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Fusion of sparse representation and dictionary matching for identification of humans in uncontrolled environment

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ABSTRACT

Biomechanics based human identification is a major area of research. Biomechanics based approaches depend on accurately recognizing humans using body movements, the accuracy of these approaches is enhanced by incorporating the knee-hip angle to angle relationships. Current biomechanics based models are developed by considering the biomechanics of human walking and running. In biomechanics the joint angle characteristics, also known as gait features play a vital role in identification of humans. In general, identification of humans can be broadly classified into two approaches: biomechanics based approach, also known as Gait Recognition and biometric based Composite Sketch Matching. Gait recognition is a biomechanics based approach which uses gait traits for person authentication, it discriminates people by the way they walk.

Gait recognition uses shape and motion information of a person and identifies the individual; this information is generally acquired from an image sequence. The efficiency of gait recognition is mainly affected by covariates such as observation view, walking speed, clothing, and belongings. Biometric based approach for human identification is usually done by composite sketch matching. Composite sketches are sketches generated using a computer. This obviates the need of using a skilled sketch artist; these sketches can be easily drawn by eyewitness using face design system software in a very short time period. This doesn't require any prior specialized software training but identifying humans using only composite sketches is still a challenging task owing to the fact that human faces are not always clearly visible from a distance. Hence drawing a composite sketch at all times is not feasible.

The key contribution of this paper is a fusion system developed by combining biomechanics based gait recognition and biometric based composite sketch matching for identifying humans in crowded scenes. First various existing biomechanics based approaches for gait recognitionare developed. Then a novel biomechanics based gait recognition is developed using Sparse Representation to generate what we term as "score 1." Further another novel technique for composite sketch matching is developed using Dictionary Matching to generate what we term as "score 2." Finally, score level fusion using Dempster Shafer and Proportional Conflict Distribution Rule Number 5 is performed. The proposed fusion approach is validated using a database containing biomechanics based gait sequences and biometric based composite sketches. From our analysis we find that a fusion of gait recognition and composite sketch matching provides excellent results for real-time human identification.

1. Introduction

Biomechanics based approaches depend on accurately recognizing humans by body movements, the accuracy of these approaches is enhanced by incorporating the knee-hip angle to angle relationships [1]. Current biomechanics based models are developed by considering the biomechanics of human walking and running. In biomechanics the joint angle characteristics, also known as gait features play a vital role in identification of humans [2–4]. General identification of humans can be categorized into 2 approaches: i) biomechanics based approach, also known as Gait Recognition [5–10] and ii) biometric based Composite Sketch Matching [11–15].

Presently, a large number of closed-circuit television (CCTV) cameras for video surveillance are installed in various places such as streets, stations, airports, shopping malls, office buildings and even private houses [16]. CCTV footages captured from crime scenes can provide valuable clues to recognize the culprits when used for gait recognition and composite sketch matching [17–20].

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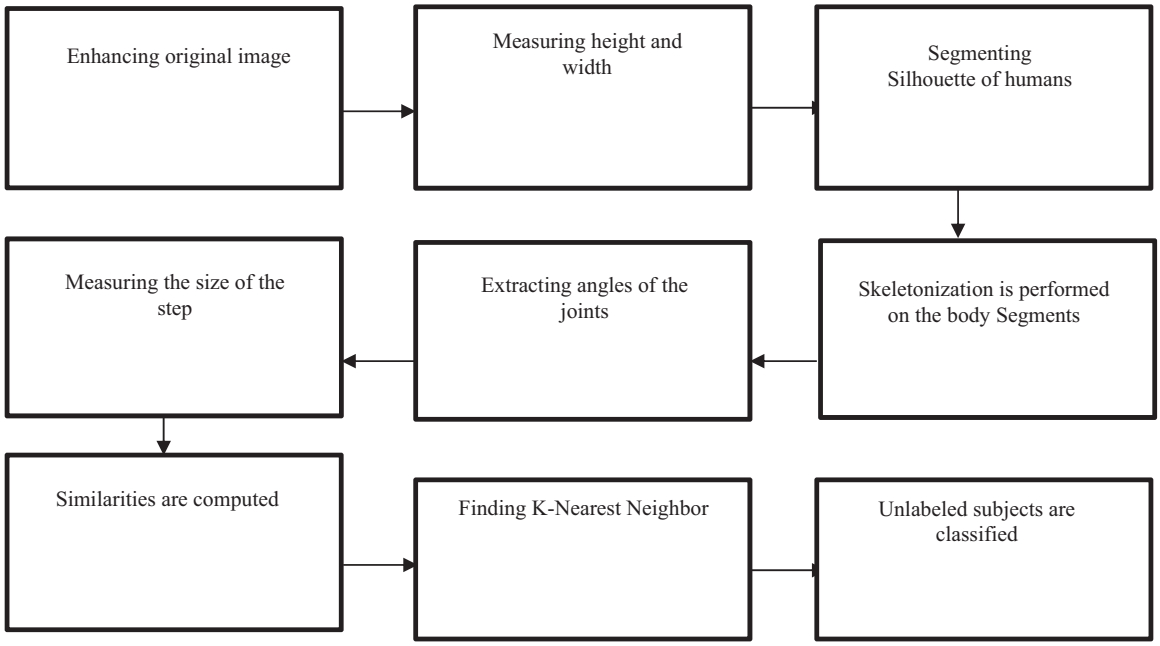

