NEW APPROACHES IN TRAFFIC SURVEILLANCE USING VIDEO DETECTION

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ABSTRACT

ArtiBrain has installed numerous incident detection systems in various tunnels across central Europe. Because of their complexity, modern detection systems present a new challenge with regard to their integration within an existing structure. So it is enormously important to make a careful assessment of the surveillance system during the planning and implementation process. Furthermore, new developments offer the opportunity to move ahead in tunnel security by upgrading to new technology.

Key words: tunnels, video detection, digital storage, traffic surveillance, safety, event related

1. INTRODUCTION

Two years ago ArtiBrain presented its newest product for tunnel video surveillance. In cooperation with the Joanneum Research Institute and with crucial support from important Austrian industry, ABT2000 was designed as a comprehensive solution in video surveillance, storage and detection. The aim of the ATB2000 was to provide security for the work on and in the tunnel and to create the most modern, innovative product for this task.

ABT2000’s proximity to market conditions and its good design have brought success against competition in several projects. In the meantime the small Austrian company has carried out an impressive list of reference projects. After these early achievements it is time to summarize the experiences and to think about new approaches and possibilities in digital video surveillance.

1.1. Company profile

ArtiBrain, a research and development company based in Austria, sees its main focus in industrial image recognition and in the development of digital storage systems. In addition, ArtiBrain has proved itself as an expert in the use of neural networks.

Through the strengthening of its own development group and close cooperation with institutes for basic research, such as Joanneum Research in Graz, ArtiBrain was able to assemble excellent experience in the field of video detection for streets and tunnels.

1.2. Short product overview on ABT2000

During the design phase of the structure of ABT2000, ArtiBrain paid a lot of attention to the concept of a modular structure in order to be able to offer a broad, but still affordable, video system. The modular structure gives the opportunity to equip small and micro tunnels efficiently, as well as large installations with several hundred video cameras.
One further important aspect was the concept of an all-in-one solution for the coverage of the entire video subject. This is the reason why ABT2000 contains – apart from detection modules – modules for storage and streaming.

1.2.1 Streaming
ABT2000 offers the possibility to spread video signals by using a codec as a digital data stream via IP networks.

Through the opportunity to use the pre-existing engineering of analogue cameras and monitors, existing installations can easily be upgraded by being refitted with the new technology.

1.2.2 Detection
ABT2000 offers a comprehensive solution of video detection on a high level. The development goal was always to produce a high performance and a minimization of the frequency of false alarms.

The system offers the calculation of all detections in real time for each frame. (25x per second). Through this the system is able to detect events within a few milliseconds.

1.2.3 Storage
The digital video storage is designed to record permanently 50 frames per second per camera. Because of the modular storing concept there is, in fact, no expansion boundary in the storage size. Through the linkage of the information of the incident detection, the storing concept can be extended from a pure ring storage to an incident storage. Therefore it is possible to use the available storage capacity efficiently by limiting the storing to only relevant incidents.

The connection with the video streaming makes it further possible to watch stored archive pictures directly on the analogue surveillance monitors. This facility can be extended to allow switching between live and playback modes because the pictures are stored in the ring buffer. The graphical user interface (GUI) with full VCR functionality (including frame-by-frame stepping) allows cutting, deleting, printing and exporting of videos.

1.2.4 Integration
To make the handling of the video installation as simple as possible without burdening the monitoring staff more than necessary, ABT2000 can be integrated seamlessly into any desired process control system. This happens through the usage of standardized industry interfaces that can be extended by modules.

Through this the operator is able to control all functionalities directly from his usual visual GUI of the process control system.

**Figure 3: ABT2000 system schematics**
2. SUMMARY OF THE FIELD EXPERIENCE

The complexity of modern video detection systems presents a new challenge in the integration of tunnel security. Not only black-boxes are installed. New systems offer a number of new possibilities:

- Smooth integration of new technology into existing systems
- Successfully managing complex detection tasks
- The union of several systems into one platform

For the usage of such systems it is enormously important to focus more on the planning and the implementation phase. This is the only way for the video surveillance systems to achieve their full potential. Especially emphasized points:

- Planning and design
- Selection and maintenance of the cameras
- Integration process and its implementation
- Conditioning of the detection tasks

The complexity of video detection tasks increases constantly. Therefore, an increase can be expected in the work to implement and operate such systems. But the benefit which is provided by these systems is enormous. Additionally, they open up specific possibilities which were previously difficult or impossible to realize - for instance, in the operation of large central control rooms.

The necessity for, and the importance of video detection is becoming greater and greater because of other factors. The two main factors are: the need to make the work easier for security personnel and the actual security of tunnel traffic, drivers and passengers.

Some of the most important advantages of modern systems are:

- Precise speed measurement by only one camera
- Precise distance measurement by only one camera
- Stable detection algorithms and fewer false alarms
- Fast detection time (only a few milliseconds) and therefore significant shortening of the reaction time
- Simple and quick integration into existing systems
- Synergy through the linkage of different modules. For instance, the knowledge of the positions of vehicles enables smoke detection even at road level
- High flexibility through the use of a software solution for the detection algorithms
- Open standardized interfaces guarantee communication with every process control system

2.1. Comparison Grid Scan versus object detection

Instead of using Grid Scan in video detection it has proved to be better to use complex object recognition.

In the case of Grid Scan, the video picture searches for modifications in defined points/fields and compares them with the previous picture. Through the combination of such movement points to groups vehicles and objects can be pursued.

