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...n and Implementation of Visitors Queue ...sity Analysis and Registration Method for Retail Videosurveillance Purposes

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...is thesis is devoted to development of ... analysis and registration method for ... systems. Developed method of ... is based on initial background ... temporal median filter and local binary ... the literature review, a problem ... examined and investigated. Basic ... limitations were also analyzed. Software ... developed to implement segmentation ... shows that method increases an ... segmentation quality and also has an ... efficiency by minimizing an impacts ... movements in an area of interest.

...veillance, retail, moving objects, ...ground mask, local binary patterns, ...

I. INTRODUCTION

...conditions for the proper functioning ...l and trading centers are disciplined ... their services stuff with visitors, ... of operational losses etc. The ... these tasks are development of ... event registration systems, ... real-time management ... trade center in general, ... videostreams within an ... previewing and analysis of ... operation of such systems ... efficiency of trading center ... reduction of different kinds of ... increasing of general discipline ... increasing of overall

... system, that are operating ... are designed at most for ... actions and behavior of ... and shipment of ... trading halls, in cash ... tasks that are able to solve ... monitoring of cash transactions, monitoring visitors at points of sales terminals, visitors queues and flows management, estimation an amount of visitors etc. It would be important to note, that these systems are able to operate in a completely automatic mode and at most cases an operators interferences are not required, wherein they provide a records and registrations of all events and videofragments at any time and place of a trading centers, operations of different kinds of videoanalysis and motion detecting systems and so on.

For marketing purposes there are different possible options of how to use information from the video archives. First of all, that is an instant messaging and notification (for example a critical increasing of visitors amount in a queue at some period of time) and administrative functions such as: reporting that is based on data stored in a databases over time.

The goal of this thesis is to provide a review of a design and implementation our method, that allows an analyzing and registration a densities of visitors queues in trade centers near points of sales terminals in a scope of real time. An information that detector provides, allows management of commercial facilities to make decisions about an optimizing working schedule of a services stuff, reconfiguration of trading points, increasing or decreasing the number of service points etc. Our method is based on a density estimation of visitors (foreground objects) in some predefined area of interest of videostreams frame. It takes into account only those visitors that are staying in video frame given area over time. The method operates with an input data that are videoframes estimated from videostreams of one or more fixed surveillance cameras that are mounted over cash terminals.

II. PROBLEM STATEMENT AND RELATED RESEARCH WORKS

An implementation of visitors queue density analysis method involves and can be decomposed to such tasks as estimation of a queue density value in real time and estimation of service stuff efficiency. Previous scientific

researches that were provided in order to solve this task concentrated on estimation of the amount of visitors and analyzing a process their motion. Nowadays were proposed several approaches of solving a people counting task. One of these approaches is based on tracking people during their movement from one area of frame to the other.

In [1] a tracking of objects that are obtained from motion detection process is provided. Another approach is based on detection and recognition structure of objects [2]. The main goal of these approaches is foreground blobs detection that are representing people by identifying their attributes such as heads, feet or silhouettes. Also, it will be appropriate to note, that these methods are especially suitable for counting people in some situations such as crowds. These methods are based on clustering feature points and identification of each moving object in the crowd due to an independent movement of these objects.

Most commonly, for automatic people counting purposes the surveillance cameras, which are mounted above the plane of movement (e.g. ceiling) are used. This significantly simplifies the task of counting, by simplifying construction of model and also eliminates occlusions during moving of objects. For example, in [2] is given a method that is based on detecting people's heads, but it is substantially depends from a hair color and clothes, and also. The shape of human's head cannot be regarded as easily recognizable.

In [3] the method of counting people in a crowded domain is given. This method can be suitable to count people within cameras located above the head for example at the entrance of transports (such as buses). System based on this method requires three lines with a specific color. As long as people are getting into a transport, horizontal lines of each frame are filled into separate stacks. When the door is closed, an analysis of these stacks and people counting process is provided. Counting of people is performed using some mathematical morphology methods for separating blobs on binary masks of a frames. This method does not require a full sequence of frames and a special background color to make calculation because the method works in a scope of real time. In [4] purposed an algorithm that provides an analyses of two lines. Thus, a blob selection is based on segmentation that uses a discrete cosine transform. Blobs separations are performed on the basis of morphological operations, and their calculation is based on determination of the lines that blob crosses at first.