Fig. 1. Gait recognition using gait features extracted from a walking human [1].

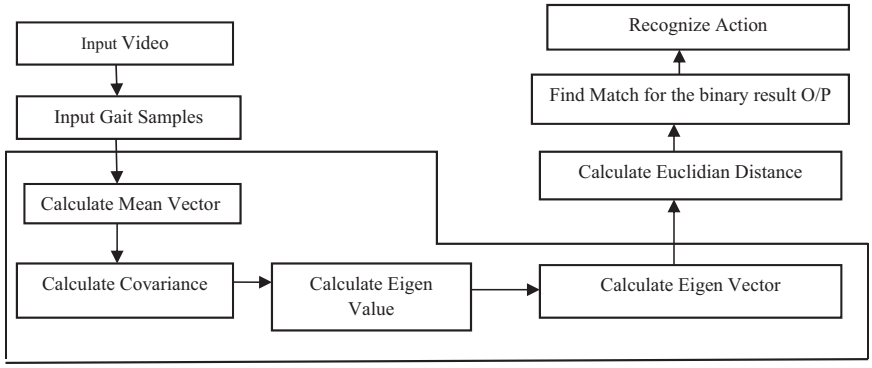

Fig. 2. Gait recognition using principal component analysis [2].

Biomechanics based gait recognition is the method of using gait traits for person authentication, it discriminates people by the way they walk [21,22]. Authentication of a walking person is performed by gait recognition which uses the motion and shape information extracted from image sequences of people who are captured using CCTV camera. It is found that information taken from image sequences of low resolution have considerable capability to discriminate a person authentically [23].

Gait recognition can be used for identifying a person from long distances. Even though gait recognition is considered to have promising characteristics, there are several challenges which have still remained unsolved [24]. Among several challenges one major challenge is that the accuracy of gait recognition gets degraded by covariates which include walking speed, observation view, belongings and clothing [25]. Walking speed is found the most important factor and common source of variation in several applications, because people tend to change their walking speed very casually in real life. Gait signatures get significantly changed when the walking speed is altered randomly [26]. It is found that the stride length is reduced when the walking speed is reduced. Moreover, individual body structure, gender, age have an effect on walking speed hence gait recognition becomes more complicated. Hence we find that it is practically impossible to accurately identify a person in real scenario using only gait recognition [27–31]. This gives rise to the need of considering other biometric based approaches along with gait recognition to accurately identify individuals.

Biometric based approach used by law enforcement agencies to identify perpetrators from CCTV footage captured is by matching it with composite sketches. Composite sketches are generated using a computer. Traditional pencil sketches usually suffer from exaggeration: there is always some amount of discrepancy between description of eye-witnesses and depiction of the offender by the sketch artist. Cited sources indicate that to draw sketch pencil sketches of the offenders highly skilled sketch artist is required. To become a skilled sketch artist specialized training is required. Moreover, to match pencil sketches with photos is a very time consuming and tedious task. Composite sketches are used by law enforcement agencies to overcome these problems. Composite sketches obviate the need of using a skilled sketch artist, hence they can be very easily created[32] by eyewitness. However, identifying humans using only composite sketches is still a challenging task because human faces are not always clearly visible from a distance hence drawing a composite sketch at all times is not feasible.

In this paper, a fusion of biomechanics based gait recognition and composite sketch matching is developed. First various existing biomechanics based approaches for gait recognition are validated. Further a novel biomechanics based gait recognition using Sparse Representation and generate score 1 is developed. Next, another