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People Identification Based on Person Image and Additional Physical Parameters Comparison

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Abstract **– This paper proposes and presents one approach for people identification based on image and additional physical parameters, height and step length, of a person comparison. People identification is very important in many areas of human life. There are large number of identification methods (biometric methods) that include a different scope of methods, for example fingerprint identification, hand geometry identification, facial recognition, methods based on human eye identification (retina and iris), gait recognition etc. Most of that methods require some kind of interaction with a person, what could be a problem in many practical applications. The method that does not require any interaction with a person is gait recognition. One approach for a people identification based on gait recognition, that uses silhouettes of a person and parameters of person height and step length, is proposed and presented in this paper.**

Keywords **– People identification, Gait recognition, Biometric methods, Person height, Person step length.**

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1. Introduction

People identification is very important in many situations and practical applications. That task is performed in different areas of human life and there are different such applications, for example from identification on airports and border crossings, to the banks and other institution which require a high level of people identification security. For such purposes, different identification and recognition methods are used. Some of such methods are for example retina scanning and iris recognition, fingerprint identification, face recognition, voice recognition etc. Most of these methods require some kind of interaction with a person, what could be problem or impossible in many situations and applications.

One way of person identification that does not require any interaction with a person is gait recognition. Previous research in this specific area (gait recognition) usually uses analysis of video from classic RGB cameras. Beside classic RGB cameras, also often is used the Kinect sensor from Microsoft and Asus Xtion that provide depth information. Kinect sensor is very popular in academic community and many projects are based on Kinect application. The main reason for that is the low price and technology that it uses. Microsoft also provides SDK (Software Development Kit) for Kinect sensor. Lack of Kinect use is its range, which is small, below 5-6m.

Gait recognition techniques include model based and appearance based techniques. Model based techniques use explicit models and some body information of a person, e.g. skeleton information. Appearance based techniques usually use extracted human silhouettes.

There are many papers that use some of the above mentioned techniques (model or appearance based) for people identification, re-identification etc. Re-identification of a person is also interesting domain.

It can be divided in short-term and long-term re-identification. Short-term is a type of re-identification where people wear same clothes from last identification. Long-term re-identification uses features which are more lasting.

Also, in the so far presented papers, authors used only RGB data, both RGB and depth data, only depth data, in indoor or outdoor environment. The data were obtained with different type of sensor. Barbosa et al. [1] used a RGB – D sensors for a people re-identification. They presented a set of 3D soft-biometric cues being insensitive to appearance variations gained using a RGB – D technology. Choi et al. [2] detect and track people using RGB – D camera via multiple detector fusion. Munaro and Menegatti [3] presented fast multi-people tracking algorithm designed to be applied on mobile service robots. Their approach exploits a RGB – D data. Møgelmose et al. [4] in their paper combine use of RGB, depth and thermal data for re-identification. Satta et al. [5] focused on people re-identification in real time based on appearance using multiple Kinect sensors. Lorenzo – Navarro et al. [6] investigated a problem of re-identification with RGB – D cameras. Munaro et al. [7] presented in their paper a comparison between two techniques for re-identification from soft biometric cues. Møgelmose et al. [8] also investigated people re-identification with RGB – D sensors. Munaro et al. [9] presented a new methodology for re-identification based on skeletal information. One important paper in gait recognition is from Han and Bhanu that is often a base for other papers [10]. They presented and proposed a new spatio-temporal gait representation, called Gait Energy Image (GEI) to characterize human walking properties. Sivapalan et al. [11] extended GEI to 3D and presented GEV (Gait Energy Volume). Hofmann et al. [12] also extended GEI with depth information. They formulate a new feature called Depth Gradient Histogram Energy Image (DGHEI). Borràs et al. [13] presented a DGait. DGait is a gait database acquired with a depth camera. Lu et al. [14] worked on the problem of human identity and gender recognition from gait sequences with arbitrary walking directions. Chattopadhyay et al. [15] investigated the applicability of Kinect RGB – D streams in recognizing gait patterns of individuals. They formulated a new feature called Pose Depth Volume (PDV). Arora and Srivastava [16] proposed a Gait Gaussian Image (GGI) (new spatio – temporal based method for human gait recognition). Nambiar et al. [17] explored a frontal gait recognition with 2D and 3D data. Iwashita et al. [18] proposed a method where the image of human body is divided in multiple areas. Then features are extracted for each area. Authors in paper [19] presented BGEI (Backfilled GEI) feature. In papers [20] [21], [22], [23], [24], [25] skeleton information is used for gait recognition.

