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NON-INVASIVE MONITORING OF CALM TRAFFIC

ABSTRACT:
This paper deals with the use of video detection to identify the occupancy of a parking place from image information. The video detection comes in handy for cases of large and indented car parks. Suitably mounted camera can cover large area and software can locate from its images occupied places. The whole video detection system interprets the situation at car park and information about free parking places could be displayed on navigation panels guiding the drivers to the nearest free places. An added value for the management is the real-time video overview about the situation.

KEYWORDS:
car park occupancy, car park management, video detection, object tracking, calm traffic

INTRODUCTION

Today, the frequently discussed problem is how to detect the occupancy of parking places at institutions, park-and-ride areas, shopping centres etc. If there is a way of reliable detection of occupancy of parking place, it could be used for many commercial and security applications as well. Targeting this domain, there was realised a project "Non-invasive monitoring of calm traffic". It solves the problem of recognition of occupancy of parking places at the University of Žilina by using the video detection.

ESTIMATION OF CAR PARK OCCUPANCY RATE

Every kind of car park has its own limited capacity of parking places given by areal possibilities. Already all accessing roads can be considered as a part of the car park system. Depending on many factors, the information about occupied parking places can differ from the real situation. This could lead to misinformation of drivers searching for a parking place. So an early and advisable consideration that the car park is full can prevent the ineffective navigation. The estimation of the maximum rate of occupancy to declare the car park as full depends on type, complexity, area and many other criteria. Generally there are hints helping to estimate the moment to declare the car park as full:

- *To gain information about vehicles routing from/to car park*
- *To use zone detection and zone navigation in cases of complex car parks*
- *To use time zones during the day with different upper limits to declare the car park as full*
- *To leave a gap to take into accounts some critical situations (fire, police, ambulance, guests, etc.)*
- *To take into account the capacity and characteristics of car park*

METHODS FOR OBJECT DETECTION AND TRACING

The content of every image (regardless if standalone or in a video sequence) can be divided into several levels of abstraction hierarchy [4]. The first one consists of pixels, elementary parts of every digital image, containing information about brightness or colours. The next level is aimed at features as edges, corners, curves, areas, etc. The upper level of abstraction combines and interprets this information as objects and their attributes. The top level uses concepts of processing and analyzing of images similar to human perception. These methods couple individual objects and define relations between them. The process of detection of an object in video sequence includes the step of catching its occurrence and locating it as accurate as possible in individual frames for further processing. The principle of tracking the object is generally based on processing the detected changes of its location, size, and shape in consecutive frames. Basic methods used to detect objects:

- *Detection of objects based on their features*
- *Detection based on shape*
- *Detection based on colour information*
- *Detection based on pattern matching*
- *Motion detection*

CAMERA POSITION

The position of a camera is important to effectively use its images. Therefore this fact has to be taken into account for every car park individually when using a video detection system. There are generally following two rules:

- place the camera to cover most parking places
- place the camera to minimize overlapping of objects (e.g. van vs. sport car)

In our case there were two possible views:

1. To shoot our experimental car park lengthwise, where all parking places were covered. But the problem was the height the camera to be placed (see Figure 1b). The farthermost objects were overlapped. It is important to keep the ratio between the height h and length d as great as possible to reach higher point of view (Figure 1a)
2. To shoot the experimental car park broad wise, where the ratio was more suitable. Though the angle of view of the camera in this position was limited (Figure 2 - not all parking places were covered) it was sufficient to verify our algorithm to detect the occupancy of a parking place.

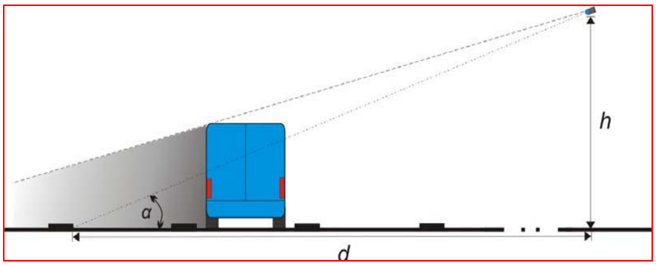

Figure 1. a) Overlapping the parking place by a vehicle, b) general view

STRUCTURE AND DESCRIPTION OF THE PROGRAMM

The program implements methods of detection of object based on its motion and colour information. It was written in the C++ language using the "OpenCV" - a library for computer vision. The source code was written according to the specification given in [1]. The structure of the application is explained in following text.

