VIDEO REGISTER PICTURE EVALUATION TO SUPPORT DRIVERS TRAINING AND EXAMINATION

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This paper refers to some problems on digital video recording of picture during driver training and examination process for obtaining driving license. Since 10 April 2006, all examining institutions have to use video and audio recording devices in Poland. The legal regulations in force do not clearly determine the functional requirements and technical parameters for video recorders; hence the actual devices used do not meet user requirements. This paper describes a deterioration of recording quality parameters of the video recorder as well as construction of camera, its main elements and their influence on the recording quality parameters. The paper refers to attention to geometrical deformation of image that is made in optical camera system. The authors have made an attempt to determine camera parameters, their location and quality of the picture. In mentioned case the objective and subjective picture validation methods will be presented.

Keywords: *video register, quality picture evaluation*

1. Introduction

According to the Ministry of Infrastructure's Act from the 27-th of October 2005 referring to training, examining and obtaining certificates by the driving instructors and examiners [4], as of the 10-th of April 2006, all centres conducting exams for the B category driving licence, should ensure that the cars used for examining, were equipped with video and audio recording devices. The recorder should at least record forward view through the front windscreen of the examining vehicle, while the viewing angle should not be smaller than 45 degrees. Picture registered must contain the date and time of the exam as well as registration number of the examination vehicle. The sound from the inside of the vehicle should also be stored. However there are no clearly determined functional requirements and technical parameters for the video recorder. The experiences of the users show, that from the types of recorders on offer, very few actually meet user requirements. Lack of requirements for the video recorders definitely hampers an effort to create a tender documentation for the purchase of the new cars. At present there are used monitoring devices, consisting of the elements from the CCTV (Closed Circuit Television).

Thus it is necessary, to determine the location and number of cameras, the video recorder should be equipped with, as well as other requirements (amongst them: colour or monochrome, sensitivity, resolution, focusing distance, location, camera direction, admissible picture distortions), minimal picture and sound quality. An important thing is ensuring appropriate quality of the picture being recorded, however the first stage of the tests, in opinion of the authors, should rely on the assessment of the static picture obtained from the cameras and selecting the right ones.

2. Cameras and the Recorders Used in the Mobile Video Registering Systems

Electrical equipment installed in the vehicles should meet technical and functional requirements, which will ensure their correct functioning in the car operating conditions. Thus they will not result in any endangering of the road traffic safety. According to the PN-EN 55022 [5] Polish Standard, they cannot adversely affect the operation of the onboard vehicle devices. Additionally these devices should be adapted to the operating conditions of the vehicle. Apart from shaking caused by the uneven roads, they have to be resistant to low and high temperatures as well as its changes, occurring during the use of the vehicle. This problem has a particular significance in the case of recorders which especially have to be adapted to the operations in such operating conditions. They form a group of so called mobile devices that differ from the devices used in the stationary monitoring system in design and the use of electronic subcomponents. One of the digital recorders adapted for use in the vehicle is MRX-1004 A from the APER firm. According to the manufacturer it is shock and vibration resistant. It can be supplied with 12 V current, directly from the car electrical system. It can have 4 cameras plugged in, while picture data is registered on its hard disc or on the Compact Flash (CF) card. Recorder allows also copying data from the hard disc to the Secure Digital (SD) memory card. Particularly useful is the use of CF cards, due to an easy data transfer and making copies outside the recorder. This is especially important in case of

examining drivers for the B category driving licence, because that data must be stored for administrative purposes, according to the Act, for the period of at least 14 days from the date of the exam. Technical data of the recorder is presented in the Table 1.

Table 1. Technical data of the APER MRX-1004A recorder

No	Name	Description
1.	Maximum resolution	720 x 288 pixels
2.	Maximum recording speed	25 picture frames / s
3.	Range of admissible operating temperatures	from + 5 °C to + 40 °C, humidity 90 % (without condensation
4.	Supply voltage	12 V (allowable.: 8 ÷ 28 V)
5.	Dimensions	210 x 43 x 145 mm
6.	Number of video inputs	4
7.	Number of audio inputs	1
8.	Number of video outputs	1
9.	Additional plug-ins	LAN, USB, RS-232

Vehicles monitoring systems usually utilize colour cameras, of vertical resolution not acceding 520 picture lines. Depending on the type of the camera optical and electronic system used, the quality of the picture from various models can differ significantly, even in case of the devices of the same resolution.

