Application of Closed Circuit Television for Highway Telematics

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Abstract. The article presents questions connected with the transport telematic systems. Both analogue (CCTV) and TCP/IP controlled (CCTV IP) visual monitoring system are presented. New concepts of technical and functional solutions are also discussed, aimed to improve the operational effectiveness of integrated control and surveillance centres managing the transport telematic systems.

Keywords: visual monitoring system, transport telematics, security system.

1 Introduction

The transport telematics is a field of knowledge integrating IT and telecommunications, intended for purposes of organising, managing, routing and controlling traffic flows, which stimulates technical and organisational activities enabling higher efficiency and safety of those systems [18, 19]. Transport telematic solutions are used for a broadly defined transport safety at multiple systems and transport facilities [16].

This issue becomes ever-important in the transport perceived as a wide-area system. This applies not only to facilities with high number of staff using different transport solutions, but also to monitoring of passenger compartments (passenger safety during transport), load safety, monitoring of routes and key transportation structures (bridges, tunnels, overpasses etc.) since they are easy targets for terrorist attacks, which if successful could disrupt transport networks, hence the entire economy over substantial area.

Telematics-based security systems could be used as part of transport telematic systems. In that arrangement they assure safety during travel, which among other is the service provided by transport telematic systems. This functionality is delivered by systems installed at permanent structures of airports, railway stations [11], logistic bases, handling terminals as well as by the systems installed in moving objects (e.g. vehicles). Consequently, the security level of both the travellers and cargo increases

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[4, 15]. In terms of reliability analysis of those systems there are already numerous publications (concerning both the entire system [2, 8, 9, 10, 12], as well as its components e.g. power supply [14] and transmission media [13]), thus they will not be discussed.

The highway telematics entails using various IT systems along highways in order to considerably increase safety during travel and commercial transport. A range of other positive effects are generated, i.e. a lower environmental impact, a higher efficiency of transport processes through traffic solutions, a better use of road infrastructure, a stronger economic validity of highway operator business [20, 21].

Highway telematics' elements include centres controlling transport, passengers, vehicles (cars, coaches etc.), drivers and cargos. Intelligent Transport Systems, subsystems managing roads, vehicles, drivers and transport services based on real-time telecommunications create a logical sequence capable of managing moving people, vehicles and cargos under changing environmental conditions. The visual monitoring is one of the subsystems. Among other is enables to assess highway conditions by locating the area where an accident has taken place and detecting its type. It can also determine the length of any consequent traffic jams (Fig. 1).

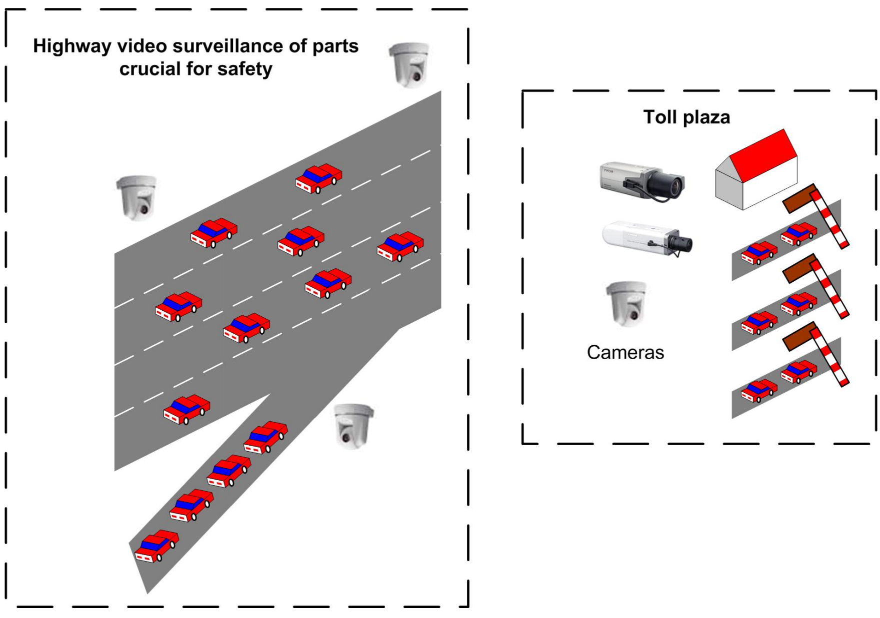

Fig. 1. Example of visual monitoring system in highway telematics

Currently there are many key solutions being implemented at visual monitoring systems concerning constructional design and organisation. Hence, the analysing of previous systems and suggesting viable changes increasing their functionality becomes of paramount importance. The article discusses issues related to telematic security systems. It particularly focuses on visual monitoring systems.

