Influence of changing the parameters of the camera system on video-based motion detection

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***Abstract*— Intruder detection in a protected zone can be performed by the physical protection which acts within the object's perimeter and survey's it (patrols, monitoring screens of CCTV systems, etc.), but intruder detection can be also done using active protection elements. Active protection elements include alarm systems (electronic safety and distress alarm systems, CCTV security systems, system for control and management of inputs, portable alarm systems). These can be subdivided based on the area in which these elements detect the intruder into following categories: ones which detect the intruder at a certain point (such as object protection systems), at a certain level, where the intruder must cross a boundary between zones on his way through the detection zone (e.g. perimeter protection systems) and in area when crossing the detection zone (e.g. area protection systems). The development of camera systems allowed for introduction of additional functions, such as automatic intruder detection within the protected zone. Using a single protective element (within a camera system) it is theoretically possible to perform various functions – motion detection, survey and check and analysis of events (security incidents). In electronic security systems, an alarm has to be verified using at least two detectors, a camera system or physical protection. That's why CCTV camera systems are currently a very interesting and often utilizes way of securing an object. The article describes part of the research focused on finding out the probability of intruder detection in a protected zone. The authors focused on the influence of changes in parameters of the camera system on the video-based detection abilities. The article cites results of experimental testing which aimed to verify whether the changes in camera system parameters influences the motion detection success rate. This experiment also confirms information provided by a questionnaire survey performed among manufacturers of security camera systems. The experimental tests performed took into account the requirements placed on them by European technical norms.**

Keywords*— *active protection, alarm system, camera system, CCTV, development, experiment, motion detection, video

I. INTRODUCTION

Many algorithms are used for motion detection in a CCTV system. Their aim is to define movement in the surveilled zone. Algorithms evaluate data which were acquired by processing visual information into a mathematical format. In general, there are two approaches to detecting movement in a picture:

- temporal/frame differences, where two consecutive frames are compared,
- background subtraction, where the scenes are compared with the pre-loaded reference values which are regularly updated [1] [2]

Apart from this, the principle of the individual algorithms' inner workings may differ in whether they use full-color or greyscale image, in how the process data from the image, etc.

There are many algorithms in existence that can identify movement within an image. The question, however, is how they manage to work in different conditions of capture and what can influence their functioning [3] [4]. When evaluation security systems of objects, it is necessary to know, what parameters may influence their performance.

As part of the research focused on this area, one part of this article is dedicated to finding out if a change in the CCTV system's settings, such as framerate or resolution, influence the motion detection capabilities. Since there are many devices and algorithms used, there is some possibility that video of varying quality is used for motion detection. This video quality can, but does not necessarily, differ from the video quality that the camera is able to provide. To find out what data do the camera systems work with, we decided to utilize two approaches. One of them was a survey among CCTV system manufacturers. It asked questions aiming to find out:

- how is the video-based motion detection performed in the CCTV systems of different manufacturers,
- whether is it possible, that a change in system parameters, such as framerate or resolution, can cause a change in the CCTV system's motion detection ability.

The questionnaire resulted in the following findings regarding the video analysis:

- video of maximum quality that the system is able to provided is used,
- video of currently set parameters is used,
- metadata (sub-stream) with somewhat lower picture quality is used; this video is captured in parallel and is independent of any CCTV system settings. This video is used for motion detection and any changes in the system's settings have no effect on its success rate.

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Following the questionnaire, we tried to confirm through experiment if changes in parameters of the camera system can influence the motion detection capabilities. In these experiments, we focused on changes in the parameters of:

- framerate (fps),
- resolution.

These parameters can be altered for many reasons, which are a combination of customers' requests and limitations of the utilized technology. Parameters can be limited by using a recording device, which at full capacity of its channels can't process all of them in highest quality. This means either the resolution of the video or its framerate has to be decreased. The European technical norm 62676-4 states the recommended video quality based on the position and activity expected of the system and this in turn depends on the maximum framerate that the camera can provide.

