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Vision based Intelligent Semaphoring System

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Abstract- The present paper suggest making an intelligent video system of command over crossroads with traffic lights, its main goal being to diminish of traffic congestions, to improve vehicle speed, to reduce environment pollution and to improve negative effects of traffic congestion over the physic and psychic state of the population. The architecture of the suggested system is made on a hardware level from three different areas: the video sensor's level, the computer process level and the represented execution level and the traffic-lights that exist in the crossroad. The software architecture of this system is made out of the main routine and a number of secondary routines of image processing and of the Fuzzy command. The existing systems are useful only in low traffic crossroads, being able to interpret informations only from the near proximity of the sensors, but unable to estimate the number of vehicles waiting in line on a traffic lane.

I. Introduction

New information and communication technologies enable a fundamental innovation in transportation and traffic system. There are many benefits from introducing these technologies into the existing transportation systems. Some important benefits are represented by the efficient utilization of the existing infrastructure and by the reduction of the resources' consumption as well as the travel time [1].

The recent advances in sensors and image processing technology offers multiples behalves for the operation of transportation systems and helps to increase the security of users. In this paper, we present an intelligent video system for the traffic command and its planed application in traffic control. It will be realized from a hardware part, based on the webcams (sensors level) which detects the traffic parameters and a software part, based on programming routines. Traffic parameters include the vehicle flow rate, vehicle velocity, the meteorological conditions as well as detection of obstacles and standstill.

Analyzing, processing and the interpretation of the informations received from the sensors will be done with the software National Instruments Vision Builder. Such intelligent systems can replace the existing cameras and improve the supervision of the crossroads and tunnels.

II. Intelligent video semaphoring system

A. System description

By its architecture, this system represents a high novelty solution with also high complexity in crossroads traffic-lightening, taking into consideration that such a configuration is not yet implemented. Development of the algorithms necessary to this crossroads traffic-lightening intelligent video system requires an interdisciplinary and complex approach of this matter, by putting together knowledge from domains such as: numeric view of the signals, Fuzzy artificial intelligence and data teletrasmision [2].

Webcams have the role to import in real time images of the road traffic and can be placed depending on the urban configuration of the crossroad (if there are/are not trees/buildings higher than 12 m, slopes leaned more than 5 %) in two alternatives: AC – altitude camera with an overview of the crossroad, or CS – camera system set on the directions of the traffic lanes. In this last choice, one of the cameras must have an optic view transverse to the center of the crossroad, by mounting it in a diametric opposite point compared to the crossroad and monitor artery conjunction.

The process computer represents the hardware support of the algorithms and routines destined to image processing and fuzzy control. The data teletransmision between the process computer, the video cameras and the execution elements is made by radio or cable, depending on the crossroad configuration.

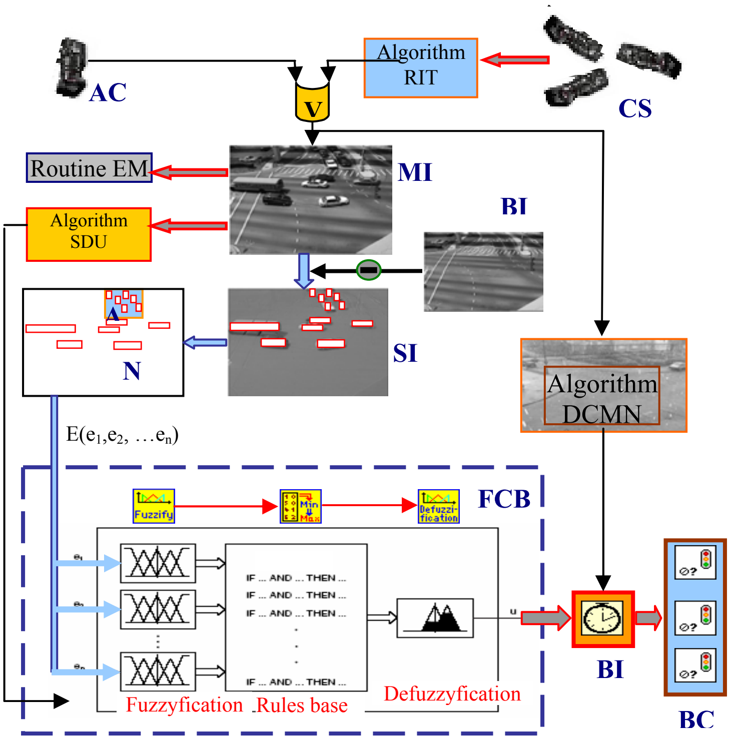

Figure 1. System Architecture

The software architecture of this system is made out of the main routine and a number of secondary routines of image processing and of the Fuzzy commands [3]. The fundamental routine has, as target, the determination of the vehicle number waiting in line on a traffic lane. For this, as you can notice in figure 1., the main MI image, that comes from the altitude camera AC or the one obtained by reconstructing the image (RIT) from the CS camera system, is submitted to a pre-processing process for removing the video sounds, followed by a numeric differentiation process from the background image BI and by applying a 'high-pass' filter to emphasize shapes. The processing operation is done by segmentation, obtaining the SI image.