2 Characteristics of Visual Monitoring Systems Used in Transport Telematic Systems

Visual monitoring systems (CCTV - *Closed Circuit Television*) could be used as part of a transport telematic system. It is a system of hardware and software measures intended for observing, detecting, registering and signalling irregularities indicative of potential threats. They comprise (depending on the configuration) the following basic devices [1, 3, 5, 6, 17]:

- cameras equipped with adequate lenses,
- transmission media with interfaces,
- recording devices,
- monitors,
- power supply,
- other (e.g. additional illumination, uninterruptible power supplies, processing devices).

Fig. 2 illustrates a typical system composed of a maximum of 16 video cameras, a digital video recorder and two monitors (a multi viewer previews all 16 video cameras - 4-split, 9-split and 16-split screen options available, the other feeds the picture from a motion detection camera which detected a movement). The digital video recorder acts as a sequential switcher, a video splitter and a recording system with movement detection. This enables optimisation of the recorded image. It can also be equipped with an Ethernet card enabling a remote control via internet (intranet) over TCP/IP protocol. Such solutions are used at toll booths along toll roads.

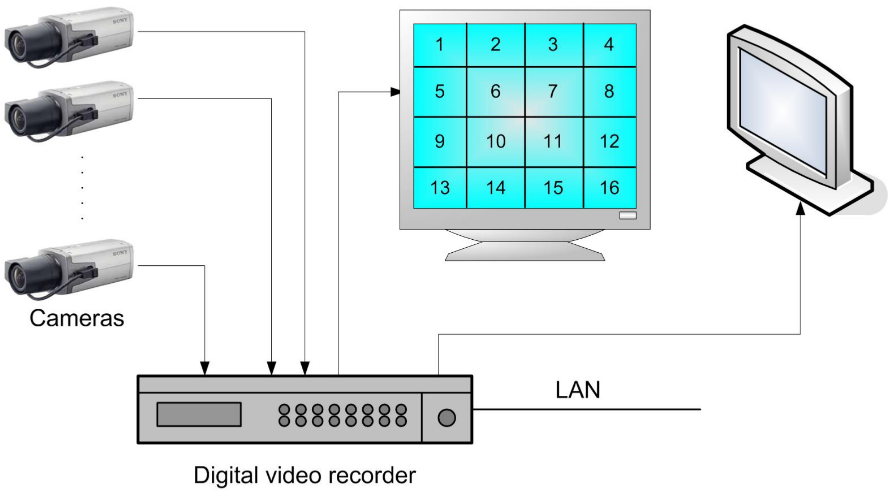

Fig. 2. System including 16 video cameras and a digital video recorder

Digital video recorders from different toll plazas can be connected via optical fibres with the central highway agency control centre. Advantages of this solution are:

low attenuation, resilience to external magnetic fields, confined energy radiation. It is used at facilities located at a considerable distance from each another. It requires converter devices to transform electric signals into optical and reverse.

A rapid IT development [7] made possible to connect directly video cameras with computer networks. Hence, images from cameras installed at different protected locations could be previewed using a computer with appropriate software connected to a computer network. The computer is equipped with built-in video server and has its own IP address. Small and local visual monitoring systems (due to high costs) will continue to use systems based on digital video recorders using coaxial cables. Scattered complexes and buildings equipped with modern telecommunication installations more often use visual monitoring system over TCP/IP. This protocol is called CCTV IP (*Closed Circuit Television Internet Protocol*). Image processing devices have their own IP addresses. One could use off-the-shelf, standard analogue elements such as video cameras thanks to video servers. The signal could be recorded through traditional video recorders and network video recorders.

3 CCTV IP Visual Monitoring System in Highway Telematic Systems

Permanent transport structures (e.g. toll plazas) which comprise one or more buildings could be potentially equipped with several solutions of visual monitoring systems. They are usually small structures (already built) which do not require many video cameras. Thus digital video recorders operating a network interface can be used as well as analogue cameras with TCP/IP network connectivity via a video server. Then such system can be connected to the surveillance centre. Should the structures be large or new-built already installed with adequate telecommunications infrastructure, the CCTV IP is the preferred solution. Fig. 3 illustrates schematically a CCTV IP system.

The surveillance centre plays a superior role to local operators' centres. It manages the entire CCTV IP system (e.g. installing new IP cameras and video servers including configuration) and also stores device-specific information from IP cameras (and/or video servers). Additional recording capabilities are generated by network video recorders.

The image from CCTV IP cameras is recorded via dedicated software. It is usually intended for intelligent video monitoring. Owing to its capabilities, video surveillance centres can be created anywhere, regardless of camera locations (both network and analogue via a video server). The movement and objects can be detected (e.g. missing object detection capability, object tracking capability etc.) thanks to intelligent image processing and advanced filters. That software usually enables the PTZ control (Pan/Tilt/Zoom), provided the camera has adequate hardware capabilities. The built-in privacy zone masking enables to cover unwanted or private areas of the image.

