Model-Based People Gait Recognition

[1]W. Kong, [1]A. Hussain, [3]H.B. Zaman, [2]M.H.M. Saad

[1]*Department of Electrical, Electronic & Systems Engineerin, Faculty of Engineering & Built Environment, UniversitiKebangsaan Malaysia, Malaysia.*
[2]*Department of Mechanical & Material Engineering,Faculty of Engineering & Built Environment, UniversitiKebangsaan Malaysia, Malaysia*
[3]*Department of Information Science,Faculty of Information Science and Technology,UniversitiKebangsaan Malaysia, Malaysia.*

A R T I C L E   I N F O

A B S T R A C T

Intelligent multi camera video surveillance is a novel research topic in recent years. Gait recognition is one of the concerns in video surveillance field. It is used to identify uniqueness of a target human in video sequences by the manner they walk in a natural way. Two approaches are available for gait recognition: Model based and Non-model based. The work addresses the important of model based gait recognition in video surveillance. To understand the human body movement, human body is represented by a model created based on the anthropometrical knowledge. The model is then tracked based on the previous value. Both static and dynamic gait features are extracted from the model for further gait analysis. In this paper we discussed the two methods (Euclidean distance based method and Anthropometrical based method) of creating human skeleton model with essential body points used in gait recognition. The study of human anthropometric allows us to improve the modeling. The two modeling techniques discussed here are able to locate lower limbs joints in most cases. However, the Anthropometrical based method demonstrates better result compared to Euclidean distance based with accuracy 85% which is very useful for gait recognition.

INTRODUCTION

Crime rates all over the world are on the rise. It has heightened the demand to ensure a free from danger environments for a liveable. Based on this reason, video surveillance is still a topic of great interest in research field. Video surveillance is a well known security tool. Ko (2008) defined video surveillance as a video camera based system used for the purpose of observing an area. It uses video to monitor activity behavior and detect abnormal or unwanted manner. There are many researches that have been carried out to develop an intelligent video system (IVSS) that is able to understand behavior (Saad, M.H.M., *et al.*, 2011).

In general, there are two different approaches for people recognition: Appearance based approach (ABA) and Gait based approach (GBA). Appearance based approach employs the features such as color information and characteristic of the clothes surface for identification. Unfortunately, there are some common issues that limit its usage. The ambient lighting affected the color of clothes and varies the color from time to time. In some cases, the similarity of clothing may causes false identification. To cope with these limitations, many studies have found out gait signatures identified from video can be used as a reliable biometric. Biometric is the automatic recognition of individual based on their physiological and behavioral characteristic (Jhapre, A.K. and J. Pal Singh, 2011) and it is unique to each individual and useful in identifying the identity of each individual. Identifying people by gait have many advantages over other method, since a person's gait can be easily recognized without the need to be in contact with the person and available at low resolution. In addition, person's gait remains unchanged when the lighting surrounding is inconsistent. GBA is preferable for people identification problem.

GBA can be divided into two categories: model based and non-model based. Model based aim to establish the model body components of manner people walk and then fit the real image data to the predefined model whereas the non-model is based on the feature of the motion of human bodies without modeling the human body or any part of body. Nearly all of the available approaches are based on single camera. In this work, we intend to construct multiple 2D models from the images acquired from multiple view cameras. The 2D models will be

Corresponding Author: Win Kong, Department of Electrical, Electronic & Systems Engineerin, Faculty of Engineering & Built Environment, UniversitiKebangsaan Malaysia, Malaysia.
tel: +6012-5993502, E-mail: kwin.ukm@gmail.com

tracked individually and next, they are combined with the additional camera calibration parameter to estimate a 3D model which can clearly be understood to handle the hidden information in 2D images. Static and dynamic gait features will be extracted for gait recognition. In real time, 2D model from single camera will be easily affected by varying viewpoints and occlusion. These issues have inspired us to apply multi-camera.

Experimental Procedure:
The overview method discussed in this paper is shown in Figure 1.
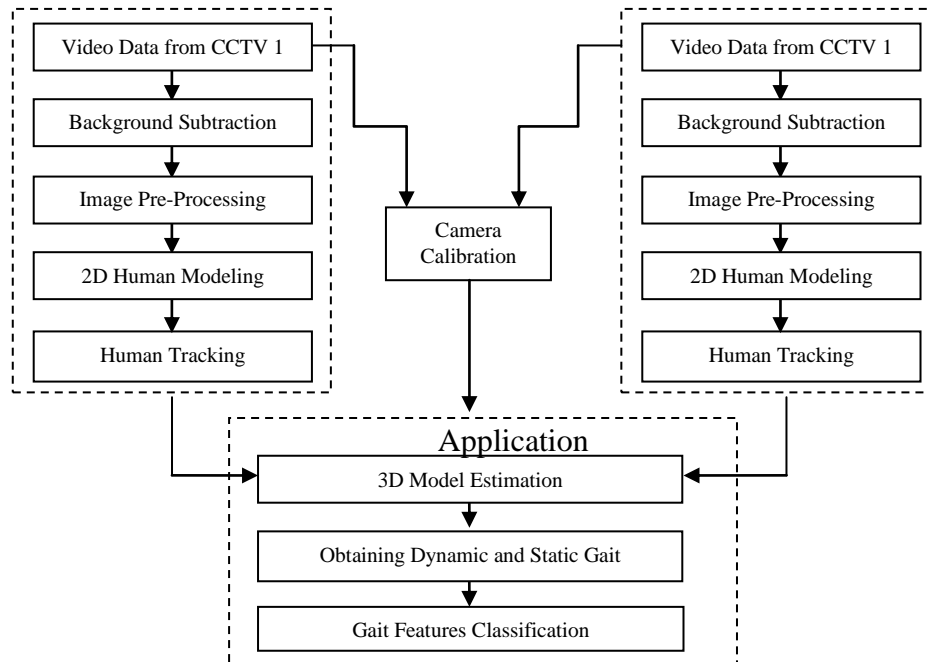
Fig. 1: Framework of the proposed method