This paper is organized as follows. Section two is divided in two subsections and describes proposed solution. The first subsection describes a process of images and parameters creation for the purpose of identification. The second subsection describes process of identification. Section three contains concluding remarks.

2. Proposed solution

Proposed algorithm for people gait recognition is divided in several parts. In the first step it is necessary to extract the silhouette of a person. These silhouettes are used for parameters obtaining and in process of identification. Using silhouettes, it is possible to identify people regardless of the appearance context, and this way is convenient for longer lasting identification. After silhouettes are obtained, parameters of a person can be also obtained. Finally, the process of identification can be performed. Here are described the process of images and parameters creating and the process of identification.

2.1. Creating images and parameters of a person for identification process

This part of proposed algorithm implies creating images and parameters for each person for its use in the process of identification. Creating images and parameters is required for each person. Images and these parameters are part of dataset for a person. For each person in dataset, the following elements are created:

- Gait cycle for each person in single image,
- Gait cycle for each person in single image where is visible the height of a person and the step length of a person,
- Text file which contains average height and step length of a person during a gait cycle.

This algorithm works in the following way. When the algorithm is started, first it is necessary to select folder which contains images with silhouettes of a person. For each person exists a folder with images and with silhouettes of a person during a gait cycle. These silhouettes are extracted from the video (for each frame) which contains a person in gait. Then it is necessary to insert number of silhouette images which will be used for creation of single image with gait cycle. For example, if four images were defined, single image for identification is composed from those fours images. When mentioned number of images is entered, the folder with images opens, and it is necessary to select the first image, then the next etc., up to the end (e.g. four images). This is illustrated in Fig. 1.

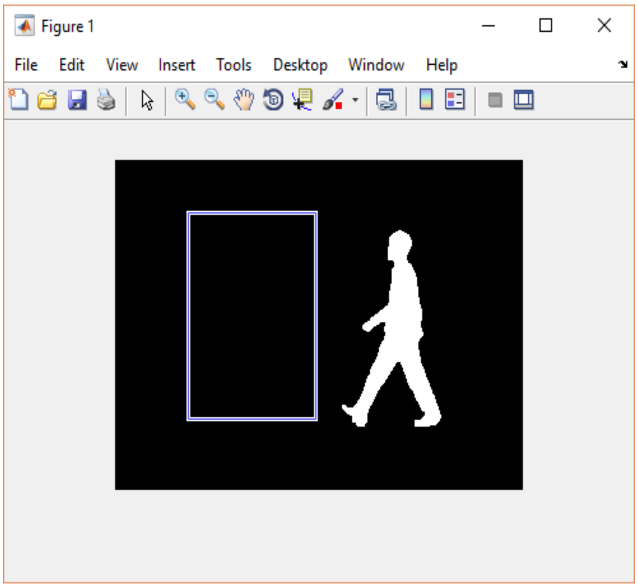

Figure 1. Selected image for parameters definition

The purpose of the rectangle in the Figure 1. is to completely select only the part that contains the silhouette of the person. It is necessary to apply a rectangle that is adapted to the size of the person's silhouette on the silhouette part and then double click. It also can be done automatically and in this case, the center of the person is detected and around the person a rectangle is drawn. Also, images can be selected randomly from dataset for specific person. In this case it is performed manually because better gait cycle can be obtained in such a way. This is illustrated in Fig. 2.

