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Gait Based Human Recognition System using Single Triangle

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Abstract
Biometrics systems are becoming increasingly important, Since they provide more reliable and efficient mean of identity verification. Biometric gait recognition (i.e. recognizing people from the way their walk) is one of the recent attractive topic in biometric research. A lot of development has been done in this field. In this research work dynamic features of human body for gait recognition has been considered two features of human body that is hand and feet for gait recognition is considered.
To be more specific centre point of base of both feet is taken as vertices of the triangle which will be found using hand as a third vertex. Angle formed at each vertex it the triangle is measured for each frame and after the completion of one cycle median of angles formed at each vertex is found out and stored. A cycle is formed one when a person whose walking posture is being captured reaches to the posture which is same as starting posture of the person .The gait system is designed using MAT LAB R2007b to accomplish this research work. Gray Level images are used for working.

Keywords
Computerized visual surveillance, biometric, image processing, gait, pattern recognition

I. Introduction

With the growing importance of applications requiring human identification [9], the demand for adequate security measures has increased dramatically in response to this demand; new technologies are being introduced aimed to ensure that the requisite level of security can be achieved. One of these technologies is often referred to as biometrics.
Biometric recognition or, simply, biometrics refers to the automatic recognition of individuals based on their physiological and/or behavioral characteristics. By using biometrics, it is possible to confirm or establish an individual's identity based on "who she is," rather than by "what she possesses" (e.g., an ID card) or "what she remembers" (e.g., a password).
An important advantage of biometrics lies in the fact that physical or behavioral traits cannot be transferred to other individuals. Examples of biological characteristics that have been explored for their potential as biometrics so far are Face, Fingerprints, DNA, Hand Geometry, Iris and Retinal Patterns, Signature, Voice, Gait and Ear.
What Biological measurements qualify to be a Biometric? Any human physiological and/or behavioral characteristic can be used as a biometric characteristic as long as it satisfies the following requirements:
•Universality: each person should have the characteristic
•Distinctiveness: any two persons should be sufficiently different in terms of the characteristic
•Permanence: the characteristic should be sufficiently invariant (with respect to the matching criterion) over a period of time.
•Collectability: the characteristic can be measured quantitatively.
A Biometric System is essentially a pattern recognition system that operates by acquiring biometric data from an individual, extracting a feature set from the acquired data, and comparing this feature set against the template set in the database. Depending on the application context, a biometric system may operate either in verification mode or identification mode [1].
• In the verification mode, the system validates a person's identity by comparing the captured biometric data with her own biometric template(s) stored in the system database. In such a system, an individual who desires to be recognized claims an identity, usually via a personal identification number (PIN), a user name, or a smart card, and the system conducts a one-to-one comparison to determine whether the claim is true or not. Identity verification is typically used for positive recognition, where the aim is to prevent multiple people from using the same identity
• In the identification mode, the system recognizes an individual by searching the templates of all the users in the database for a match. Therefore, the system conducts a one-to-many comparison to establish an individual's identity without the subject having to claim an identity. Identification is a critical component in negative recognition applications where the system establishes whether the person is who she (implicitly or explicitly) denies to be. The purpose of negative recognition is to prevent a single person from using multiple identities. Identification may also be used in positive recognition for convenience (the user is not required to claim an identity). While traditional methods of personal recognition such as passwords, PINs, keys, and tokens may work for positive recognition, negative recognition can only be established through biometrics.

II. Overview Of Gait System

A. Gait Recognition System

Gait recognition is a multistage process (Fig. 1). It is important that gait capturing is performed in environments where the background is as uniform as possible. Moreover, since gait recognition algorithms are not, in general, invariant to the capturing viewpoint, care must be taken to conduct capturing from an appropriate viewpoint. Preferably, the walking subject should be walking in a direction perpendicular to the optical axis of the capturing device since the side view of walking individuals discloses the most information about their gait [5].

