REAL-TIME DEMONSTRATION OF THE FRAMEWORK FOR EVENT DETECTION IN A PARKING LOT

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ABSTRACT

The demonstration presents the operator console of the framework for detecting events in a parking lot. The console application connects safely through the Internet to the running framework installed in Gdansk, Poland, receives video streams and event data from it and allows data visualization. The installation consists of multiple cameras, including fixed and PTZ ones. PTZ cameras are able to follow moving objects automatically. The place and time of vehicles stopping in a parking lot is the main event detected by the framework. Other events include detection of vehicles stopping outside of a parking place, persons entering/leaving a building or walking along the road and detection of vehicle leaving and entering the building.

1. FRAMEWORK DESCRIPTION

A prototype video surveillance installation covering a part of the parking lot around an office building in Gdansk, Poland, has been established. The installation contains 8 fixed cameras with different orientations in relation to the ground, covering a total number of 54 parking places. The installation is supplemented with 2 PTZ cameras. Sample images from cameras can be seen in Fig. 1 and 2.

The framework is able to detect various events in video streams from multiple cameras placed in a parking lot. Detection of parking vehicles is the most important one. This includes identification of the parking time, parking place and identification of the vehicle.

Additionally, the system detects a few supplementary events that are useful to a parking lot operator:

- vehicle stopping on a road, outside of any parking place,
- detecting persons entering or leaving a building,
- counting vehicles entering or leaving a parking lot.

The framework architecture is fully distributed, which means that nodes of the framework formed by image processing servers, operator consoles and the central server may be placed anywhere in the world, provided that the network connection (LAN, Internet) is available. An important aspect of the proposed system is the issue of data transmission. A layered approach was devised, based on TCP/IP protocols suite, which enables the sensitive data to be transferred by means of open Internet, regardless of the presence of Network Address Translators or firewalls which typically interfere with establishment of multimedia communication sessions. At the foundation of the developed solution lays the Extensible Messaging and Presence Protocol (XMPP). Its use provides an added value of security and message integrity layer (based on TLS standard), authorization, addressing scheme and a container for information structuring within self-describing, XML-based messages. Furthermore, XMPP grants access to a plethora of the protocol extensions including so-called Jingle protocol, which is a tool for establishing multimedia communication sessions. This forms the core of the system's audio and video streaming functionality. In fact Jingle is a session-control (signaling) protocol while the actual multimedia data transfer is performed out-of-band of XMPP connection due to performance reasons. For this purpose encrypted Realtime Transfer Protocol (RTP) sessions are utilized. As a consequence, the initiation of multimedia streaming may be problematic in the presence of NAT devices or firewall on the route between transmission endpoints. Therefore, an additional proxy service has been implemented within the system, which allows for the efficient multimedia transmission between any connected terminals regardless of their network conditions.

2. OPERATOR CONSOLE

A system operator accesses the video analysis results by means of a dedicated module called the operator console (Fig. 1). This module constitutes the client side of the distributed analysis system. Using the console, the operator requests access to data streams from the selected cameras. This request is processed by the server and the console receives on-demand streams consisting of encoded camera frames and metadata containing analysis results. The received streams are presented on the monitor screen, with metadata overlaying the camera images. The type of metadata presented on the screen is selected by the operator, it may contain both high-level information (text messages indicating the detected event, frame encompassing the object that caused the event) and the low-level analysis results (object detection masks, tracker frames, detection areas, classification results, etc.). Additionally, the console provides the lists of formerly detected events, currently tracked objects and statistics of the analysis results. The operator may also use the console for sending control commands to the system server, including PTZ camera positioning. Therefore, the console is both the tool for assessment of video analysis performance and the system front-end for the operator of the working monitoring system.

Fig. 1. Operator console application

3. PARKING EVENT DETECTION

Low-level video image processing for the purpose of event detection includes operations performed independently in video frames acquired from each fixed camera. They are devoted to moving object detection, tracking and classification. Moving object detection is based on the background modeling method utilizing Gaussian Mixtures while object tracking is performed with Kalman filters. In case of tracking conflicts, visual object features are analyzed in order to provide correct association [1].

Each object moving in a camera field of view is classified into two categories: vehicles and other objects. For the purpose of classification process a set of SVM classifiers (Support Vector Machines) is used. Classifiers, for a specified camera observation angle, are trained using previously prepared synthetic 3D models. These models represent various vehicle types and people in different stages of movement. Such models are further projected to a 2D plane and parameterized [2].

Parking event detection includes identification of the parking time, place and vehicle. Detection of the parking moment (i.e. when a vehicle has parked) is implemented as a set of spatial and temporal rules that lead to stopping a vehicle in a parking place. Parking places are defined as polygons "drawn" in the image frame (Fig. 2). Detailed description of the parking event detection is provided in [3].

Vehicles identification involves tracking the vehicle moving in the parking lot from the gate to its final stop. For this purpose, moving objects are identified correctly in different cameras' fields of view using object appearance features and spatial and temporal constraints related to cameras' deployment in a parking area.

Fig. 2. Parking places (light polygons) selected in video frames from two cameras with different viewing angles

4. PTZ CAMERA HANDLING

The framework utilizes PTZ cameras. They may be aimed automatically at a desired spot in the monitored area by selecting any point in video frames from fixed cameras, presented in the operator console. Furthermore, if a moving object is selected, it is automatically tracked by all PTZ cameras regardless possible transitions between fixed cameras' fields of view. Aiming PTZ camera at any point found in a fixed camera field of view requires a calibrated environment. Additionally, in case of moving object tracking, an image processing delay is compensated by aiming PTZ camera at the predicted object position [4].

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8. REFERENCES

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