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Human Gait Recognition And Classification Using Similarity Index for various conditions

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Abstract. Gait recognition is usually referred to signify the human identification by the style/way people walk in image sequences. Our aim is to implement the traditional gait recognition algorithm and to show the variation in gait recognition when subject is observed parallel to camera under three conditions- walking normal, carrying a bag and wearing a coat. However in this case, the work devises a novel method for the purpose of similarity computation rather than the traditional recognition where the overall recognition rate of 78.57 percent was obtained.

1. Introduction

With the advent of technology and computers in modern world, security has become one of major concerns. Being humans we always try to ease our access to any system. Traditionally, we used to have passwords, pins and other methods to prevent our data from being misused. As the time passes by and threats grow we try to have unique features that determine the identity of the person and prove the authenticity. All passwords and pins can be shared, so a technique was developed that is based on the unique features of the person, who is allowed to access the system. This was named as the biometrics.

Biometrics is the automated use of physiological or behavioral characteristics to determine or verify identity of a person [1]. Physiological biometrics are related to shape of body parts and are more stable. These include fingerprints, face recognition, iris scan etc. Behavioral biometrics such as signatures, speech, gait, and voice recognition etc are related to behavior of a person and are more prone to changes depending on factors such as aging, injuries, or even mood. Recognition based on the (static) human shape as well as on movement, suggests a richer recognition cue that constitutes our gait. We define gait to be the coordinated, cyclic combination of movements that result in human locomotion [2]. The movements are coordinated in the sense that they must occur with a specific temporal pattern for the gait to occur. Besides other biometrics such as face, eyes and fingerprints, human gait is an important biometric that is used for the identification of people. For every individual, the physical characteristics sets up its gait, so the gait is believed to be as unique to a particular person as eyes or face is.

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Gait recognition is the process where the features of human motion are automatically obtained/extracted and later these features enable us to authenticate the identity of the person in motion. As like other pattern recognition techniques, gait recognition technique also involves 2 stages: Information is derived from human locomotion in the first stage i.e. feature extraction stage and in the next stage, i.e. the recognition stage, a standard similarity computation technique is used to obtain results for being a match or a mismatch. A unique advantage of gait as a biometric is that it offers potential for recognition at a distance or at low-resolution or when other biometrics might not be perceivable [3].

The rest of the paper is organized as follows: Section 2 presents the Gait Recognition Algorithm, while Section 3 discusses the hardware requirement and software used in the human gait recognition system. Section 4 discusses the implementation and the proposed algorithm and Section 5 provides the experimental results. Finally, Section 6 will end the paper with conclusion and future works.

2. Gait Recognition Algorithm

As a new technology of biometrics, gait recognition has recently gained more and more interests from researchers due to its several attractive properties. The biomechanics' literature makes similar observations "A given person will perform his or her walking pattern in a fairly repeatable and characteristic way, sufficiently unique that it is possible to recognize a person at a distance by their gait" [4]. Gait recognition essentially aims to recognize a person by automatically extracting movement characteristics of the walking person in the video. In fact, it seems that it is the possibility that a subject may not be aware of the surveillance and identification that raises public concerns about gait biometrics.

Based on the work "Simplest Representation Yet for Gait Recognition: Averaged Silhouette" algorithm presented by Z. Liu and S. Sarkar [5], we use it as our base algorithm that presents a robust representation for gait recognition which is compact, easy to construct, and affords efficient matching. It also simply aligns and averages the silhouettes over one gait cycle rather than using time series based representation comprising of a sequence of raw silhouette frames or of features extracted therein. Finally, it bases recognition on the Euclidean distance between these averaged silhouette representations. However in this case, the work will involve a different method for the purpose of similarity computation rather than the traditional recognition technique using the Euclidean distance between the averaged silhouettes.

3. System Design

In this section, we implement the proposed algorithm for human gait recognition. The overall system design of the gait recognition system can be categorized into two parts, the hardware requirement and software environments.

3.1. Hardware Requirement

Hardware is the main part of the gait recognition system. The hardware that is needed to accomplish this task is a personal computer and a video camera with higher resolution quality that will capture the video from which the frames will be extracted. But in this case, we are not using any camera as we will be using an already created database.

3.2. Software

Software that we used to implement this work is MATLAB. MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming. The MATLAB application is built around the MATLAB language, and most use of MATLAB involves typing MATLAB code into the Command Window (as an interactive mathematical shell), or executing text files containing MATLAB code and functions.

4. Implementation

4.1. Gait Database

In this research, we used the publicly available CASIA gait database: Database B [6]. This database is a large multi-view gait database, consisting of 124 subjects; the data was captured from 11 views. Three variations, namely view angle, clothing and carrying condition changes, are separately considered. The format of the video filename in Dataset B is 'xxx-mm-nn-ttt.avi', where

- xxx: subject id, from 001 to 124.
- *mm: walking status, can be 'nm' (normal), 'cl' (in a coat) or 'bg' (with a bag)*
- *.nn: sequence number.*
- *ttt: view angle, can be '000', '018', ..., '180'.*

4.2. Proposed Algorithm

The research consists of four main phases: The first phase involves extraction of the silhouette of an individual. Calculating the gait period or gait cycle of the individual follows this. Finding the sum of silhouettes is the next step. Finally, similarity score computation and matching process is performed for recognition. The detail of the design is shown in Figure 2.

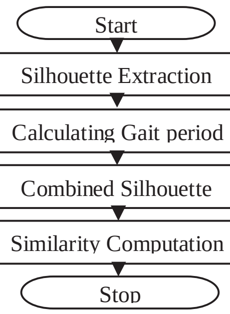

Figure 1: Gait recognition in flow chart.