A CCTV IP visual monitoring system offers capabilities unavailable with analogue counterparts:

- video transmission over long distances has no impact on the image quality,
- multiple recording and copying of the same footage does not damage the quality of recorded image,
- video signal recorded once by the camera can be used any number of times regardless of location,
- bi-directional communication with the camera enables not only its configuration, but also other functions (e.g. intelligent cameras),
- motion detection and alarm capabilities of the camera itself (intelligent cameras),
- data buffering of image recorded by the camera,
- *Power over Ethernet* capabilities.

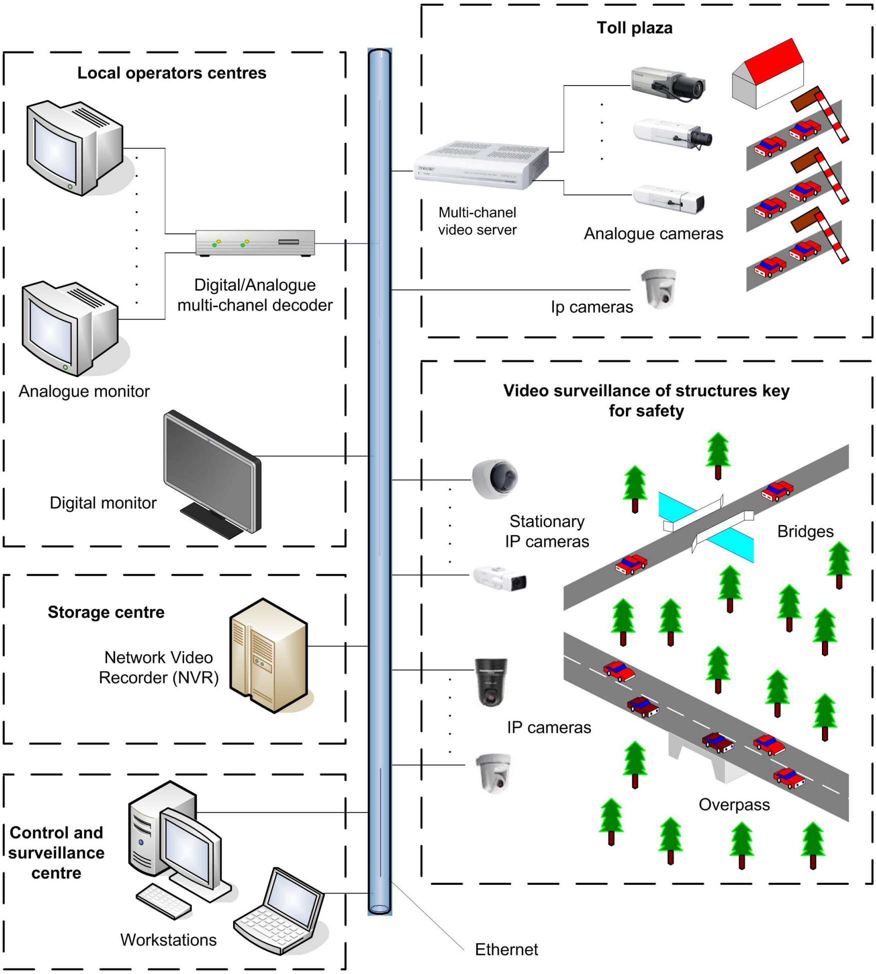

Fig. 3. Schematically presented example of a CCTV IP system

When designing modern visual monitoring systems used as part of transport telematic systems one should consider the following:

- video streaming directly from the camera,
- image resolution in megapixels,
- cameras with thermovision capabilities (thermovision cameras),
- bulk memory functionality available in cameras and video servers,
- Power over Ethernet (PoE),
- quality of service (QoS),
- software with the image preview functionality for mobile devices (e.g. smartphone),
- ONVIF-compliant (Open Network Video Interface Forum).

Those guidelines mean that the designed visual monitoring system will have better operational parameters and it would be a better platform for future updates (particularly so if the equipment used was ONVIF-compliant).

4 Conclusion

The issues discussed in this paper concerned visual monitoring systems used in transport telematic systems (especially in highway telematics) and their potential to increase the travel safety. At present, the developing and deploying of these or similar solutions is of paramount importance to Poland. Single implementations are insufficient. The European and global trends also have to be followed as they aim to create integrated control and surveillance centres of transport telematic systems, particularly so as far as telematic security systems are concerned. This approach will help to install systems with high operational efficiency. Of course, one should always bear in mind emergency intervention services and operational procedures should any danger arise (especially in case of accidents and terrorist attacks).

As part of further research, the authors plan to conduct a reliability analysis of CCTV IP visual monitoring systems. They plan to put emphasis on bulk memories in cameras and video servers. The other research direction will concern electromagnetic compatibility issues related to those systems.

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