DETECTION OF DANGEROUS GOODS

Principles and technologies

Juin 2012
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1. Issues of detection of dangerous goods

The presence, in high-risk areas, of vehicles transporting dangerous material may transform banal traffic incidents into catastrophic events often with a high human and material cost.

These high-risk areas may have one or several of the following characteristics:

- Confined conditions which make the consequences of accidents which may occur even more devastating (tunnels, town centres).
- Situations of restricted access which make the evacuation of users and the access to aid much more difficult than on traditional routes (tunnels, bridges).
- Locations close to high-risk installations or storage areas of toxic products (nuclear sites, Seveso sites etc…).

Recent accidents have demonstrated that the presence of lorries in general, and especially of lorries transporting dangerous goods was likely to provoke damage out of proportion with the initial incident.
Up to now, the detection, follow-up and control of lorries transporting dangerous goods has been based entirely on visual monitoring usually carried out by representatives of the forces of law and order or by the companies of the sites in question.

These checks are in general neither systematic nor efficient, because of the amount of traffic flow to be managed at certain sites. In any case, the cost of rendering these checks efficient would be prohibitive if they were to be carried out exclusively by human means, without the assistance of identification assistance tools.

However, despite their limitations, this monitoring has shown that any regulation access restrictions which may exist are frequently not respected by the transporters, whose priority it is, is to find the shortest journey between loading and unloading points.

For all the above reasons, the implementation of automated control systems, and possibly of sanctions for the access to regulatory sites involves major issues for public security and for road infrastructure cost-efficiency.
The only method which can be envisaged at present depends on the detection and recognition of dangerous goods signs which transporters are obliged to attach to their lorry. This identification is necessarily based on sophisticated optical techniques.

2. Regulatory background

The signing concerning the transport of dangerous goods has been unified since 1997.

Dangerous goods being transported should be presented with various different signs including signs with hazard codes and hazard symbols.

These signs should be visible at the front, at the rear and on each side of the vehicle. They are orange and measure 30×40 cm. They are divided into two parts widthways. They contain identification numbers (see below), or can be empty if the container used may transports several dangerous goods.

The hazard code is in the upper part. It is composed of two or three numbers, sometimes preceded by a letter, which indicates the nature of the hazard in question. The first letter represents the main danger, and there is always a second figure representing the secondary danger (0 if there is only one danger). If necessary, an additional hazard will be represented by a third figure.

The presence of the letter X in front of the numbers indicates the hazard of a violent reaction if the product comes in contact with water.
For more information on the regulated signing of the transport of dangerous goods, see the texts of the EU or the summaries published by the different organisms concerned.

For example: http://en.wikipedia.org/wiki/Dangerous_goods

3. Restrictions and limits of detection of dangerous goods

The dangerous goods signs have the advantage of being perfectly standardised in Europe and in most countries of the world.

The diamond sign contains a lot less information than the identification rectangle. This is therefore the element which has to be identified and read.

The identification rectangle should be attached:

- On the front of the vehicle.
- On the rear of the vehicle.
- On the side of the vehicle when the load is composed of several distinctive trailers transporting different materials (in this case, unmarked orange rectangles are stuck on the front and on the rear, which implicitly indicate consultation of the side rectangles).
It is not usually possible to read the plates from the side because of the concealing effects caused by the presence of several parallel lanes.

Reading from the rear of trailers presents several disadvantages which limit the efficiency (presence of several non-essential pieces of information).

It is preferable to carry out the identification on the front of the vehicle.

One of the difficulties consists in identifying in a specific way the dangerous goods sign and the number plate which have similar signs. Any confusion between these two signs would make the identification of one of the plates impossible. Also, in most cases, it is necessary to distinguish them, because both the dangerous goods and the lorry need to be identified (using its matriculation number) in order to ensure a relevant follow-up. It is only useful to know that a given lorry transporting dangerous goods has entered a tunnel if we can also tell that this same lorry – identified in a unique way by its matriculation – has left the tunnel or not.

*Simultaneous display of both dangerous goods and matriculation plates*
Other issues which represent restrictions in relation to the state of plates for dangerous goods:

- Some plates are in fact stickers, which are less reflective to infrared.
- Some plates are so damaged or so dirty that they are almost impossible to identify and read.
- Some plates are made up of individual numbers grouped in a way that limits the readability.
- Some plates are not regulated (non-conform characters, non-reflective support etc…)

All of these restrictions limit the efficiency of the identification and the reading of plates for dangerous goods. Survision estimates that the goods can be identified and read correctly in 90% of cases at the most.

Although limited, the efficiency of the control by optical technologies is still more precise than a visual control and its systematic nature make it a major instrument in the reinforcement of security in tunnels, on bridges and in town centres.

4. The solution offered by SURVISION

4.1. Functional principles and architecture

SURVISION has perfected a solution combining specifically designed cameras and sophisticated algorithmic image-processing techniques, in order to allow for the deployment of efficient tools for the control of the flow of vehicles transporting dangerous goods.

The proposed architecture is based on a set of cameras deployed along the site that is to be protected.

It is these cameras which carry out the extraction of dangerous goods number plates, without any need of processing servers, and provide data through IP to a data aggregation server. The
dangerous goods cameras (DG cameras) can be used alone or in combination with number plate cameras (ANPR cameras). The transmission is carried out through radio or cable IP networks. The required bandwidth is reduced, as the cameras provide information that is already processed and digitalised.