The advantages of this method are:

- Usage of simple algorithms
- Simple implementation
- Smaller computer capacity necessary
- Manageable options in the parameterisation
This procedure, however, comes to its limitations very fast, as far as detection accuracy and frequency of false alarms is concerned:

- Inaccurate relocation of the vehicles (no possibility to measure the speed)
- Overlapping vehicles cannot be separated
- Inaccurate measurement of the size of vehicles
- Difficult distinction between reflections, cones of light, lens flares, etc.

In the case of the object detection, a moving object is registered completely and it is identified by unmistakable characteristics. Afterwards these objects can be found with a very high accuracy. Through the knowledge of the precise size and position, as well as exact speed and distance, measurement between single objects is possible.

Combined with the capability of modern computer systems and an evaluation of all 25 pictures per second the movement of all objects can be pursued and examined very precisely. Reflections, lens-flares and similar disturbances can already be filtered out by means of the characteristics of the objects.

Figure 4: Live image taken from the camera
Figure 5: Movement detection by using Grid Scan
Figure 6: Separation and measurement by using object detection

3. CURRENT DEVELOPMENT AND FUTURE STEPS

3.1. Providing Information to the emergency task force

Especially in the case of emergency it is important that information is provided to the emergency services quickly and in a goal-oriented way. ArtiBrain is developing, in cooperation with the Austrian fire-brigade, a new tool for the head of operations - a graphic information system.

This system should provide current and pre-stored video pictures from the tunnel. Furthermore the task forces receive important additional information from the tunnel, which helps them to co-ordinate its action. (i.e. the number of cars involved in an accident or the present air flow conditions in the tunnel).

A special feature is, however, the connection to the information centre via a specific WLAN interface. This means that this ad-on gives the team the opportunity to have an exact picture of the situation of the accident before its arrival, so that the team can be provided with reinforcements as quick as possible.

3.2. Detection in the street

After the success of ABT2000 and the experience it has accumulated, ArtiBrain prepares for the next the logic step and moves with the video detection from the tunnel onto the street. Here you can find two difficult conditions for detection through a video camera: environmental conditions like snow, rain, sun etc. and a great number of zoom/pan cameras.
Presently ArtiBrain is trying to face these challenges in co-operation with the Joanneum Research Graz through several research projects.

Solution topics for problems which occur during outdoor operations:

- The occurring environmental situations are trained through databases. Specific background databases are responsible for different circumstances such as light and shadow.
- Through new detection algorithms, it is aimed to minimize the frequency of false alarms.
- The object recognition is extended to vehicle recognition on the basis of specific characteristics. These characteristics are also trained by databases and neuronal networks.
- Through self-learning methods it is tried to minimize the conditioning effort in new systems.

Through the use of dynamic cameras (zoom/pan cameras) the video system is constantly confronted by the problem of new situations. If a zoom/pan camera is used that can assume a number of predefined positions very precisely, detections can be configured for each of the positions (let us say - a number of virtual cameras for each physical camera).

The software activates the corresponding configuration as soon as such a position has been reached. While the camera is moving, detections are inactivated. In order to achieve this goal there is a need for close cooperation with manufacturers of exact repositioning cameras.

Video detection outside means new tasks for the detection systems:

- Automatic release of the breakdown lane of whole motorway sections in the case of strong traffic volume within a few minutes.
- Continuous controlling of the breakdown lane through the detection system.
- Cameras position themselves automatically to survey special incidents.
- Recognition of ‘wanted’ vehicles by evaluation of the licence plate.

3.3. New Video Codec for storing and streaming

Currently used video codecs provide good picture quality between 4 and 16 Mbit/s bandwidth. New, modern compression solutions offer the possibility to transport considerably more video data via even thinner networks. At present the development concentrates on three codecs.

3.3.1 MPEG4

MPEG4 provides fundamentally a strongly lossy compression. This procedure is organised so that only changes between pictures are transmitted as data. In addition, moving information in the picture is evaluated in the form of mathematical vectors. A genuine change to video material is made by this procedure.

All MPEG procedures suffer by the fact that a single picture is only be represented by the surrounding of the preceding pictures. If an individual picture has been lost, the video stream may be disturbed for a long time.

3.3.2 JPEG2000

JPEG2000 is the successor of the JPEG standard. The designers decided to look at the overall environment in which images would be tasked in future and decided that a compression scheme that worked well in network environments was the most desirable. In comparison to MPEG4 in JPEG2000 each frame is coded individually. So there is no change in the video
content itself. Additionally this standard may offer the possibility to store results given from the detection directly in the video.

In addition to the benefits of scalability, JPEG2000 delivers a better compression than JPEG. And, at more extreme compression ratios, JPEG2000 delivers significantly better quality. JPEG2000 is intended to be royalty free and is an international standard.

3.3.3 H.264
H.264 (aka MPEG-4 Part 10) offers a clear decrease in bandwidth compared to all previous codecs. Full picture PAL streams become possible with less than 300Kbit/s.

All current Codecs provide good quality pictures at very low bandwidths. However JPEG2000 and H.264 will be favoured clearly as future codecs. JPEG2000 on account of its simple handling and its good cost efficiency.
H.264 on account of its amazingly small bandwidth with outstanding picture qualities. MPEG4 on the other hand still suffers from the problem of missing standardization and has often been badly implemented.