In [5] an approach based on Markov random fields for segmentation of moving objects and background modeling and spatial constraints was used. In [6] given review of a system that determines inhomogeneous moving objects and uses a mixture of dynamic texture models segmentation. In [7] given a method that is based on tracking motion of moving objects contours groups. This method based on transformation parameters between frame and calibration parameters of camera. [illegible] of methods is based on direct detection of [illegible] frame. These methods can be separated [illegible] categories: full object detection and [illegible] detection. Method described in [8], is [illegible] probabilistic segmentation patterns and shape [illegible] In [9] a set of detectors using AdaBoost [illegible] This approach uses Haar wavelets used in [illegible] In [10] presented an algorithm that distributes [illegible] object into seven parts and Viola-Jones method [illegible] determine the orientation of these characteristics [illegible] [11] splits object into several parts and is based [illegible] wavelet features.

In summary, we can conclude that in most [illegible] appearance approach is used, that usually requires [illegible] preprocessing and training state. These methods [illegible] highly dependent from human models construction [illegible] some cases are not compatible with such situations [illegible] blob occlusions, illumination changes, digital noise [illegible] and so on. The training processes can be [illegible] complicated [13] and therefore increases the [illegible] and maintenance costs.

III. Requirements And Assumptions

An input frame for a density analysis and [illegible] method can be estimated from any IP-camera with [illegible] resolution videosequences or from DSP cameras. [illegible] Nowadays, the most common types of IP-cameras [illegible] transmit video frames within a frequency up to [illegible] per second and with resolution up to 12 MPixels. [illegible] transfer, an input image is compressed using [illegible] MPEG-4 or H.264 streaming video compression [illegible] techniques. A software implementation has been [illegible] method that supports RTSP protocol, which allows [illegible] remotely manage the flow of data from the camera [illegible] providing the ability to execute commands and [illegible] to files on remote server.

Figure 1. An example of input frame and rectangular [illegible] located nearby point of sales terminal

protocol gives an availability to receive and audio and video streams from any network or translating video streaming applications. system supports ONVIF - a standard that defines of interaction devices such as IP-cameras, orders, video servers, and video management particular, the ONVIF specification is based web-services, RTP/RTSP protocols, SOAP video compression standards: H.264, MPEG-. The protocol is designed primarily to unify video devices, from video surveillance regardless of the brand and type, without the their own SDKs, which is unique to each and type of devices.

network camera (Fig. 1) should be placed at 1.5-2 m above objects of interest, and have an to maintain a statistical model when the scene that is the scene devoid of foreground objects, computing a change in input frame, which is a B(x,y). A pixel format of an input image from IP-camera required to be RGB24 and with up to 5 MPixels. Then a frame is pre-processing its size to 704x576 and by transforming it to space. A rectangular area of interest can be any must be located nearby point of sales terminal.

IV. METHOD DESCRIPTION

method localizes blob on the zone of interest, it ide a construction of binary mask in order to in the area of interest. At first, an input be converted to HSV color space and then the must be separated. For a spited channel V estimation is provided by constructing a using algorithm that consists of 5 steps:

Initialization of original model background. ground $B_t(x, y)$ is generated at time t is by splitting an input frame I(x, y) to blocks of els. For each block calculated difference in pixel the previous and current frame and determining to a number of stable in previous and current updating background model locks containing 95-100 %

model by using selective each pixel of video frame =k+1 elements, in which -frame is recorded, and the ained in the initial model in step 1. The value of the nding order, and the search middle of the cyclical buffer. $B_t(x, y)$ is by replacing its in the middle element of

patterns operator. For the the local binary patterns are used. This operator for each block estimated on step 2 provides labeling of its pixels using threshold the neighborhood of each pixel that is a center value of a local 3x3 window:

$$T(x_c, y_c) = \sum_{k=1}^{P} 2^k L(g_k - g_c), \quad (1)$$

where (x_c, y_c) – coordinates of central pixel, g_k – value of P neighborhood pixels, g_c – is equal to a pixel value in the center (x_c, y_c). the function L can be defined as follows:

$$L(x) = \begin{cases} 0, x < 0, \\ 1, x \geq 0 \end{cases}, \quad (2)$$

In general, the local binary patterns use a symmetrical set of neighbors. In this case, g_p corresponds to the values of P-equals in space pixels located on a circle with radius R. The histogram of the local binary patterns codes is calculated over all block of image and it can be used as descriptor of block texture. As shown in (1), local binary patterns are invariant to monotonic changes in pixel values.

