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Review on Gait Recognition: A Biometric Approach

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ABSTRACT: Recognizing people by their gait has become more and more popular nowadays because; gait recognition can work well remotely, gait recognition can be done from low-resolution videos and with simple instrumentation, gait recognition can be done without the cooperation of individuals, gait recognition can work well while other features such as faces and fingerprints are hidden and gait features are typically difficult to be impersonated [1].

Recent ubiquity of smartphones that capture gait patterns through accelerometers and gyroscope and advances in machine learning have opened new research directions and applications in gait recognition. A timely survey that addresses current advances is missing. In this article, we survey research works in gait recognition. In addition to recognition based on video, we address new modalities, such as recognition based on floor sensors, radars, and accelerometers; new approaches that include machine learning methods; and examine challenges and vulnerabilities in this field. In addition, we propose a set of future research directions. Our review reveals the current state-of-art and can be helpful to both experts and newcomers of gait recognition. Moreover, it lists future works and publicly available databases in gait recognition for researchers [1].

KEYWORDS: Biometrics, gait recognition, identification, silhouettes, fingerprints, features.

I. INTRODUCTION

Biometric authentication, or simply biometrics, refers to identifying or verifying a person according to his/her biological or behavioural characteristics (also known as traits or identifiers). There are many biometric traits, such as fingerprints, face, and gait. Typically, gait manifests a person's walking style. Gait recognition means authenticating a person by his/her manner of walking. Early medical and psychological studies showed that human gait had 24 different components, which could be used for identifying an individual. Moreover, in the previous works, it was shown that the light points attached to individuals' joints could be used for representing a human motion, and point light displays could be used for distinguishing human activities. All the above works indicated that every individual had unique muscular-skeletal structure, which could be used for identifying him/her. Therefore, gait recognition is feasible. Traditionally, gait-based authentication has been studied through analysing the videos of human motion. However, the ubiquity of smart phones equipped with accelerometers and gyroscopes has opened a new dimension to gait-based authentication because of the unique ability to capture gait patterns by accelerometer and gyroscope. In addition, wide spread applications and advances in machine learning have resulted in improved accuracies. This survey is an attempt to bring a comprehensive, most up-to-date research and analysis of advances and the state of practice in gait-based authentication [1].

UNIQUE PROPERTIES OF GAIT RECOGNITION:

Gait recognition has several unique properties that other biometrics lack.

- First, human gait can be captured far away from the individual. In contrast, other biometric systems require that the individual is close to the biometric data collector or physically contacts it. This favourable characteristic has vital significance, while other biometric features such as fingerprints cannot be captured [1].
- Second, gait recognition can be done at low resolution. When acquired videos are low resolution, other biometric systems such as face recognition may not work well. In this case, it is desired to use gait recognition [1].



- Third, gait recognition can be done with simple instrumentation. A camera, an accelerometer in the smartphone, a floor sensor, or even a radar can be used for collecting human gait [1].
- Fourth, gait recognition can be done without the cooperation of the person. In contrast, other biometrics such as fingerprints require the individual putting his/her finger on the sensor for data acquisition [1].
- Fifth, gait features are hard to be impersonated. This is because gait recognition typically uses human silhouettes and activities. This property is very important to crime analysis [1].
- Sixth, gait recognition still works well while features such as face images are hidden. It is easy to hide an individual’s face, but hard to conceal human motions [1].

GAIT RECOGNITION FEATURES:

Gait is a synchronized movement of bones, muscles and nerves of hip, knee and ankle joints rotations. The cyclic nature of the walking style provides the periodic leg movement. Gait of a person is generally represented as a walk cycle describes in the fig below which has two phases: stance phase and swing phase; gait cycle has eight stages: (i) initial contact of the foot or toe. (ii) Loading response as placing the entire foot over the floor with the limb segment’s reaction. (iii) Mid-stance as the intermediate support. (iv) Terminal stance is denoted as heel off. (v) Pre-swing is the initialization of knee movement. (vi) Initial Swing. (vii) Mid-Swing. (viii) Terminal Swing. Parameters extracted from gait sequence are step length, stride length, cadence, speed, dynamic base, progression line, foot angle, hip angle and squat performance. The measurements extracted were analysed, interpreted to recognize the individual through the techniques like temporal or spatial, kinematics, Marker less gait capture, pressure analyser, kinetics and dynamic electromyography [7].