3. Assessing Quality of the Static Picture

To assess the quality of cameras, one uses reference pictures. During the work conducted at the Motor Transport Institute the *Delta CCTV Test* testing picture was used, developed by „DELTA" firm from Poznań (www.delta.poznan.pl), with the overall dimensional proportions 4:3 (Fig. 1).

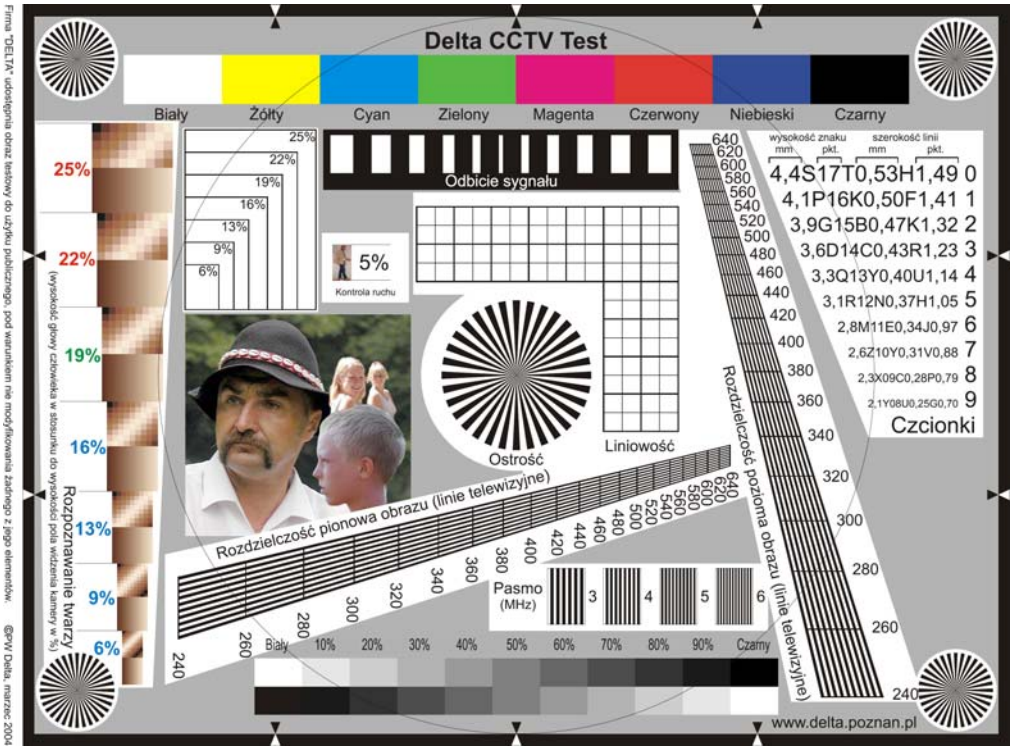

Figure 1. Test picture for the CCTV

The quality of the picture recorded, apart from the camera, is affected also by a type and parameters of the compression algorithms used in the recorder, as well as quality of the transmission track between the camera

and the recorder. The device described uses MJPEG compression, relying on the recording picture sequence, subjected to encoding to JPEG format. In order to assess the picture quality, the above mentioned test picture was used. Pictures obtained from four cameras, used with this video recorder, are shown on the Fig. 2.

Three colour cameras were used of vertical resolution, 520 lines (camera 2), 520 lines (camera 3), 480 lines (camera 1) and one monochrome camera of 700 lines (camera 4) resolution.

Figure 2. Pictures from four cameras, showing CCTV test picture

Locating Test Picture on the control monitor screen has been chosen in such away, so that it takes the whole height of the screen and the black framing of the picture is not seen. Identical principle should also have been used for the remaining edges of the picture, but significant geometrical distortions of the picture made such adjustment impossible. According to the requirements of the PN-EN 50132-2-1 Polish Standard [6] geometrical distortions of any part of the picture should not be more than 2 %. This requirement has not been met for any of these cameras.

Maximum resolution has been determined from the section, for which it was still possible to distinguish black lines and white spaces between them.

Based on the pictures registered by the cameras, the assessment was made of the picture - connecting cables – picture recorder set. Section of the registered picture, showing lines used for determining vertical resolution, has been shown in the Fig. 3.