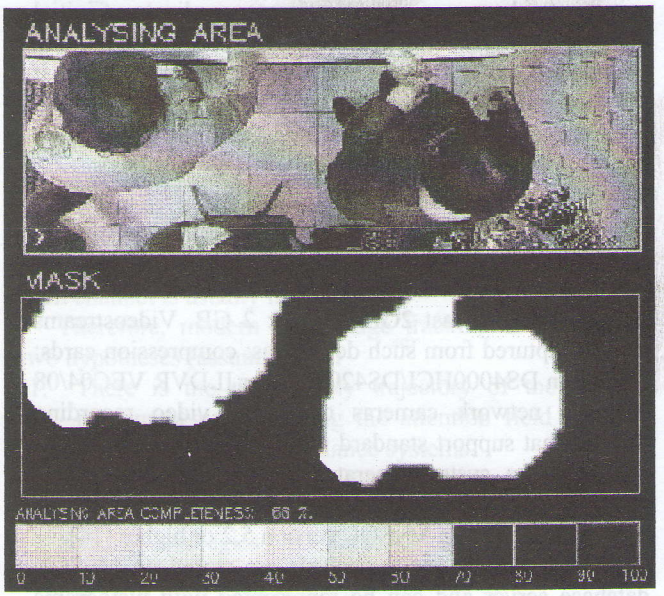

Figure 2. Input located area of interest, binary mask and value of binary mask completeness.

Step 4. Using conditional morphological filtering operators. The first morphological operation that is used for binary mask processing is erosion. This is a basic operation and its main task is to erode boundaries predefined area of a set of foreground pixels. Let X is a subset of E and lets denote the structure element B. The morphological erosion is defined by:

$$X \ominus B = \{x | (B)_x \subseteq X\}, \quad (3)$$

Using this operation, all sets of pixels which can entirely contain the structure element B will be contained in the eroded object.

The second operation that is implemented for a binary mask processing is a dilatation and its primary feature is to grow the boundaries the sets of foreground regions:

$$X \oplus B = \left\{ x \middle| \left(\hat{B} \right)_x \cap B \neq \varnothing \right\}. \quad (4)$$

The results of algorithm implementation are shown in Fig. 2.

Step 5. Moving objects area estimation. At this step we provide an area computation of each segmented objects within binary mask. Area estimation of each objects is based on computation of their variance at current and previous frames. To compute areas of moving objects a method that is based on chain codes is used:

$$A = \sum_{i=1}^{n} c_{ix} \left(y_{i-1} + \frac{1}{2} c_{iy} \right), \quad (5)$$

where n - length of chain, c_{ix}, c_{iy} - x and y components at i-th element of chain c_i (c_{ix}, $c_{iy} \in$ (1, 0, 1), that denotes to coordinate changes x and y), y_{i-1} – y-coordinate of initial point at chain element c_i in predefined coordinate system. Segmented moving object is considered to be selected if the area ratio in the current frame to the previous frame does not greater then a predefined threshold that can be chosen in accordance to area of interest dimensions.

V. CONCLUSIONS

For a proper system operation of software, users PC must meet following hardware requirements: CPU frequency of at least 2GHz, RAM: 2 GB. Videostreams can be captured from such devices as: compression cards: Hikvision DS4000HCI/DS4200HCI or ILDVR VEC04/08 or from network cameras or digital video recording devices that support standard video playback and transfer ONVIF; The system operates on PCs with Microsoft Windows XP/7/8/10 operating systems and database management system MySQL version 5.2 or higher [14].

The results of queue analysis are stored on MySQL database server and can be represented with histograms (Fig. 3).

To connect to the server user must select servers IP address and port and enter user name and password. If connection succeeded, by default result data will be plotted and displayed for a current day. User can display data for any time interval with histograms steps: by month, weeks, days, hours or minutes and for any video channel from which results were recorded. Also previewing data module contains some functions that allows to save a displayed data to XLS, HTML, CSV and image files.

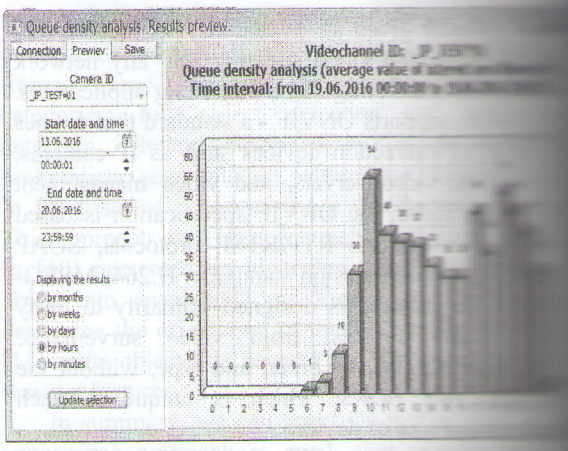

Figure 3. Queue density analysis results

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