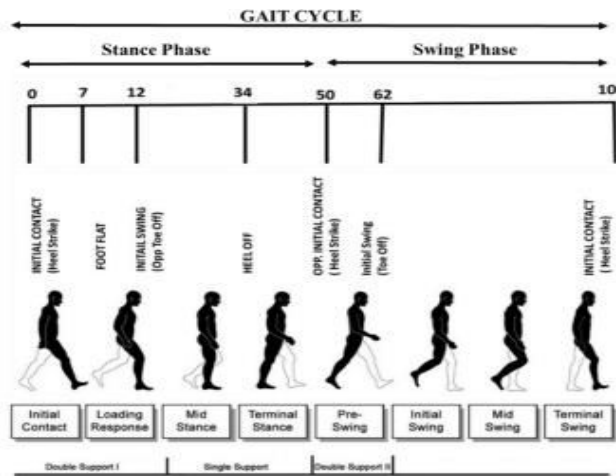


Fig: Gait Cycle

FRAMEWORK OF GAIT BIOMETRICS:

Regardless of the underground techniques implemented, a typical gait recognition system includes four phases, namely data acquisition, feature representation, dimension reduction, and classification.

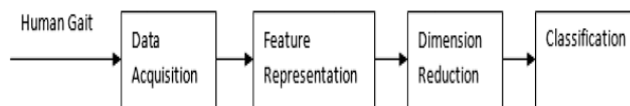


Fig: Framework of Gait Biometrics

Data acquisition: The data acquisition module is designed for collecting human gait data. Generally, human gait data is a set of temporal-spatial data, which includes activities of human body during a period of time. Specifically, human gait data can be collected in four ways, namely camera, accelerometer, floor sensor, and continuous wave radar. The features of human gait are included in the raw data collected during the data acquisition process [1].



Feature representation: To recognize individuals, the gait recognition system must extract gait features from raw data collected during the data acquisition phase. Feature representation is the first step for feature extraction, which converts raw data into specific styles. For video-based gait recognition, there are mainly two sorts of feature representation methods (model based/model-free methods). For example, Lee and Grimson divide human silhouettes into seven parts and each part was fitted by an ellipse. Then, they took parameters of those ellipses as features. This is a typical model-based method[1].

Dimension reduction: In general, the dimensionality of features extracted from raw data in the feature representation step is higher than training data, resulting in the famous under sample problem. And the classification process will fail. Therefore, before classification, it is desired to extract useful features using a feature reduction algorithm. There are many dimension reduction methods, such as LDA and PCA [1].

Classification: Direct gait classification methods are the simplest methods for gait recognition, which do not extract temporal features from gait sequences. Instead, this sort of method just uses several key frames in a gait sequence. Another approach is to use the similarity of gait temporal sequences for recognizing an individual. Recently, gait recognition systems have been built on HMMs successfully [1].

MILESTONES OF GAIT RECOGNITION [1]:

Year	Description
1994	First gait recognition system
1997	First model-based gait recognition system
2000	First floor-sensor-based gait recognition system
2005	First continuous-wave-radar-based gait recognition system
2005	First accelerometer-based gait recognition system
2006	First model-free gait recognition system

