation in which:
    - The vehicles travel at 120 km / h;
    - The driver needs 5 seconds to recognize and read a message on the panel within the distance of visibility;
    - The distance traveled by a vehicle until the driver can read the message is 120 x 1,000 / 60 / 60 x 5 = 167 meters.

Thus, panels with visibility of 200 m are appropriate to the assumptions above.

Telecommunication Requirements

This item describes the requirements for the communication channel between the LPR System and Central Control. The bandwidth needed for transmission of data already processed on the identification of vehicles (LPR). If these situations is considered as a premise that:

- Identification of 100% of the vehicles via LPR;
- Each identify has 200 bytes;
- In those circumstances are sent 500 x 200 / 60 = 1,667 bytes / s, or 13.3 kbps data useful.

Therefore, in these conditions any link available in the locality can be used, because it is not necessary broadband channels.

Local Processing Unit Requirements

Since the local processing unit and other equipment will be unattended area:

- The equipment of the unit should be kept in box with resistance to vandalism or theft;
- The enclosure must be weatherproof according to IP66;
- The local software is designed to not require processing more than a desktop computer.

III. CONCLUSION

The proposal permit to have an efficient system that permit to monitor vehicles though license plate recognition system with the following characteristics:

- Capacity to identify vehicles without disrupting the normal flow or even cause a decrease in speed;
- Non-intrusive scenario in perspective of owners or users of vehicles, for example not rely on devices or tags installed in all vehicles, as opposed to RFID;
- Possibility to sending images or other types of high-volume data by the communication channel;
- The use of others technologies, like RFID, are more sophisticated than LPR and it is subject to fraud, as use of adhesives or mud applied on the plate;
- The LPR may have read rates with less success than RFID. This can result in higher operating costs, mainly associated with inspections generated by errors on LPR. Moreover, the performance of LPR can be harmed by adverse climatic conditions, such as storms.

The next step of research is to evaluate the collected information on pilot project and identify the number of false positive results, in order to evaluate if this technologies is appropriated for real time monitoring operation.

IV. ACKNOWLEDGEMENT

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