II. The Experiment Process

The experiments were performed in compliance with the technical norms for CCTV security systems (62676-4) and with the requirements for transmissions (62676-1-2). A person walking at a normal pace served as a testing target.

The experiments were carried out in a way that allows for comparison of individual results. The camera surveilled a constantly lit environment, which did not contain any distracting elements. The test target repeatedly carried out the same movements in the same distance to the camera and fit into 100% of the camera image's height. This eliminated the possibility, that a change in camera's resolution might influence the resolution attributed to the moving object. Each test consisted of 100 repetitions.

First, tests in the highest resolution possible provided by the camera were carried out. Subsequently, the same tests were performed at a lowered resolution. At the same time, tests were carried out at 4 different framerates. When performing tests, the framerate was gradually lowered in decrements of 5 (15, 10, 5, 1). Framerate higher than 15 would very likely have no influence on improving the detection abilities of the system. This value provides a sufficiently smooth picture. At the same time, the norms for surveillance systems do not require a higher framerate for motion detection application. We chose the decrements by 5 because even if the system framerate is set at a certain value, in reality, the value fluctuates. On top of that, a small change in framerate in individual tests would not cause any change (provided the framerate influences detection) that would be observable.

Tests were conducted at different levels of sensitivity settings for video motion detection in individual devices. If the test setting of this sensitivity showed cases where motion within the image was not detected and there were no false positives, the highest possible sensitivity setting was used. In other cases, the sensitivity was set so that it would be possible to conduct some movement at highest resolution and framerate of 15 fps with some portion of movement going undetected. The sensitivity of video detection was not changed in the course of testing a single device. After the sensitivity was set, only aforementioned parameters (resolution and framerate) were changed.

III. Results of Experiments

Nine cameras from five different surveillance systems manufacturers and one video management software were used in this experiment.

In testing camera no.1, 4 framerate settings were used. The results show that a changes in framerate and resolution do influence the results of detection. The camera was best at detecting motion when it was set for the highest resolution it was able to provide. In general, with all resolutions used, the best detection capabilities were shown at highest possible framerate (15 fps). Based on the results obtained, it cannot be said that lowering resolution or framerate automatically results in detection abilities of the camera. However it is observable, that the detection success rate changes with framerate and resolution.

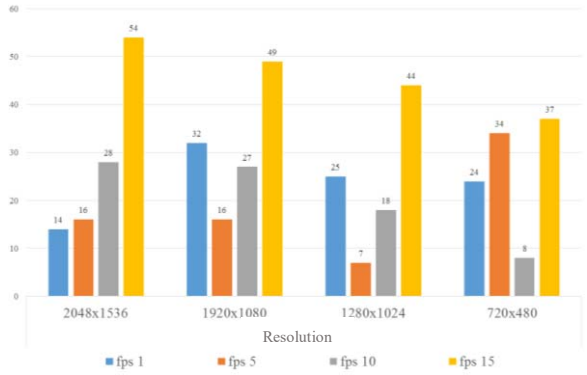

Fig. 1 Motion detection success rate by camera no.1 at different resolutions and framerates

Three resolution levels were used in testing camera no.2. These tests also showed changes in motion detection when resolution or framerate was changes large enough to show, that changing the parameters does influence the camera's abilities to detect motion. As in the previous case, the detection success rate was higher at higher framerates.

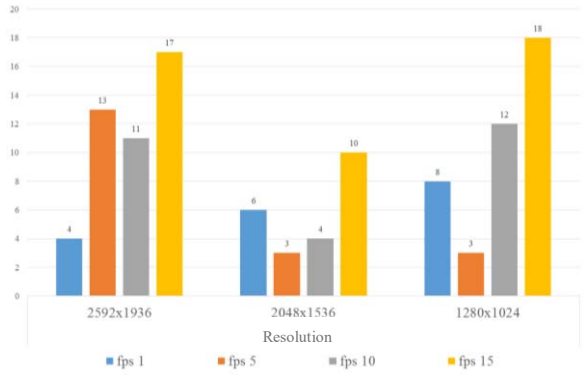

Fig. 2 Motion detection success rate by camera no.2 at different resolutions and framerates

When testing the success rate of camera no.3 motion detection, similar values were obtained when changing framerate and resolution (see Figure 3). The changes observed after changing parameters were not significant. The changes occurred after a change in framerate at higher resolutions, where the success rate declined slightly. The changes are however not

significant enough to state that they were caused by changing any given parameter.