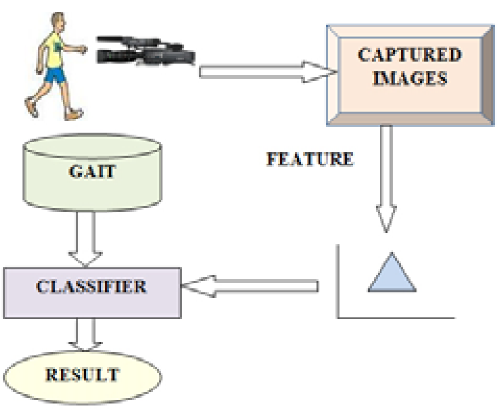

Fig. 1: Block diagram of a gait recognition system.

Once a walking sequence is captured, the walking subject is

CAPTURED

separated from its background using a process called background subtraction. A critical step in gait recognition [2] is feature extraction, i.e., the extraction, from video sequences depicting walking persons, of signals that can be used for recognition. This step is very important since there are numerous conceivable ways to extract signals from a gait video sequence, e.g., spatial, temporal, spatiotemporal, and frequency-domain feature extraction. Therefore, one must ensure that the feature extraction process compacts as much discriminatory information as possible. Finally, there is a recognition step, which aims to compare the extracted gait signals with gait signals that are stored in a database.

B. Gait Cycle

Stance phase is separated into four components (loading response. mid-stance, terminal stance, and pre-swing), and swing phase, into three components (initial, middle, and terminal swing). The position in the cycle where each phase begins is recorded as a percentage. Initial contact and toe-off are instantaneous events.

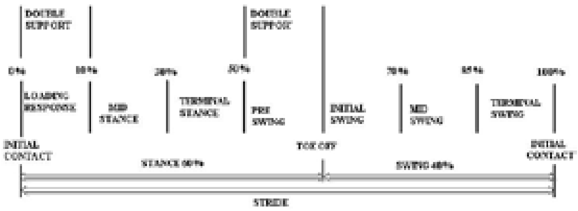

Fig. 2: Schematic representation of the gait cycle.

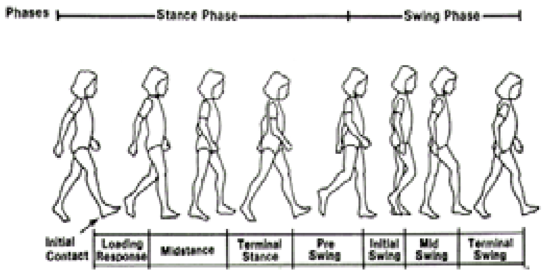

Fig. 3: Representation of a Subject moving through the gait cycle.

The walking pattern is studied as a gait cycle (Fig. 2 and 3), which is defined as the movement of a single limb from heel-strike to heel-strike again. The gait cycle begins with stance phase, which is 60 per cent of the cycle, at initial contact of the heel. Next comes loading response, with plantar flexion occurring at the ankle to get the entire foot on the ground, followed by mid-stance, in which the weight of the body passes forward over the stable foot as the ankle dorsiflexes. Terminal stance then occurs, with the heel leaving the ground and the foot plantar flexed in pre-swing, leading to toe-off. Next comes the swing phase of gait, which is 40 per cent of the cycle, with initial swing, in which muscles control cadence and foot clearance; then mid-swing; and finally terminal swing, with the foot prepared for contact with the ground before the cycle begins again with heel-strike. Heel-strike and toe-off are the instantaneous events in the gait cycle. There are two periods of double support, each of which is 10 per cent of the cycle, when both feet are in contact with the ground; these are the initiation (loading response) and termination (pre-swing) of stance phase. Familiarity with the following additional terminology is necessary for an understanding of the basics of gait analysis. Direction of progression is the direction in which the patient proceeds along the walkway during the collection of gait data. Step length indicates the distance from a specific stance-phase event of one foot to the same event of the other foot. It is named after the lead foot. For example, the right step-length is the distance from left heel-strike to right heel-strike, or the distance covered by the right lower limb in taking one step. In abnormal gait, the step lengths of the two sides may be unequal. Stride length is the distance from the initial contact of one foot to the following initial contact of the same foot; this sometimes is called cycle length. Velocity refers to the average horizontal speed of the body along the plane of progression, measured over one stride or more. It is typically reported in centimeters per second or meters per minute (in a normal adult, velocity is 103 centimeters per second [sixty-two meters per minute]). Given the same cadence, people with longer lower limbs walk at greater velocity than those having shorter lower limbs, because of their greater step and stride lengths. Cadence is the number of steps per unit of time, represented as steps per minute. It decreases from the age of four years through the age of seven years. For a normal adult, cadence is 120 steps per minute.

