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Real-Time Security Application to Identify the Distance and Size of an Object with CCD Camera

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Abstract: **Security cameras become more widespread each day. These are monitored via image processing techniques. Image processing techniques yield better results if the distance of an object is known. This study develops an algorithm to identify the distance and size of an object and, in this respect, empirical studies were conducted. Images obtained from two security cameras were processed and the distance and size of the object was measured.**

Keywords: **Image Processing, Alarm systems, Security.**

I. INTRODUCTION

Image processing is usually used to identify and analyse an object in security applications. Real-time images are examined and evaluated instantly. Security systems increase an individual's and the society's ability and capacity to protect themselves against threats. Thanks to the developments in technology, human-based security systems are replaced by technological security systems [1]. Security systems comprise a number of interacting elements: sensors placed at different locations to be monitored, monitoring units where data from these sensors are collected and evaluated and warning elements controlled by monitoring units [2-3].

Although security cameras are commonly used today, a person which constantly monitors and evaluates them does not often exist. New systems are needed in order to process images in security cameras and take necessary precautions. It is quite important to process images obtained from observation cameras in border police stations, traffic cameras and those protecting individual spaces. A security camera which does not process images only records events. On the other hand, image processing enables to identify and prevent threats and suspicious events beforehand [4]. Various environmental factors such as low resolution, insufficient light and movements of the objects and variability of distance of an object, rain, fog and snow make image processing difficult [5]. Smart security cameras can automatically identify and analyse necessary information in recorded videos. Video monitoring applications are used in a wide spectrum. Smart security cameras are used in internal and external security, prevention of crimes in public and private areas, traffic control and prediction of accidents, tracking patients, monitoring the old and children, airports, train stations, roads, parking areas, stores, shopping malls and offices [6]. These systems attract more and more attention each day. A single camera may identify distance and image processing in a very limited way. However, smart security systems with multiple cameras are much more successful [7-9].

Security is a global question of social stability and economic development. Therefore, studies on the solutions to security problems are related to the whole humanity. These problems sometimes cause massive economic losses and endanger human life and national security [10]. Computer image applications have become more rapid in recent years. Smart monitoring systems, security, machinery view, robot- and automated-guided vehicle are even used in entertainment and

computer gaming sectors. Scale, complexity, activity, resolution and other disruptive effects make it difficult to obtain natural results. Multiple cameras help overcome these problems. However, this may cause a harmonization problem. There are some algorithms called camera skipping which enables harmonization and skipping from one camera to other. Thanks to these algorithms, images obtained from a camera can be evaluated more successfully.

Existing camera skipping algorithms may be divided into three groups: (I) feature-based (II) geometry-based and (III) hybrid based approaches [11]. In feature-based approaches, colour and other distinctive features of monitored objects are matched with images obtained from the camera [12-14]. Geometry-based approach can be categorized into three approaches as location-based, alignment-based and homograph-based. Location-based approaches are similar to the coordinate system. Alignment-based approaches compare an object with another object. Homograph based approaches calculate images which intersect in a two-dimensional platform. More than one approach is used in hybrid based approaches.

Movement identification algorithms are divided into three categories. These are different background methods, statistical methods and visual flow methods. In the present study, difference calculation method is used among different background methods in order to differences between two images as it is the method least affected by surrounding elements. This method suggests that calculation of absolute difference of sequential image frames is the most basic method to identify any potential movements in images with a motionless background [15]. In this method, colourful image frames obtained sequentially are converted to grey images in order to make image processing easier, which is performed via the following equation:

$$I = \frac{R + G + B}{3} \tag{1}$$

In this equation, (R) denotes the red component value, (G) green component value, (B) blue component value and (I) grey component value of the pixel in RGB image. Afterwards, it is identified whether absolute difference of sequential images in proportion to total number of pixels exceeded a certain threshold or not. This difference is calculated thanks to the following equation,

$$CF(T) = 1\frac{1}{wxh}\Sigma_{x=1}^{w}\Sigma_{y=1}^{h}\left|I_t(x,y) - I_{t-1}(x,y)\right| > E_1 \tag{2}$$

In this equation (ÇF) denotes average frame difference, (It) current frame, (It-1) previous frame, w horizontal pixel size of the image, (h) vertical pixel size, (x, y) location of the respective pixel and (E1) threshold value. Absolute value of differences between brightness values of (It) and (It-1) pictures belonging to an image located in any (x, y) location exceeds the determined threshold value, the image is defined as moving [16]. In this respect, active areas are obtained from the difference between clipped background and current picture. Threshold values statistically correspond to an important brightness difference. It is an empirically found value and identifies whether the difference between two pixels is caused by a movement [17]. It is aimed to increase or decrease identification sensitivity through changing this value [18-20]. In the present study, an image obtained from two cameras were processed an algorithm of distance and square calculation was developed. In addition, thanks to the equipment, the system can alarm, flash its lights and be turned on and off by a remote controller as well.