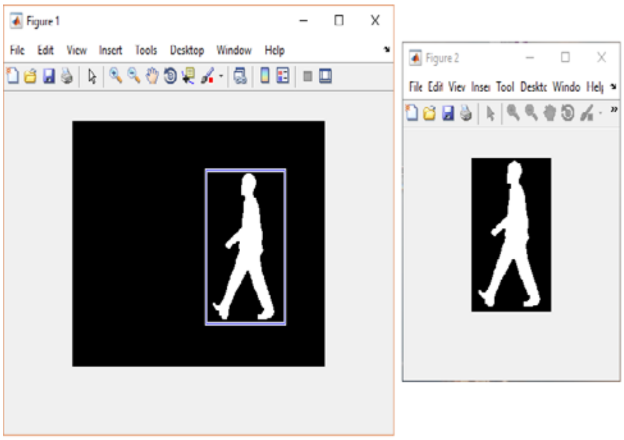

Figure 2. Cutting a section that contains only a person silhouette

In the smaller image (Fig. 2,) it is necessary to note points that will define a height of a person and step length of a person. That also can be done automatically. It is shown in Fig. 3.

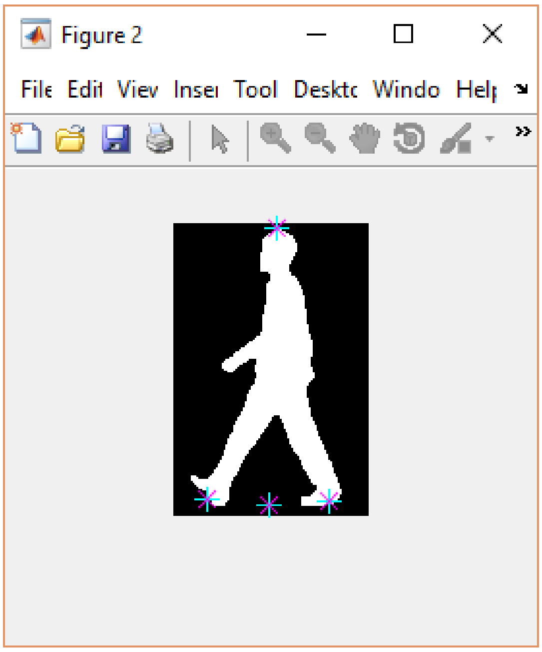

Figure 3. Silhouette of a person with defined points

The order of defining the points is head, left side, right side and middle between the left and the right point. After defined points, the lines with lengths (person height and person step length) are drawn, as it is shown in Fig. 4.

This process needs to be repeated for each image defined with inserted number. When all parameters are defined in all images, the selected images are saved in the form of single image that makes the entire cycle of walking. Two images are saved, one containing only a person in gait without parameters (Fig. 5.) and one containing a walking cycle along with the parameters (Fig. 6.).