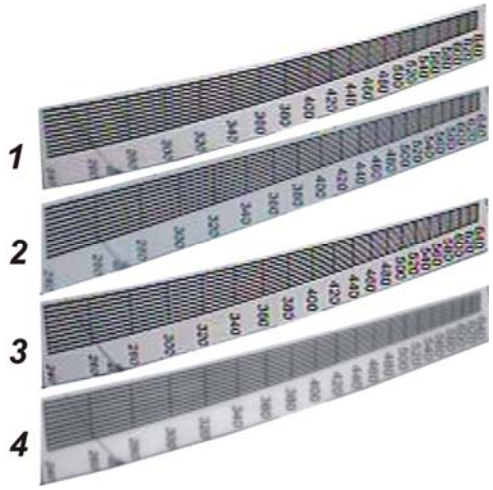

Figure 3. Fragments of the picture used for the purpose of estimating the vertical from the cameras

Following resolutions of the TVL (picture lines) were obtained:

- 460 TVL – camera 1 (480 lines acc. to the producer),
- 460 TVL – camera 2 (520 lines acc. to the producer),
- 480 TVL – camera 3 (520 lines acc. to the producer),
- 440 TVL – camera 4 (700 lines acc. to the producer.

4. Assessment of the Pictures Sequence Quality

Due to the limited data transmission speed and required capacity of the data carrier, where the date is filed, the algorithms used are of so called lost data compression [3]. This causes significant deterioration of the picture and sound quality. Reconstructed data file differs from the original and it becomes necessary to evaluate its quality from the aspect of the degree of date compression. Before being used the compressed data is decompressed. The criterion of decompressed data quality is dependent on the compression techniques used, but it is impossible to formulate unified, commonly useful quality criteria and the extent of admissible degrees of compression [7]. The necessary condition is to maintain clarity of the reconstructed picture as far as the elements, essential for assessment of the person taking the exam for the driving license, are concerned. An important aspect, which must be taken into consideration while assessing the quality of the picture registered by the video recorder, is quality of the original picture, by which here is meant the uncompressed picture from the camera, or cameras co-operating with compression and filing module of the video recorder. Therefore, first stage aiming at determining minimum quality picture has to take into consideration defining the quality of the picture obtained from the camera. Second stage should consider the quality of the picture, subject to compression by the recorder. The picture obtained as a result of processing the original picture is of a „good" quality usually when visually it looks pleasantly natural (without heavy distortions), or it is useful for some purposes. However there is no universal measure allowing determining quality of the reproduced picture in each case. There are three methods used to determine quality:

- Objective measurements of distortions (otherwise known as automatic measures) – measurable quantities or vector ones defined automatically according to a set dependence;
- Subjective quality measures (otherwise known as observation measures) – psycho-visual quality assessment, curried out by a group of specialists (users),
- Statistical simulation measures – more complex, referring to a particular application, and evaluations based on as faithful as possible simulation of the real conditions of the picture analysis as well as statistical analysis of the classification tests results.

In order to evaluate the pictures, a sequence from four cameras has been recorded installed in the Opel Astra I estate. The sample picture from the recorder equipped with 4 cameras is shown in the Fig. 4. The picture sequence obtained allows a further study.