II. SMART SECURITY SYSTEM

The software needed for the smart security system shown in Fig. 1 was developed via Delphi. The system is controlled by a computer. The system prototype consists of two cameras. The image taken from cameras is processed and the system alarms and sends an e-mail in case of any danger based on security settings adjusted by the user. In addition, projector is also controlled based on these settings. The system can be controlled via a remote controller, too.

The system aims to constantly protect a certain area. Images obtained from security cameras are always scanned and the system warns the user when any dangerous image is identified. Two pieces of IP cameras were used in the application programme. The resolution of each camera is 640x480, which requires monitoring a total of 614400 pixels. This will cause a slowdown in scanning. Since the system operates real-time, it is necessary to scan images immediately. In order to eliminate this problem, monitoring is performed for each 16 pixels, which reduces the number of pixels to be monitored to 2400 pixels. In other words, scanning speed increases by 256 folds. As a result, the height and width of an object can be

identified. Because distances are known beforehand, it is possible for application programme to calculate the real size of an object.

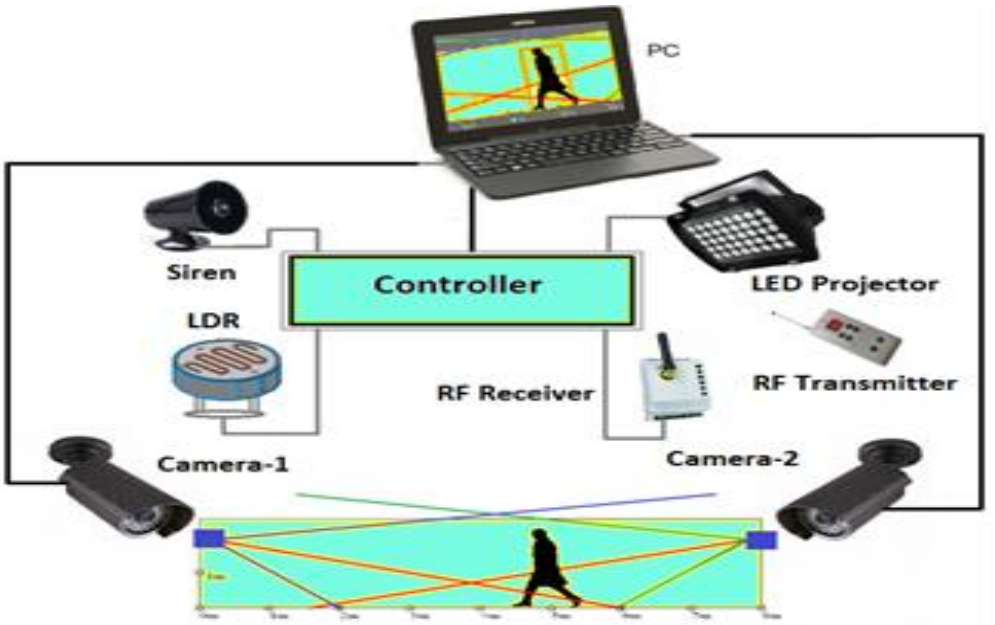

Fig. 1. Smart Security System

III. FINDINGS AND DISCUSSION

In Fig. 2, a moving object is seen and its location and size are identified. The system yielded quite successful results when tested at different speeds and circumstances. As the application is always monitored by the computer, identified object can be correctly classified. Application circuit is controlled by a micro-controller integrated with the application programme. The system alarms the user if alarm system is activated and PC signals an object at a dangerous size in the protected area. Furthermore, illuminating system is activated or deactivated based on the signal sent by PC. Thanks to the remote controller, the user can activate or deactivate alarm system, scanning or illuminating manually. These three settings can also be adjusted as default.

In the application circuit, PC and USB protocol interacts. Alarm system, illuminating system and indicators are controlled via PIC18F4550 micro controller. RF signals sent by the remote controller are decoded by PIC16F628 Micro controller and reported to PIC18F4550 micro controller. LDR sensor monitors the brightness in the related area.

The indicator in the application circuit consists of LEDs which gives information about activation or deactivation of alarm system, scanning, illuminating, current status of default settings and signals from the remote controller. All of these enable the user to monitor the whole system

Results obtained from the application are shown in Table 1. It is possible to identify the distance and size of an object thanks to this software. Images taken from two cameras were processed and distance and size of moving objects were identified. The child in A-1 is measured to be 364 cm away and 129 cm tall as shown in Fig. 2.