There are two major abilities essential to walking. The first, Equilibrium, is the first ability to assume an upright posture and maintain balance and the second, Locomotion, the ability to initiate and maintain rhythmic stepping. Normal human walking is an extremely efficient process. The energy expended in normal gait (2.5 kilogram- calories [10.5 kilojoules] per minute) is less than twice that spent while sitting or standing (1.5 kilogram-calories [6.5 kilojoules] per minute). Deviations from normal gait greatly increases this energy cost.

1. Stance and Swing

Each gait cycle is divided into two periods, stance and swing. Stance is used to describe the entire period during which the foot is on the ground and swing the period for which the foot is in the air. Stance is subdivided into three intervals according to the sequence of floor contact for both limbs. Both the start and end of stance involve a period of bilateral foot contact with the ground (double stance), while the middle portion has a period of single limb contact (single limb stance). The duration of single limb support for one limb equals the swing of the other. The relative distribution of the periods of gait within a gait cycle is 60% for stance and 40% for swing [4]. The subdivision and distribution of the periods of gait motion for both limbs is more easily seen within Fig. 4.

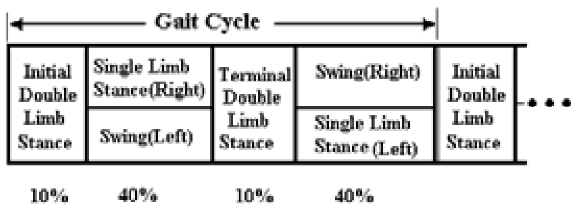

Fig. 4: The subdivisions of stance and their relationship to the bilateral floor contact pattern.

2. Phases of Gait

In order to provide the basic functions required for walking, each stride involves a series of complex motion patterns[8] performed by the hip, knee and ankle. The term stride is synonymous with a gait cycle. Stride length is the linear distance in the plane of progression between successive points of foot-to-floor contact of the same foot (right-to –right or left–to–left); step length is the distance between successive points of foot-to-floor contact of alternate feet (right-to-left or left-to-right). Step and stride lengths are measured from a central points on the long axis of the foot. The stance and swing periods of gait can be further divided into

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eight functional patterns known as the phases of gait. Analysis of a person's walking pattern [3] by phases more directly identifies the functional significance of the different motions occurring at the individual joints. The phases of gait also provide a means for correlating the simultaneous actions of individual joints into patterns of total limb function.

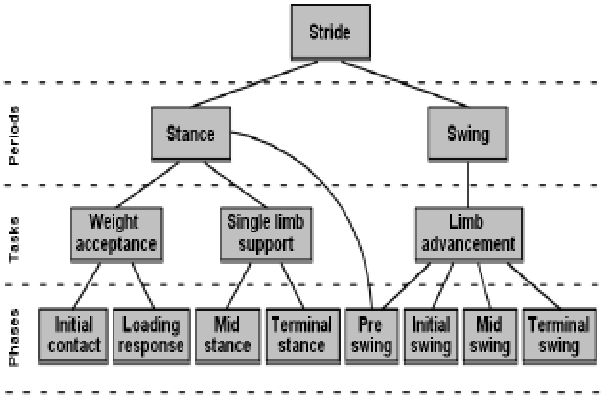

Fig. 5: Divisions of a gait cycle.