The ability to perform moving targets extraction especially human from video data using a static camera is the first step in video surveillance. The performance of human model construction strongly relies on the quality of the human silhouette extracted from the segmentation (Bhanu, B. and J. Han, 2011). Assume that we have a set of silhouette raw data extracted from a static camera after performing background subtraction. Background subtraction is a process of extracting the target from an image. The existence of artifact images are hugely affects the feature point's extraction performance. Therefore, some pre-processing such as morphological operation must be done to augment the feature extraction completion. In this work, Canny edge detection method is used to obtain the silhouette edge. Bounding box is then created based on the blob labeling. From the bounding box, the height and width of the body of the body can be measured easily.

Selection of a model is crucial for tracking and classification as an error can result in wrong estimation. There are many existing way to represent human body (Guo, Y., *et al.*, 1994; Su, H., F. Huang, 2005; Cunado, D., *et al.*, 2003). The easiest method is using the stick figure based on the body silhouette. It can also be modeled as simple as points with connected sticks. In this paper, the challenging part is to identify the apparent gait features from the interconnected joint and the self-occlusion and inter-occlusion of body parts. To improve the modeling process, Kalman filter tracking method is used to track the model in each video frame. This tracking process estimate the current feature points based on previous feature points. In multi-camera network, two models are tracked individually in each camera.

Next, we construct a 3D model from the two 2D models from the respective cameras by reconstructing the 3D position of the feature point using the vanishing point calibration algorithm. Lastly, Gait signatures are obtained from the 3D model and used for further classification.

RESULT AND DISCUSSION

The algorithm discussed above is implemented in MATLAB. There are two main results which is vital to the success of the algorithm. The first is the constructed model based on the Euclidean distance edge profile construction. The binary silhouette segmented after background subtraction was preprocessed to minimize the unwanted edge. Centroid of silhouette is essential for this method. Euclidean distance between edge points and

centroid are computed to construct an edge profile. The head, legs and hands points were obtained by locating the maxima. Result for model one is shown in Figure 2.


| (a) | (b) | (c) | (d) |
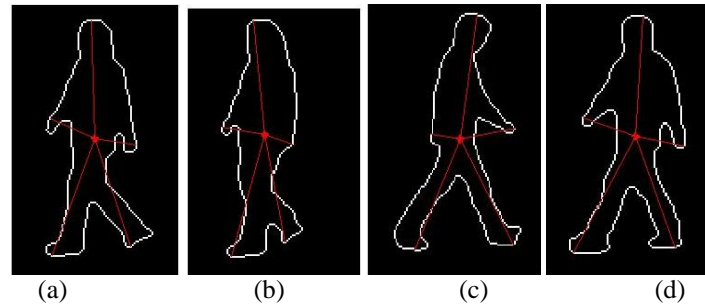
Fig. 2: Human body edge and Euclidean distance based model for (a) person 1, (b) person 2, (c) person3 and (d) person 4.

Ensuing, the second model is based on the anthropometric model and lower limbs self-overlapping detection. In general, anatomical knowledge is used to extract the body points. The body points are connected to form a skeleton model with 10 joints (head, neck, shoulder, hands, pelvis, knees and ankles). Result is shown in Figure 3.

Referring to Figure 2 and 3, it can be seen clearly that the anthropometrical based method shows better representation of the target's gait. It shows more stable result compared to the Euclidean distance based method. The Euclidean distance based method is limited only if human's hands are not occluded between each and wrong identification of legs arises due to the self-occlusion of silhouette. However, it is simple and less computational. The anthropometrical based method, on the other hand, works better since the self-occlusion detection approach is considered when modeling the silhouette.

Conclusion And Future Work:

This paper affords an improved method for gait recognition. The proposed method which used the binary silhouette and anthropometrical based model was found to be better descriptors for human object compared to the human body edge and Euclidean distance based model. Additionally, it is able to locate lower limb joints with a better precision.

| (a) | (b) |
| (c) | (d) |
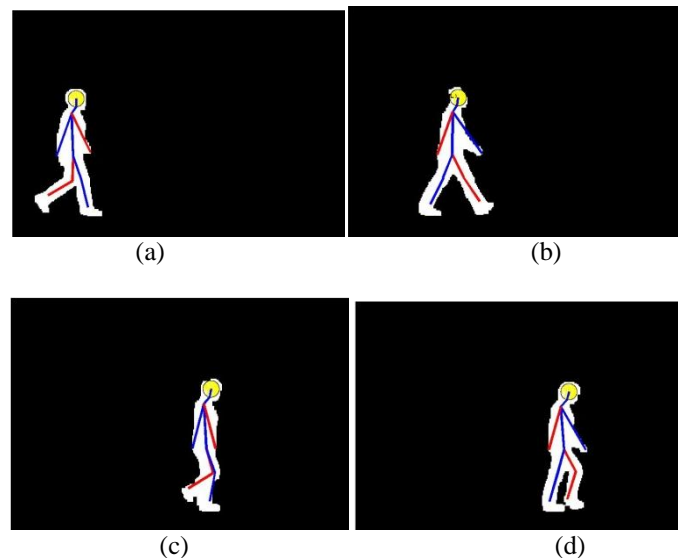
Fig. 3: Binary silhouette and anthropometrical based model for a target at frame (a) 10, (b) 20, (c) 39 and (d) 42.

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