II. LITERATURE SURVEY

Rong Zhang, and et.al, has shown a novel 2-step, model-based approach for gait recognition using human body movements exclusively. As the concealable shape information is avoided, our method is more robust than the shape-based ones. Applying this approach to CMU MoBo data-set and USF Gait Challenge data-set, they achieve recognition rates of 96% and 61% respectively. The lower recognition rate for USF data-set is attributed to both the larger number of subjects and the longer distance from camera to subjects. This suggests that proper zoom lenses are needed to ensure that the gait motion is seen at sufficient detail[2]. **Drishty, and et.al**, has described the various methods of identifying a human being from body silhouette and gait. The general model followed by various researchers for gait-based recognition has been provided in context of person authentication. It was found during the survey that, gait recognition has been done using various classifiers, namely, artificial neural networks, support vector machines, genetic algorithms and fuzzy logic. Since hybridising the classifiers may lead to better performance, so it is concluded that effective hybrid systems can be utilised to develop high potential gait recognition systems [3]. **Miss Kalpana Soni, and et.al**, presents an exhaustive literature work in the field of gait recognition which is a growing field for biometrics system. In any gait recognition system, the accurate generation of silhouettes, appropriate feature extraction and appropriate classifier for classifying the features are very crucial. Different approaches have been presented by different authors for the above mentioned three crucial phases of the gait recognition. All the noteworthy contributions have been incorporated in this paper pertaining to the above mentioned three phases. This paper definitely helps researchers who are currently involved in gait recognition-based biometrics system [4]. **Nishtha Gupta** intended to provide an overview of the basic research directions in the field of gait analysis and recognition and its comparative study with other biometric features. Also provides the technique used for gait recognition, its challenges and the comparison with other biometric technique. The recent developments in gait research indicate that gait technologies still need to mature and that limited

practical applications should be expected in the immediate future. At present, there is a potential for initial deployment of gait for recognition in conjunction with other biometrics [5]. **Abdullah S. Alharthi, and et.al**, discussed the character of gait data poses the problem of identifying features suitable for gait classifications, desirable in a number of application areas. The three gait-sensing modalities covered in this paper have produced data which is most amenable to the use of deep learning, to address the automatic extraction of such features. Deep learning CNNs typically outperform shallow learning models in the most essential metrics. Furthermore, multi-sensor and multi-modality fusion results in better accuracy and robustness. This is achieved by employing the available flexibility in data representations, ANN architectures and the choice of model hyper-parameters. Gait analysis benefits from methods introduced and tested in other applications of deep learning. However, it requires particular attention due to its spatiotemporal character, the options for ubiquitous gait sensing and the privacy concerns they raise, as well as the cost of achieving research, development and commercialization objectives. Deep learning from multi-sensor, multi-modality gait data offers new options in the strong drive towards personalized healthcare, as well as towards more robust and un-intrusive biometrics for safety and security [6]. **Nithyakani P, and et.al**, identified the basic knowledge about the human gait is and then explored. The comparative analysis with the existing techniques of gait recognition were discussed. In this work, the survey of recent deep architecture model on human gait identification, authentication and clinical applications were discussed. Future research directions and challenges were identified [7]. **Shantanu Jana, and et.al**, discussed gait analysis and recognition for forensic applications. Detail discussion on nature of available databases presented in this paper. Understanding gait recognition methodologies and their applications discussed in broad level. Throughout the survey, authors found that gait analysis has high impact in biomedical engineering, medical areas and forensic experiments. There is large scope in research in gait recognition. Gait recognition is so popular because it recognizes people from distance. Silhouette Extraction methods are discussed elaborately. Strong feature extraction methods are discussed [8]. **Mikalya Freitas** has presented a comparative work at the gait recognition research using wearable sensors. Firstly, introduced gait recognition and highlighted its benefits as a subject identifier and also defined wearable sensors and their importance. Secondly, reported the findings of gait recognition studies over the years and divided each study up by their sensor placement, sensor type, data analysis algorithms and methods used and performance. Thirdly, gave an in-depth look at three frequently used gait analysis algorithms: CNN, kNN and decision tree [9].