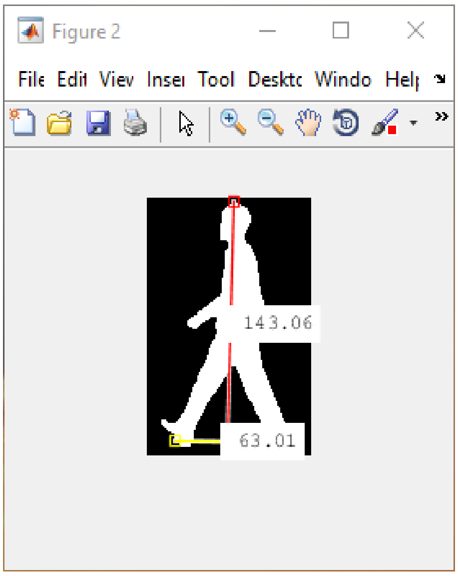

Figure 4. Silhouette of a person with calculated height and step length

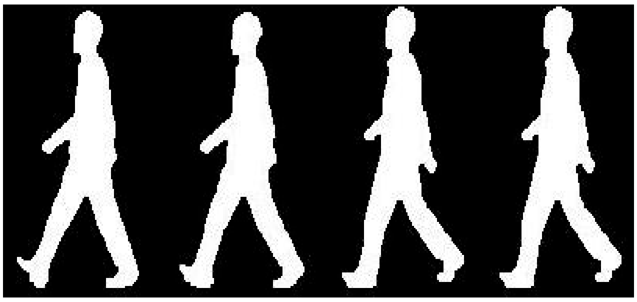

Figure 5. Image that contains a person gait cycle

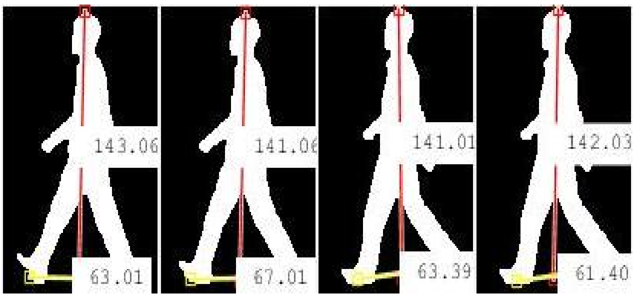

Figure 6. Image that contains a person gait cycle with parameters (height and step length)

When selecting images, it is important to take care of selecting the images that best describe the person's gait cycle. Along with the mentioned images (Fig. 5. and Fig. 6.), also text files with information about person height and step length are saved. These text files contain information about height and step length obtained from selected images and also average height and step length during a gait cycle. All this is illustrated in Fig. 7., Fig. 8., Fig. 9. and Fig.10.