The formula used for similarity comparisons is:

$$D = \sqrt{\frac{\sum [I_2(x,y) - I_1(x,y)]^2}{\sum [I_1(x,y)]^2}} \quad (1)$$

Any two images when compared using root mean square value are said to be similar if the value falls under the given threshold.

5. Results and Discussions

The preprocessed binary silhouettes were obtained. The sum of silhouettes was calculated as the first step from which we obtained the index of silhouette with maximum sum. This was the silhouette that contained the maximum information because the sum of that silhouette will be highest at the full stride stance. The number of pixels in foreground will reach a maximum when the two legs are farthest apart (full stride stance) and drop to a minimum when the legs overlap (heels together stance). Since the gait is periodic so the information will again be highest at next full stride stance. Now a loop is applied to add all the images between two full stride stances. Besides obtaining the sum of images that fall between two full strides, a counter is run to calculate the number of images that form a gait cycle. Hence, combined silhouette can be obtained for that individual. That silhouette is added to gallery database against that person.

Figure 2. Gait cycle sample images

The images above show a few sample preprocessed silhouettes taken from one gait cycle. The combined silhouette of the images, when calculated is shown below. All the combined images were compared to silhouettes of other people for the purpose of recognition.

Figure 3. A Sample of Combined Silhouette of an individual walking parallel to the image plane.

Any two images when compared using root mean square value are said to be similar if the value falls under the given threshold. Lesser the value more similar is the images. On performing experimentation, results show **0.6** is safe threshold for recognition while some matches were found above the given value and some mismatches were found on the score below the values.

Variation in gait recognition when subject is observed parallel to camera under three conditions - walking normal, carrying a bag and wearing a bag as shown in Table 1 and figure 4.

Table 1. Comparison ratio showing variation in human gait recognition

	Normal Vs Coat	***Normal Vs Bag***	***Bag Vs Coat***
Person1	0.3697	0.2920	0.4384
Person2	0.2785	0.2434	0.3336
Person3	**0.7672**	0.5522	0.5488
Person4	0.3642	0.4897	0.3549
Person5	0.2435	0.4291	0.4873
Person6	0.3342	0.4401	0.3385
Person7	0.5203	0.4317	0.3448
Person8	0.3735	0.4281	0.5418
Person9	0.5920	**0.6566**	0.3527
Person10	**0.6732**	**0.6262**	0.3232
Person11	**0.7823**	**0.8007**	0.3768
Person12	0.2737	0.5245	0.5182
Person13	**0.6802**	**0.7044**	**0.7044**
Person14	0.4536	0.4538	0.2589

71.42% recognition was obtained when normal walking pattern was compared with walking pattern of same person wearing a coat. Again recognition of **71.42%** was obtained when normal walking pattern was compared with walking pattern of same person carrying a bag. **92.85%** recognition was obtained when gait of person wearing a coat and carrying a bag were compared.

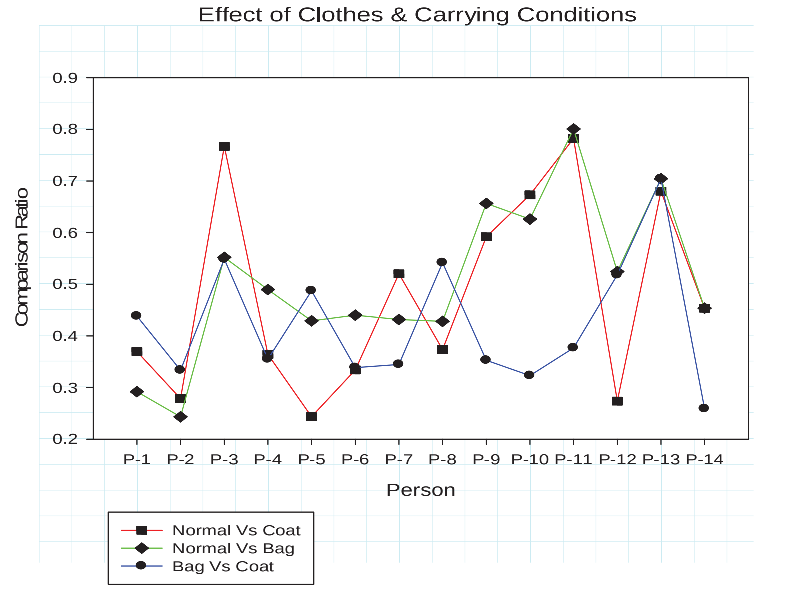

Figure 4. Graph showing comparison ratio in different scenario.

6. Conclusion

Gait Biometrics is an emerging and ever changing field of technology that can be implemented into just about anything that requires a security protocol. Literature survey [7] suggests most of topics have been touched if not explored to the fullest. Most of the results are calculated when the algorithm is implemented in ideal conditions and on particular databases. It is still not fully deployed in practicality because the confounding factors have not yet been fully blotted out. There is a lot of work to be done in different domains such as effect of terrain and slopes, calculation of the gait cycle in such conditions, the effect of bad weather and poor visibility, the effect of shoe type on the gait cycle and the measures that should be take to minimize the effect. One of most exciting works which can be done is that how does age affect the gait and how shall we incorporate the changing factor for each interval of life cycle? We can also try to increase the efficacy of present algorithms that work on multimodal fusion of various techniques. At last we can say that in order to make it stronger faster and more precise a lot of work is still to be done.

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