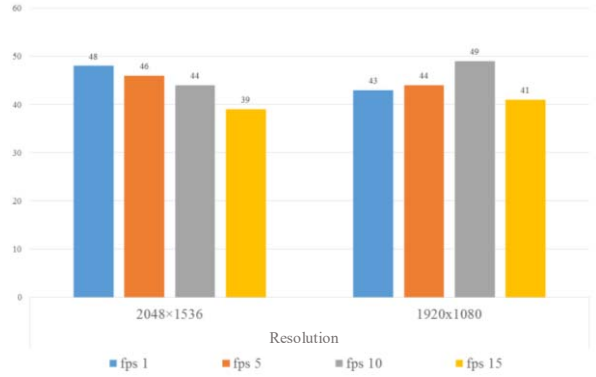

Fig. 3 Motion detection success rate by camera no.3 at different resolutions and framerates

When testing the fourth camera, similar results were obtained as with the third one, by the same manufacturer. The results chart (Figure 4), showing the success rate of motion detection of this camera, shows that most changes occurred with the change in framerate. They were not significant and did not have rising or declining tendency, so once again, we cannot conclude that the change in parameters has significant influence on the results.

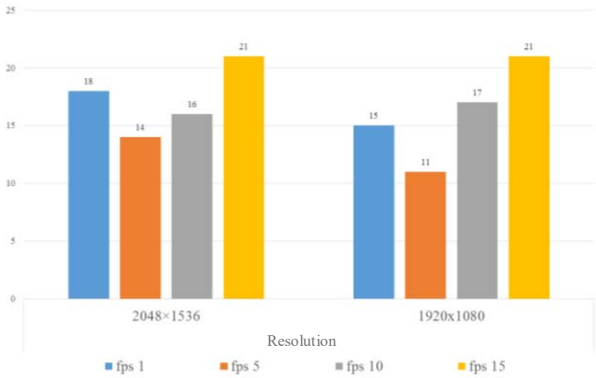

Fig. 4 Motion detection success rate by camera no.4 at different resolutions and framerates

Testing the fifth camera resulted in similar conclusions as cameras 3 and 4, which were made by the same manufacturer. Figure 5 shows that changes were small and irregular, therefore again in this case, it cannot be conclusively stated that a change in parameters influences the camera's detection ability.

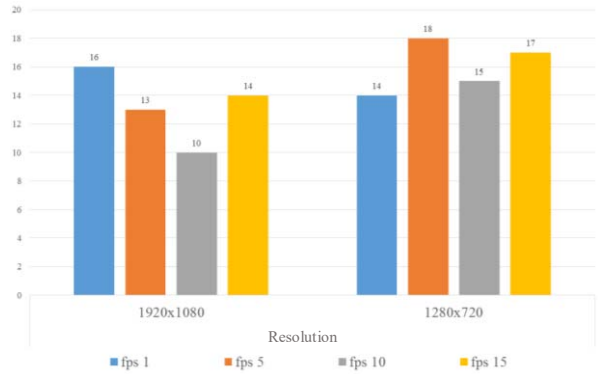

Fig. 5 Motion detection success rate by camera no.5 at different resolutions and framerates

Next up, cameras 6 and 7 were tested, both from the same manufacturer. One camera has the maximum resolution of 3 megapixels, the other 2 megapixels. Two resolutions were selected for each camera. The results of the testing are shown in Figures 6 and 7. In both cases, the changes in resolution and framerate had no effect on the results, meaning they do not influence the detection capabilities.