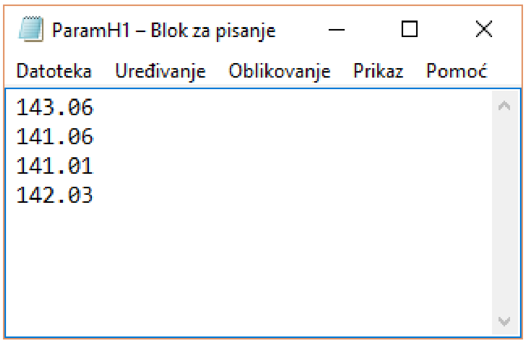

Figure 7. Height of a person obtained from selected images

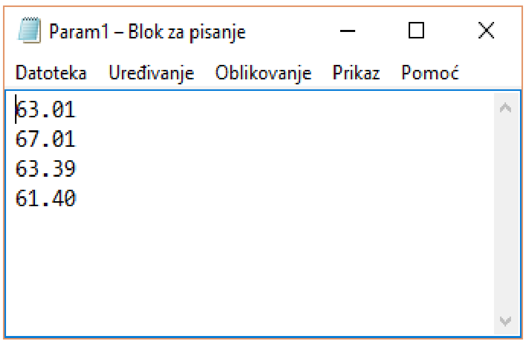

Figure 8. Step length of a person obtained from selected images

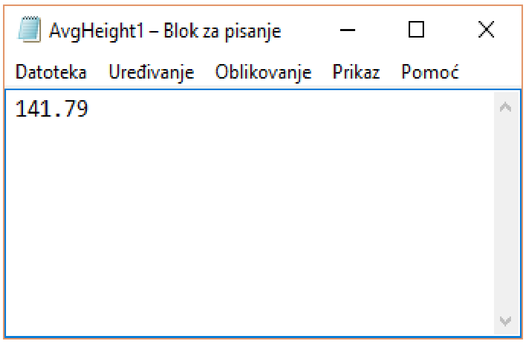

Figure 9. Average height of a person during a gait cycle

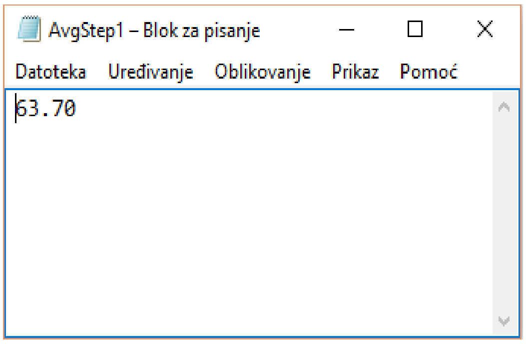

Figure 10. Average step length of a person during a gait cycle

It should also be noted that here it is not about the actual height and step length of the person because it is done on 2D images. If depth images are available, it is possible to calculate real height and step length of a person, as it is shown in Fig. 11. In this case, when real height and step length of a person are needed, different calculations are required.

Figure 11. Real height and step length of a person obtained from depth image

2.2. Process of identification

Process of person identification is defined through several steps and includes comparison of images and parameters of a person which is to be identified with those in dataset. These steps include the following:

- Person identification based on silhouette,
- Person identification based on image which contains gait cycle,
- Person identification based on image which contains gait cycle and gait parameters,
- Person identification based on average height and step length,
- Final identification based on results of previous steps.

Person identification based on person silhouette is the first step of identification. It is a comparison of silhouette of a person which is to be identified with those stored in dataset. It is necessary to load a video from which silhouettes of a person can be extracted or in temporary folder place images that contain silhouettes for comparison with images stored in dataset. Also, in real time, from a sensor can be extracted silhouettes. For every person there are folders that contain images with silhouettes, image with gait cycle, image with gait cycle and parameters and text files with information about person height and step length. This is the dataset and contains all that information about person for identification. If the video is loaded, the algorithm will cut images that contain only person silhouettes and place them in a temporary folder. But, it is also possible to easily copy the already defined person silhouettes and manually place them in a temporary folder. Once this action was done (when silhouettes are available), it is necessary to select one image from the temporary folder. This is illustrated in Fig.12.

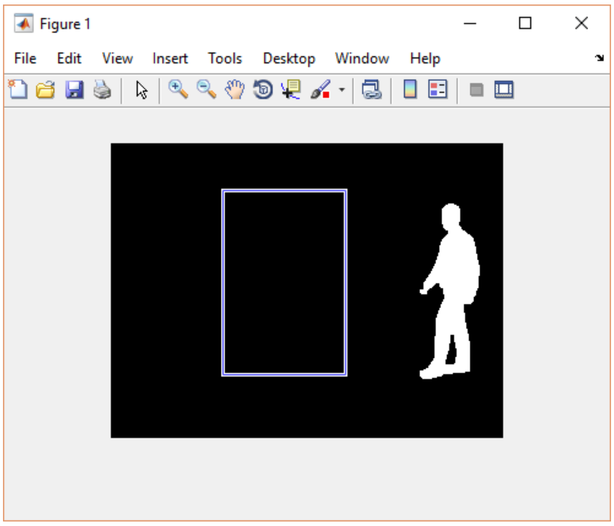

Figure 12. Silhouette of a person for comparison with silhouettes in dataset

When a silhouette shown in Fig. 12. is cut (as is shown in Fig. 2.), then it is compared with silhouettes in the dataset. Normalized cross correlations are used for this task [26] [27] [28]. To realize the normalized cross correlations, *normxcorr2* command in Matlab is used. It should be mentioned that this algorithm was developed in Matlab. This used method is suitable for application when template matching is implemented, what is in this case performed, because the silhouette is compared with silhouettes in the dataset. After this, the algorithm will conclude and give information which of the persons was identified in this step.