Each of the eight phases has a functional objective and enables the limb to accomplish three basic tasks: weight acceptance, single limb support and limb advancement. Fig. 5 shows the relationship between the periods, functional tasks and phases of gait.

III. Proposed Methodology

A. Introduction Proposed Method

A vide variety of systems requires reliable personal recognition schemes to either confirm or determines the identity of an individual requesting their service. Biometric recognition refers to the automatic recognition of individuals based on their physiological and or behavioral characteristics. Human gait is promising biometric resource. Human gait is an important biometric for identification. For identifying non-cooperative people, gait is attractive when the distance between the camera and the subject is far away. Gait recognition techniques mainly fall into two broad categories namely model based and model free approaches. Current research on gait recognition is usually based on an averaged gait image or silhouette sequence, or a motion structure model. The movement of the different components (e.g. head, arm and thigh) in the averaged gait image have not been studied closely [1,6-7]. Human gait can be defined as a form of locomotion in which the body's centre of gravity moves alternately on the right side and left side. During walking, the human body functionally divides into the passenger and locomotors units. The upper body is a relatively passive passenger unit that rides on a locomotors unit. Each gait cycle is separated into two distinct periods, the stance and the swing phase. The stance phase is the entire period during which the foot is on the ground and the swing phase begins as the foot is lifted from floor.

B. Working Methodology

Fig. 6: Dot points on subject selected parameters

As in [7] human body is segmented into seven components. In our proposed method we have taken two components of human body. The first component is hand and second component is feet. The second component is subdivided into two parts i.e. left feet and right feet. In our proposed method we have taken concept of angles between two lines. We initially insert dot point on subject selected parameters at all frames, as shown in Fig. 6. Then these dotted frames of each individual are inputted in our gait system, which is designed in Matlab for gait recognition analysis.

One triangle is drawn between these points i.e. hand, right feet and left feet. Then we draw a triangle between these points shown in fig 7.

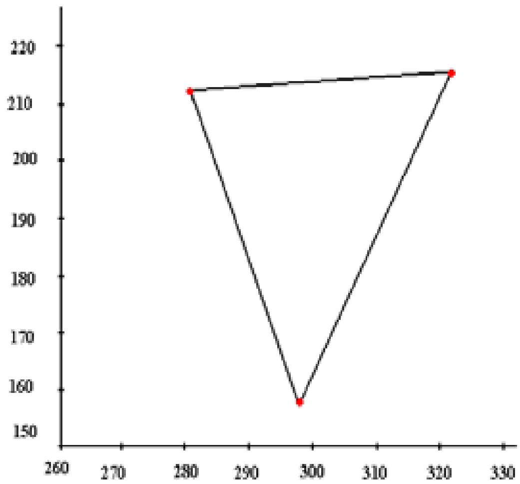

Fig. 7: Triangle ABC after connecting points

ABC triangle is built between points. Angles are angle BAC, angle ABC and angle ACB . Point A represent hand, point B represent left feet, and C represent right feet. Then we calculate each angle of triangle and find mean value for all frames in a cycle. For calculating the angle we apply the following formula

M1=(y2-y1)/(x2-x1)

M2=(y3-y2)/(x3-x2)

M3=(y3-y1)/(x1-x1)

Where Θ1, Θ2, Θ3 are angles

C. Proposed Algorithm

1. Input frames of video for one cycle.
2. Convert each frame into gray scale.
3. Compute pixel value for following
    - Hand
    - Right feet
    - Left feet
4. Construct triangle between pixel values of this desired frames.
5. Calculate angles of triangle.

6. Calculate mean of angles for one cycle.
7. Print the result of mean.
8. Exit

IV. Conclusion

This paper focuses on gait based analysis depending on the partitioning of human body according to different body parts. Since the gait technique uses the concept of movement of different body parts and studies them accordingly. Basically it depends on collection of various images captured for various people that is stored into database and then analyzes them.

It has been found that gait based analysis can provide a new scenario for biometrics. Using the methodologies which include some sort of computations with respect to the organization of body parts.

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