Definition of Region of interest - ROI

There are defined three ROI for each parking place. Two of them are used to gain relevant data (Figure 2: blue, the narrower ROI1, the wider ROI2).

The ROI3 is used to visually inform about the occupancy of a parking place (Figure 2: green=free, red=occupied). For every ROI are defined four basic pixel values of its position in the frame: top, left, width and height.

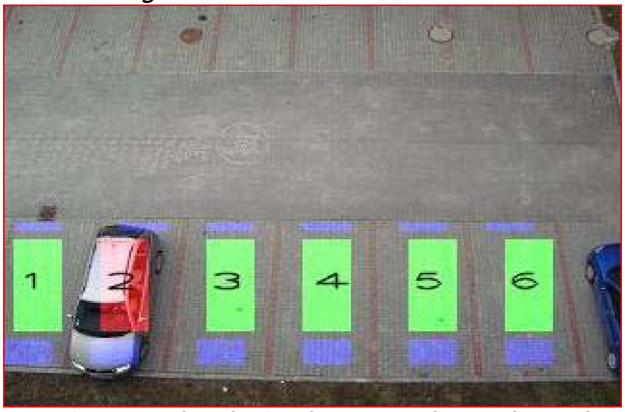

Figure 2. Example of ROI placement for parking places

Detection of moving object

For the proper run of the application it is important to accurately designate the moving objects and to interpret their impact on the parking place. Therefore the following schema illustrates the most important part of the application (Figure 3).

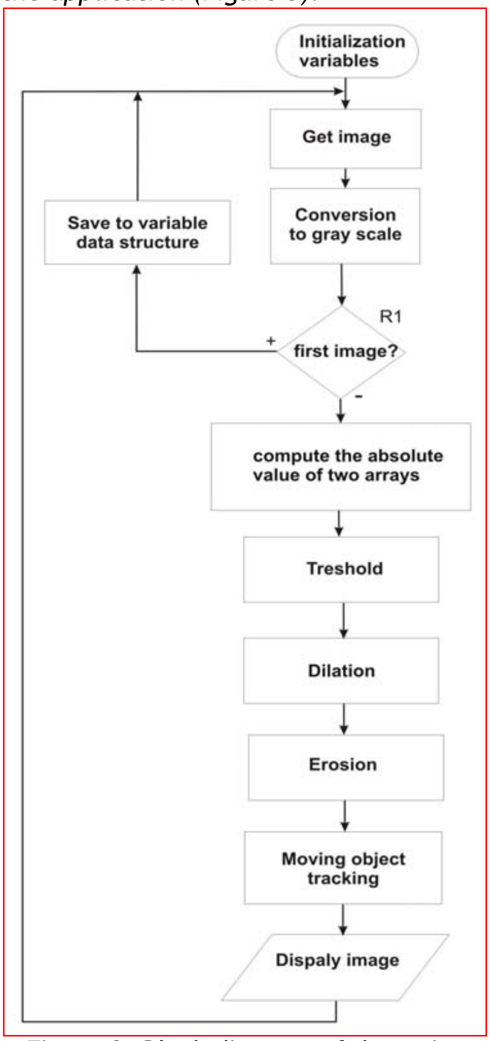

Figure 3. Block diagram of detection of a moving object

Block of initialization of variables

Definition and initialization of variables used during the application run for storing data

Block of getting image

The reading of image data into variables. There are three alternatives of getting the image data:

- *Reading the video from connected camera (integrated webcam, camera connected through supported interfaces)*
- *Reading the video directly from a local storage in AVI format*
- *Reading the image directly from a local storage as a simple file*

Block of conversion

Because of further processing, here takes the conversion from colour to greyscale place

Block R1

Because there is nothing before to compare with the first image, the application stores it in a variable to compare it with the next one.

Block of computation of changes

Computation of data changes takes place. Figure 4 shows us an example of detected changes in two consecutive frames.

Figure 4. Example of comparing two consecutive frames in time of 0,5s

Threshold block

The value of change for each pixel varies in range from 0 to 255. Processing such data structure would be complicated. Therefore a transformation to binary values is needed. It is important to set properly the threshold value [2]. The following example shows the presence of a shadow as an unwanted element when setting the threshold too low. The threshold value has to remove the artefacts and to preserve the best compactness of pixels of the moving object. The threshold value was estimated experimentally (Figure 5).