The last stage of the fundamental routine is the N sequence of estimating the number of vehicles waiting in line and the build of the E (e1, e2, ……. en) vector, who's elements are the numbers of vehicles standing in line on the road artery, and the index represents the number allocated to the road arteries (or to the traffic lanes, if on from way there are several directions that can be followed).

The secondary routines of image processing gather the event memory EM routine, the algorithm for unfriendly weather conditions detection DCMN and the emergency situations detection algorithm SDU.

The event memory routine uses a circular recording buffer with a stocking capacity of 48 h and its role is to provide witness video digital recordings for road-event like situations (road accident of robbery from vehicles in crossroads). The routine also performs the "running the red light" function.

The SDU - emergency situations detection algorithm's goal is to establish the approach to the crossroad of a light-signaled vehicle followed by priority on the identified lane given by the Fuzzy FCB command block. The Fuzzy FCB command block has the role to establish the command times of the traffic-lights.

In this moment it is solved the problem of identification the number of vehicles in the crossroad or the degree of lane's occupancy.

B. Experimental results

Images provided by the video cameras are rich of visual traffic information. Video processing can deliver diverse traffic information. Those quantitative informations, like velocity, occupancy, number of vehicles, etc. are directly generated from the image data or by other sensors technology.

In figure 2 is presented an image from a crossroad, catched with the video cameras. During the preprocessing phase it is realized the image quality improvement as well as her conditioning. Through conditioning is modified the image format (number of plans, bits) so that this one became compatible with the entire processing link. The result of the RED plan extracting from the original color image is showed in figure 3.

Figure 2. Original image

Figure 3. RED plan extract

In an image, the regions with the highest density of informations are those where happens fast variations of intensity levels, color or depthness. Such discontinuities are called edges. Generally those appoint a steep or less steep transition from a region with certain properties to another with different properties, indicating the end of a region and the beginning of another one. There are a lot of operators to extract the outline. As a reference, in many specialized books, are presented the following operators: Sobel (figure 4), Kirsch and pseudo-Laplace.

Figure 4. Sobel Edge Detection

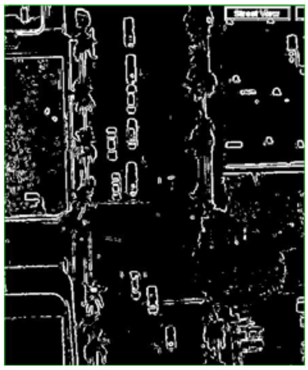

Figure 5. Auto Threshold type Moments

Because of the significant differences between the gray levels of the object's or background's pixels, must be applied a threshold to transform the grayscale image in a black-white binary image, as is showed in figure 5.

Binary morphological operations extract and alter the structure of particles in a binary image. These operations can be used during the inspection application to improve the information in a binary image before making particle measurements, such as the area, perimeter, and orientation. These transformations can be also used to observe the geometry of regions and to extract the simplest forms for modelling and identification purposes.

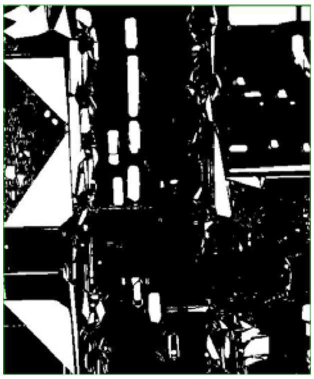

Figure 6. Advanced Morphology type Convex Hull

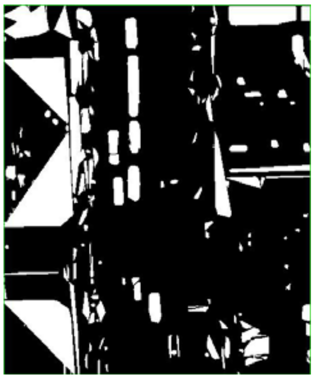

Figure 7. Advanced Morphology type Remove Small Objects

In figure 6 is showed the morphological function Convex Hull, which has the role to close an object whose outline is discontinuous, and in figure 7 is presented the result of applying the Remove Small Objects function.

Figure 8. ROI constraint and Count Pixels

Figure 9. Find Edges

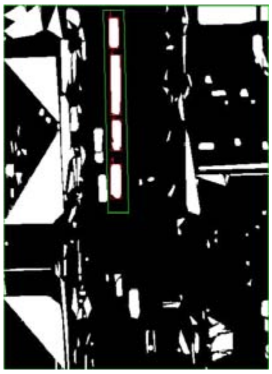

Figure 10. ROI constraint and Detect Objects

To extract the application's results there are three different ways:

1. Constraint of a region of interest (ROI) and applying Count Pixels function to establish the filling level and to determinate the occupancy zone from the region of interest.
2. Applying Find Edges function to obtain informations about the vehicle's length or the distances between those.
3. Constraint of a region of interest and applying Detect Objects function to determinate the number of vehicles from the region of interest.

II. Conclusions

In this paper we have presented an intelligent video system for traffic surveillance. In this ongoing project the intelligent semaphoring system will combine video sensing with image processing and data communication. The semaphoring system could potentially and advantageously replace every known camera, frame grabber and computer solution in visual traffic surveillance [4]. The next steps in our research project include the development of the Fuzzy command block FCB and secondary routines, like unfriendly weather conditions detection DCMN and the emergency situations detection SDU.

Acknowledgement

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