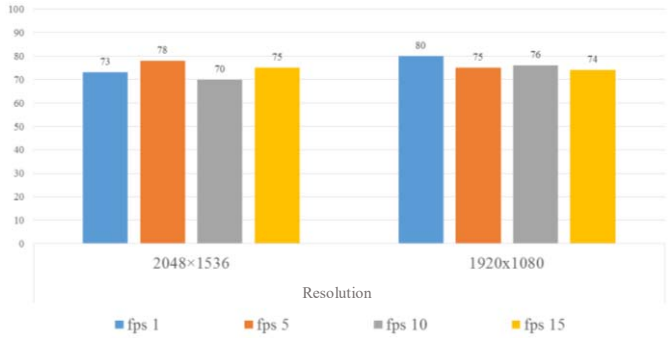

Fig. 6 Motion detection success rate by camera no.6 at different resolutions and framerates

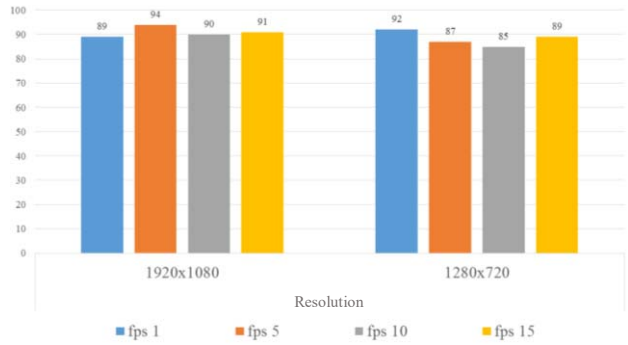

Fig. 7 Motion detection success rate by camera no.7 at different resolutions and framerates

Camera no.8 has the maximum resolution of 2 megapixels. Apart from this resolution, a lower HD resolution was used as well. There were no changes to the detection capabilities when altering settings significant enough to show a correlation. Specific results are shown on Figure 8.

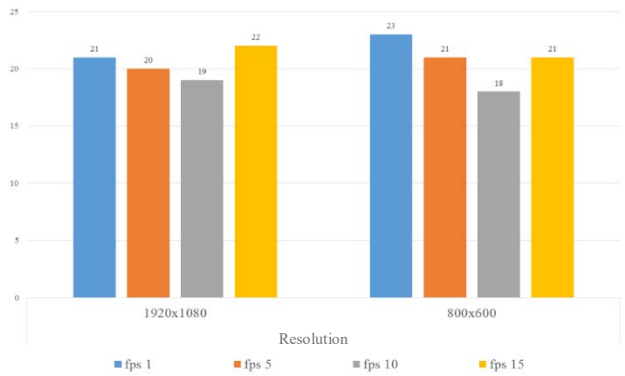

Fig. 8 Motion detection success rate by camera no.8 at different resolutions and framerates

Finally, camera no.9 had the resolution of 1.3 megapixels. It allowed for 3 different resolutions. The changes in success rate of motion detection were irregular and on a small scale, therefore we can infer from this that they were not caused by the change in settings. Results of the tests are shown on Figure 9.

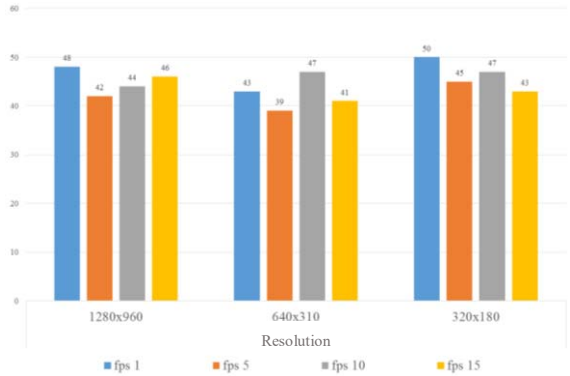

Fig. 9 Motion detection success rate by camera no.9 at different resolutions and framerates

During these video management tests, the highest resolutions of the cameras were used. Cameras had resolutions of 1.3 megapixels, 2 megapixels and 3 megapixels. All cameras had the same video detection settings in the VMS. The results of these tests are shown on figure 10.