Next step performs sampling, i.e. choosing images for creating single image with gait cycle, as was shown in Fig. 5. This is performed automatically, but it can also be done manually. Only difference is that in this case images that will be created are for identification (not for dataset) and are used for comparison with images in the dataset. In the same way an image with the parameters of person height and step lent is created. Two methods are used for comparison of these two images with dataset images. These two methods are the PSNR (Peak signal-to-noise ratio) and the SSIM (Structural Similarity). Both methods fall into objective methods for determining image quality and are used in this case to compare the similarity between the two images. The SSIM index is 1 for identical images, which means it ranges from 0 to 1. For the PSNR, it is 100 for identical images and is measured in dB. Through these two steps, information about identified person for each of these two methods is obtained. After these steps, average height and step length of person are calculated and compared with those in the dataset. Also, information about the identified person in this step is obtained.

When all the values (information about identified persons) through the previous steps are obtained, the algorithm makes final conclusion about identified person based on this information. The algorithm prints the final result and shows the name of a person and identification percentage of accuracy. This is illustrated in Fig. 13.

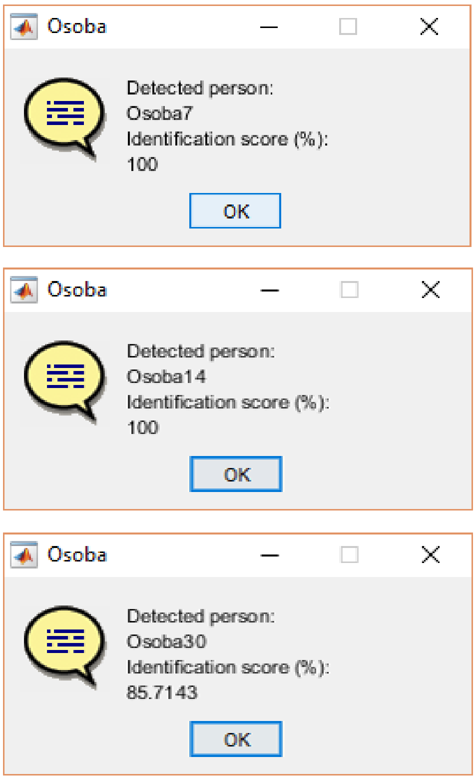

Figure 13. Identification results

In the identification process all that is needed for this process is stored in a temporary folder that was created for this purpose only. Images and documents that are created, placed and stored in the temporary folder are:

- Images of silhouettes cut off from the video or manually copied,
- Image of person silhouette for comparison with those in dataset,
- Image with person gait cycle,
- Image with person gait cycle and parameters,
- Auxiliary images based on which images with gait cycle and parameters are created,
- Text files with information about person height and step length.

After the process of identification is completed, the temporary folder and its content are removed by algorithm. It is re-created at the next identification process (for identification of some other person).

For research purposes, for proposed algorithm testing and its quality confirmation, silhouettes from Casia Dataset B were used [29] [30] [31].

3. Conclusion

This paper proposes and presents one way and method for people identification based on person gait recognition. People identification is very important in many areas of application and many papers were presented with topic of people identification. Certain identification methods require some kind of interaction with a person. Gait recognition is a method that can be used for identification without any interaction with a person.

The approach presented in this paper is very accurate since it is composed from several steps of identification. Also, the overall identification process is performed in reasonable time. It uses human silhouettes and additional parameters, height and step length, of a person. Human silhouette is extracted for a person and compared with those stored in dataset. Also, from the silhouettes is created an image that contains a gait cycle. That image is also compared with those stored in dataset. Besides that, one more image with additional parameters (person height and step length) is created and also compared. From the silhouette of a person are obtained height and step length that are used in the process of identification. It also could be used some other characteristics of a human body, such as the length of arms, legs, torso etc., with real values obtained from depth images. Because the presented approach has several steps, and is composed of several sub-identifications before final identification, it is very accurate.

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