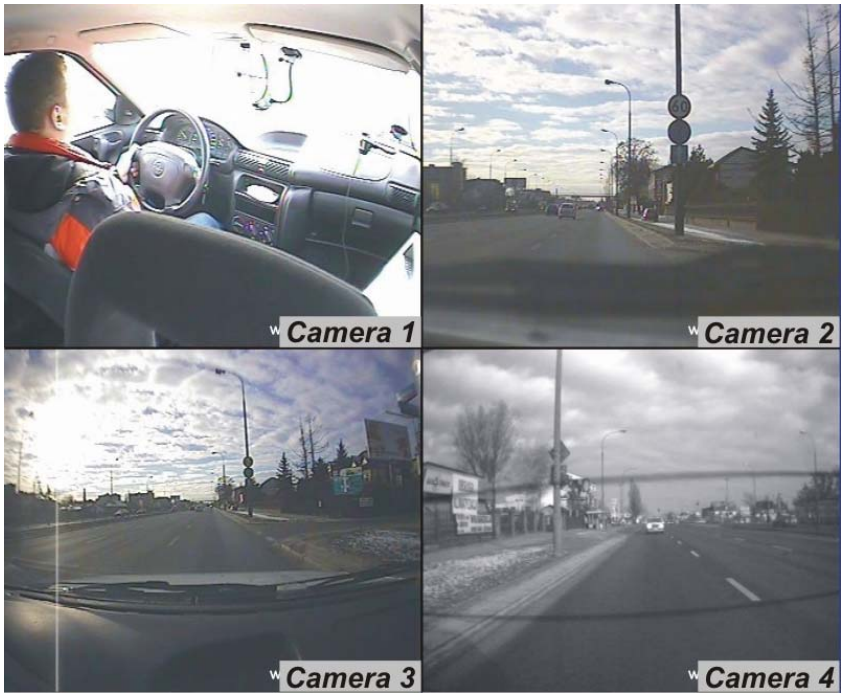

Figure 4. Sample picture registered using recorder equipped with 4 cameras

Many research shows that a single compression technology cannot be effectively used in most of the applications, and points to a need for non-uniform compression. It therefore becomes necessary to develop a quality measure which is to able of determining the amount of degradation level, the kind of degradation and the impact of compression on different frequency ranges in a reconstructed image.

A lot of publications concerning the image quality measurement show the measures are numerical, combining the pixel differences in the original and degraded images into a single number. Although there are some efforts to establish a stronger relationship with subjective evaluation, the scalar measures are not able to describe either the degradation type or the local error. Only general purpose graphical measure that can be used with some success to describe both the amount and the type of degradation is Hosaka plots. However, its application to images with different deterioration of quality has indicated a number of difficulties:

- the selection of the two main parameters for the block size and the variance threshold is not easy and depends on the compression ratio, compression algorithm, and the frequency contents of the worsened image,
- the plots transparently display the artifact of blackness but are not equally successful in showing blurriness.

Professor A. M. Eskicioglu [1, 2] proposes graphical measure based on three criteria. To be able to make a local error analysis, the first step depends on division a given image into areas with certain activity levels using, as in this case of Hosaka plots, a quad tree decomposition. The block sizes in the decomposition scheme may be from 2 to 16 pixels. This gives four classes of blocks having the same size. Class *k* represents the collection of *k* x *k* blocks. A higher value of *k* denotes a lower frequency area of the image. After obtaining the quad tree decomposition for a specified value of the variance threshold, it is necessary to compute three values for each class (i = 2, 4, 8, 16), and normalization.

The calculations have to be made as follows:

- the number of pixels / the number of pixels in the entire image,
- the number of different pixel values / the number of possible pixel values in the image area,
- the average of the standard deviations in the calculated blocks / a preset maximum standard deviation (the preset value have for example 100).

The sample obtained characteristic values of the image are shown in a normalized bar chart (Fig. 5).

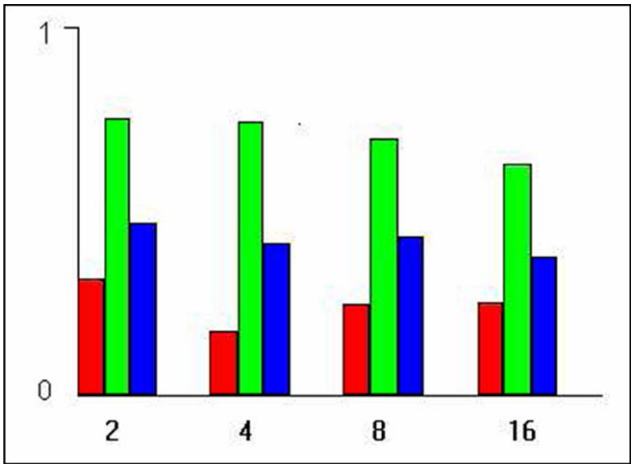

Figure 5. Sample characteristic values of the image obtained by the Eskicioglu computing method

Conclusions

Motor Transport Institute is conducting work on developing minimal requirements for the video recorders used during the exams for the exams for the B category driving license. These devices can be utilized also during the training process. For this purpose, apart from the tests aimed at establishing the optimal number and locations for the cameras, there will also be a method developed to assess the picture quality and minimal requirements for that. In the authors' opinion, in order to do that, it is essential to combine objective and subjective picture quality assessment methods. Such approach will ensure taking into account the experts opinions (from the subjective-observational assessment) and will enable obtaining numerical values, using which minimal picture quality will be defined. The first stage of tests should however rely on defining static requirements, such as the amount and location of the cameras as well as their technical parameters. The article presents evaluation of the vertical resolution of the cameras and a sample picture registered during tests. The tests being conducted are only an introduction to defining requirements for the video registers. The next stage of the tests is conducting, by a group

of experts, an evaluation of the pictures' quality, according to the procedures recommended by ITU (International Telecommunication Union). Pictures obtained will be used for defining a minimal quality, using automatic assessment method („objective").

References

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