TABLE I. MEASUREMENT RESULTS

	Distance	**Height**	**Status**
A-1	364 cm	129 cm	There are movements
A-2	315 cm	125 cm	There are movements
B-1	370 cm	168 cm	There are movements
B-2	299 cm	169 cm	There are movements
C-1	282 cm	147 cm	There are movements
C-2	392 cm	136 cm	There are movements
D-1	364 cm	129 cm	There are movements
D-2	392 cm	136 cm	There are movements

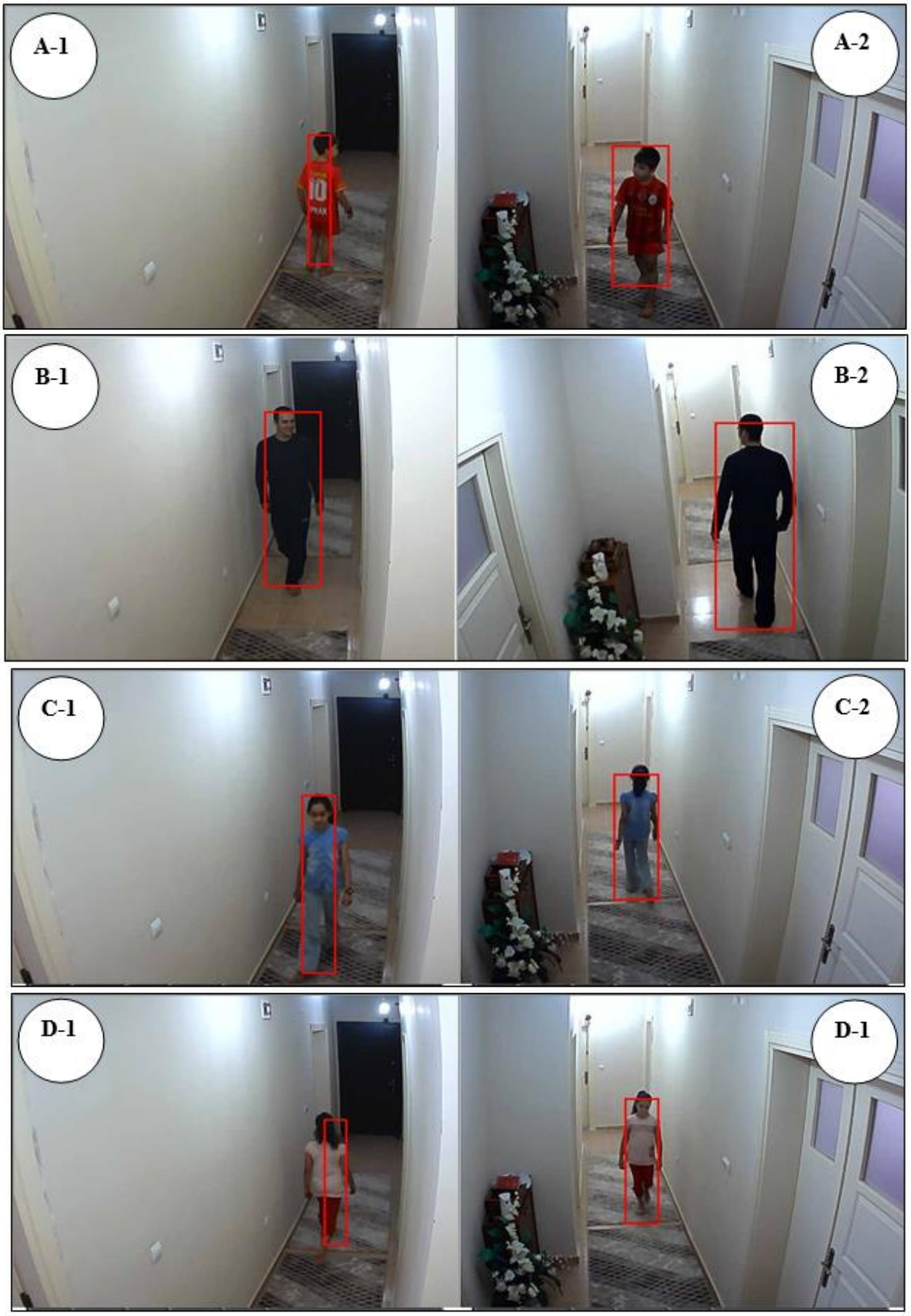

Fig. 2. Identifying the size and location of an object

IV. CONCLUSION

This study demonstrates that computer-assisted image processing in smart security systems can yield more sensitive, rapid, uninterrupted and reliable results. In the present study, distance and identification of an object in the protected area was performed thanks to image processing techniques. Contrary to previous studies, Delphi programming language was used for the algorithms in the software instead of other instant systems. Moreover, an algorithm for distance measurement was developed through simultaneously evaluating images taken from two IP cameras. The system was tested and successful results were obtained.

This study is prototype and number of cameras can be increased. Security problems may be eliminated when images taken from security cameras are evaluated and used rapidly.

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