Figure 5. Example of using the threshold (values: left 35, right 80)

Blocks of dilatation and erosion

Even after an ideal threshold, the information about changed pixels will be insufficient to locate the moving object as a whole. To overcome this, several morphological transformations are used [3], [5]. The goal can be reached by their appropriate combination and properly set structural elements. All pixels of a moving object will be then compact. The modified binary image matches the moving object. In this state, there is no problem to find the object (Figure 6).

Block of moving object detection

Using mentioned modifications we can locate moving objects by finding their borders after the erosion step. The application gains data about the binary object and stores them. Based on the saved data as well, we can detect and display the moving object in actual frame to demonstrate this way the process we described.

The visual location of an object is done by a function drawing a rectangle around it (Figure 7). There are some limitations on accuracy according to the speed limits and refresh rate.

Figure 6. Example of an image dilatation (left) followed by erosion (right)

Figure 7. Example of visual location of an object

Evaluation of parking place occupancy

If required data for evaluation of occupancy are available (detected motion of an object in ROI1 and colour information from ROI2), the application is driven by the algorithm of evaluating changes of parking place occupancy (Figure 8.).

CONCLUSION

There was proposed an algorithm for evaluation of parking place occupancy by joining two methods of object detection. The algorithm is resistant to influence of weather conditions and walking pedestrians on car park. It is based on attributes of objects (speed and size of vehicles) that need to be detected. The functionality of the application was proved at the car park of university (Figure 9, 10).

The proper evaluation of parking place occupancy was only influenced by vehicles moving too fast.

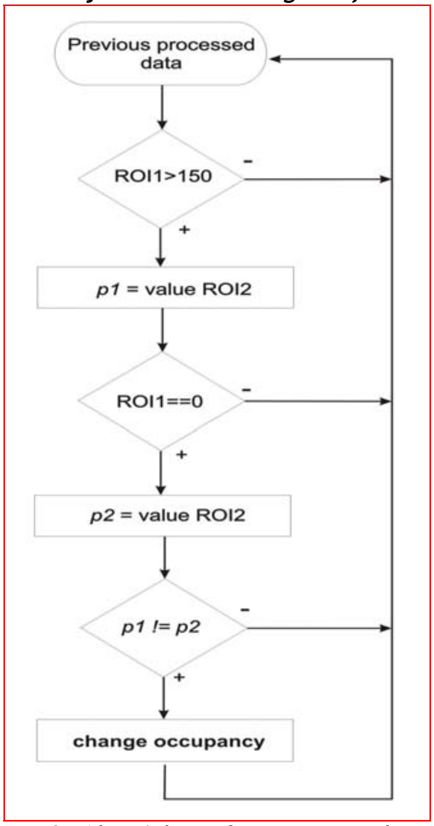

Figure 8. Algorithm of occupancy changes

Figure 9. Filling of parking places

Figure 10. Freeing of parking places

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REFERENCES

[1.] HALGAŠ, J., Riadiaci videodetekčný parkovací systém: diplomová práca. Žilina: Žilinská univerzita v Žiline, 2010. 45s.

[2.] HUDEC, R., Snímanie obrazu, vysokoškolská učebnica, EDIS, August 2008, 150 strán, ISBN 978-80-8070-880-1.

[3.] R. HUDEC, M. BENČO: Systém automatickej identifikácie dopravných priestupkov, Medzinárodná konferencia „Research in Telecommunication Technology 2006", Part II. pp. 133-136, September 11th - 13th 2006, Nové Město na Moravě, Czech Republic, ISBN 80-214-3243-8.

[4.] JURIŠICA, L. - HUBINSKÝ, P. - KNOT,J. Detekcia a sledovanie objektov. In AT&P journal. [online]. 2005, číslo 6. www.atpjournal.sk/casopisy/atp_05/pdf/atp-2005-06-69.pdf

[5.] P. LUKÁČ, M. BENČO, R. HUDEC, Z. DUBCOVÁ: Color image segmentation for retrieval in large image-databases, TRANSCOM 2009, pp. 113-116, Žilina, Slovakia. ISBN 978-80-554-0039-6.

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