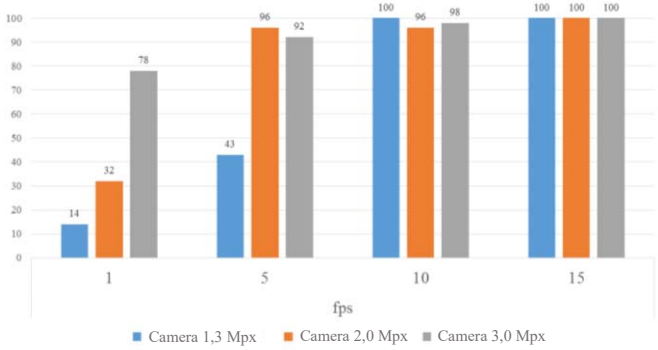

Fig. 10 Success rate in detecting motion within the VMS, using different cameras and framerates

As can be seen in this case, both framerate and the type of camera, i.e. the resolution, influences the motion detection success rate. The results show that the detection capability of the VMS has a rising tendency with the increased framerate. The changes in success rate also occur when using different cameras. However, it cannot be stated conclusively, that changes in resolution has influence on the motion detection. This can be explained by how the systems work – the changes in motion detection success rate can be attributed to not just the resolution, but the way the camera communicates with the VMS.

IV. Conlusion

The results of these tests who, that it is not possible to rule out the possibility, that changes in parameters, such as framerate or resolution, will influence the detection capabilities of any surveillance system. It can be observed that systems work differently. Most of the systems compared showed sighs that they use data for motion detection which are not influenced by current settings of the system. It is very likely that these systems have a dedicated video stream used for analysis (such as video-based motion detection).

Differences in motion detection success rates between individual devices are caused by non-uniform sensitivity settings for motion detection. However, these changes have no influence on the tested data, because the changes would show in both lower and higher success rates.

Results obtained from this experiment confirmed the results obtained from the survey of the manufacturers of surveillance systems. Based on this, it can be concluded that changing the parameters of the surveillance system can influence its video detection capabilities. Video motion detection in surveillance systems works in various ways. The system may:

- evaluate current system settings and work with the image acquired in quality based on current settings; in such cases, the change in some parameters may influence motion detection,
- always work with an image of maximum quality or a separate image of lower quality; in such cases, motion detection is not influenced by the system settings.

It is possible to conclude that the changes of the system may influence video detection, but this is dependent on what system is used. It is therefore crucial to take this fact into account when designing and setting up surveillance systems in real settings. Individual integrators should know the devices they work with, their capabilities and limitations. This fact should also be included in technical norms aimed at this field and prevent incorrect functioning of the systems.

Acknowledgment *(Heading 5)*

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References

[1] LOVEČEK, T. VEĽAS, A. ĎUROVEC, M. 2015. *Bezpečnostné systémy: poplachové systémy.* ŽILINA: EDIS. 2015, ISBN: 978-80-554-1144-6

[2] LOVEČEK, T. RISTVEJ, J. RISKA, T. 2013. *Application of research laboratories of the university science park in research of crisis*

management and protection of critical infrastructure facilities in the transport sector. ŽILINA: EDIS. 2013. ISSN: 1898-4509

[3] CAPUTO, C. A., 2014. *Digital Video Surveillance and Security*. Second edition Oxford: Elsevier. ISBN 978 0-12-420042-5

[4] NILSON, F. (2009) *Intelligent Network Video, Understanding Modern Video Surveillance Systems*, CRC Press Taylor & Francis Group, LLC, chapter 7, 145 s. ISBN 978-1-4200-6156-7

[5] STN EN 62676-4, 2015 Obrazové sledovacie systémy na používanie v bezpečnostných aplikáciách. Časť 4: Pokyny na používanie

[6] STN EN 62676-1-2, 2014 Obrazové sledovacie systémy na používanie v bezpečnostných aplikáciách. Časť 1-2: Obrazový prenos. Všeobecné požiadavky na obrazový prenos