This data is made available in real time on the network and can be integrated by using SURVISION middleware in order to combine them with other data or to construct a specific application which exploits this data.

SURVISION also provides an application called AUTOFOCUS which uses number plate and dangerous goods data as well as a certain number of alert functions.
Typical installation architecture
An unlimited number of cameras can be connected to the Autofocus system. In the same way, several consultation Clients can be used simultaneously. The system also allows the export of data or of alerts towards exterior interfaces (display panels with variable messages, centralised technical management interfaces, emails, etc…)

4.2. Implantation

When the application is used to monitor the access to a tunnel, the dangerous goods plate recognition cameras (and the number plate recognition cameras if these are present) can be located either inside or outside the tunnel. These cameras are usually installed before the tunnel so that the detection takes place before the vehicle enters the tunnel. Other cameras are installed at the tunnel exit in order to be able to film the vehicle as it exits the monitored area. It is not necessary to identify the dangers goods again on exit, as the vehicle identification is confirmed by the number plate.

In some cases (tunnels or particularly long bridges), cameras can be placed at regular intervals in order to provide a more accurate identification of vehicles transporting dangerous goods.

A dangerous goods plate camera and a number plate camera should be used for each lane monitored in order to optimise the performance. The cameras can be installed at the tunnel arch, on the side walls, on a pole positioned away from the road, on an overhead installation or on the pediment of the tunnel. Where there are multiple lanes, it is recommended that the installation be directly above the lanes in order to prevent plates of vehicles on one lane being hidden by vehicles travelling on the other lane.
Two cameras installed on an overhead installation frame

Two cameras installed on a pole in a horizontal position
The height of the installation can vary from 1-8 metres. The distance between the cameras and the vehicles can vary between two and twenty metres for the MICROPAK and between two and forty metres for the VISIPAK (the actual distance can vary according to the dimensions of the number plates, and therefore of the country).

Because the architecture used is based on local processing of video streams (by the cameras themselves), the network limitations are of little importance. The system requires little bandwidth and can function, if required, on radio networks.

4.3. Camera specifications

The cameras used for the detection of dangerous goods are the VISIPAK or the MICROPAKs. The MICROPAK provides number or dangerous goods plate data. The VISIPAK, as well as this data extracted from the camera functioning in black and white and in infrared, provides images and a colour video stream from a second camera which may have different settings (especially the zoom).

In these cameras, all of the necessary elements for filming are embedded in a single casing:

- SONY optical unit.
- LED of infrared illumination which works in an invisible range (850 nanometers).
- Electronic synchronisation components between the shutter of the camera and the LED illumination.
- Electronic processing components which allow for the digitalisation and MPEG4 compression of the stream at the source in order to facilitate transport and storage.

The SURVISION cameras were specifically designed to take into consideration the specific restrictions associated with tunnels:

- Exclusive use of very high-quality raw stainless steel.
- All fixation elements are fixed in place and there is a small chain is to prevent the camera from falling onto traffic lanes.
• IP67 protection which allows for high-pressure cleaning.
• Upper fixation to allow for positioning over an arch.
• Waterproof connectors and remote adjustment devices in order to reduce time required for on-site interventions.

These cameras provide very high quality video streams optimised for recognition of dangerous goods signs and matriculation numbers. The streams are optimised because:

• They are infrared within the wavelength of reflectivity of dangerous goods signs and matriculation plates.
• A dynamic control of the camera and LED parameters allows us to constantly obtain the best possible image of the plates.
• The compression algorithms allow for best conservation of the contrast of characters written on the plates.

For more information on the MICROPAK and VISIPAK, please see the presentation datasheets corresponding to these cameras.

4.4. Specifications of the camera firmware

Dangerous goods plate recognition uses technologies similar to those of number plate recognition. The cameras process in real time the video streams in infra-red provided by the cameras. The detection is carried out entirely automatically, thereby eliminating the need for an external activation device (such as a ground loop). Once localized, the plates are segmented in order to separate the characters. Each segment is then subject to OCR (optical recognition of characters) processing. Finally, syntax filters are applied in order to eliminate possible ambiguities which may remain between several characters.

At each stage, several algorithms are combined. The processing is applied to each video frame so that the plates are read several times before the data is provided to the application.
This process makes it possible to guarantee an optimal detection and recognition performance.

For dangerous goods plates, certain specific elements should be taken into account and require adaptation of the image-processing algorithms or the addition of specific algorithms. These are:

- The rectangular format and the presentation on two lines of information requiring a particular processing.
- The frequent lack of reflectivity of the plates requiring a processing of characters with weak contrast.
- The co-existence in the same image of signals coming from the sign dangerous goods and the matriculation plate which require the dissociation of these signals in order to allow a distinct processing.

For more information about the techniques used by SURVISION for number and dangerous goods plates, please consult the presentation documents on the specifications of SURVISION technologies.
4.5. Data integration and exploitation

SURVISION offers a simple and user-friendly middleware which allows integrators to construct interfaces and databases which integrate the data produced by the SURVISION cameras and servers (dangerous goods codes, matriculation numbers, JPEG images and real-time video streams).

For more information on this middleware, see the SDK documentation (Software Development Kit) accompanying this middleware.

SURVISION offers trainings to the integrators who desire to learn more about this middleware.

SURVISION also offer a turnkey application, called AUTOFOCUS, which allows for the storage and consultation of data as well as the emission of alerts.

For more information about this application, please see the presentation datasheet and user guide.