III. COMPARATIVE RESULTS

Compared to other biometrics, gait has some unique characteristics. The most attractive feature of gait as a biometric trait is its unobtrusiveness, i.e., the fact that, unlike other biometrics, it can be captured at a distance and without requiring the prior consent of the observed subject. Most other biometrics such as fingerprints, face, hand geometry, iris, voice, and signature can be captured only by physical contact or at a close distance from the recording probe. Gait also has the advantage of being difficult to hide, steal, or fake.

Although the study of kinesiological parameters that define human gait can form a basis for identification, there are apparent limitations in gait capturing that make it extremely difficult to identify and record all parameters that affect gait. Instead, gait recognition has to rely on a video sequence taken in controlled or uncontrolled environments. Even if the accuracy with which we are able to measure certain gait parameters improves, we still do not know if the knowledge of these parameters provides adequate discrimination power to enable large scale deployment of gait recognition technologies. Moreover, studies report both that gait changes over time and that it is affected by clothes, footwear, walking surface, walking speed, and emotional condition. The above facts impose limitations on the inherent accuracy of gait and question its deployment as a discriminative biometric. The ambiguity regarding the efficiency of gait-assisted identification differentiates gait from other biometrics whose uniqueness and invariability, and therefore appropriateness for use in identification applications, can be more conclusively determined by the study of the similarities and differences between biometrics captured from several subjects under varying conditions. This is why, at present, gait is not generally expected to be used as a sole means of identification of individuals in large databases; instead, it is seen as a potentially valuable component in a multimodal biometric system [5].



The table 1 show the comparison with other biometric features [5].

BIOMETRIC	UNIQUENESS	UNIVERSALITY	PERMANENCE	CIRCUMVENTION	PERFORMANCE	COLLECTABILITY	DISTINCTIVENESS
Signature	P	P	P	G	P	G	P
Speaker	P	A	P	G	P	A	P
Face	P	G	A	G	P	G	P
Iris	G	G	G	P	G	A	G
Keystroke	P	P	P	A	P	A	P
Palmprint	A	A	G	A	G	A	A
Retina	A	G	A	P	G	P	G
Gait	A	A	P	A	P	G	P
Fingerprint	G	A	G	A	G	A	G
Ear	A	A	G	A	A	A	A
DNA	G	G	G	P	G	P	G
Odour	G	G	G	A	P	P	P

Table 1: Comparison of various biometrics with gait (P=poor, A=average, G=good.)

IV. CONCLUSION

In this article, we have presented a detailed survey on gait recognition. First, we have listed the history of gait recognition. Early gait recognition systems are built on video. In the past several years, the industry also built gait systems using floor sensors, accelerometers, and wave radars. Second, we have discussed the framework of gait biometrics. It is mainly comprised of four modules, namely data acquisition, feature representation, dimension reduction, and classification. (1) Data acquisition: The gait data can be acquired by camera, accelerometer, floor sensor, and radar. Different acquisition method outputs different gait data. (2) Feature representation: Different gait data can be represented in different ways. For video-based gait data acquired by camera, model-based and model-free feature representations are the main techniques. For gait data collected using accelerometer, floor sensor, and radar, there may be a variety of features, extracted in the frequency, time, and space domains. (3) Dimension reduction: Typically, features extracted from gait data cannot be directly used for classification because the dimensionality of features extracted from raw data in the feature representation step is higher than training data. Therefore, a dimension reduction technique is needed. Dimension reduction can be divided into two types, namely feature reduction and outliers’



removal. Feature reduction aims to delete non-important features, while outliers' removal aims to remove bad quality signals. (4) Classification: Classification is the last phase of a gait recognition system, which identifies individuals. In this article, we mainly discussed seven kinds of classification algorithms, namely distance, correlation, machine learning, neural network, hidden Markov model, dynamic time wrapping, and Bayesian classification [1].

REFERENCES

1. A Survey on Gait Recognition, Changsheng Wan, Li Wang and Vir V Phona,2018
2. Human Gait Recognition, Rong Zhang, Christian Vogler, Dimitris Metaxas, 2014
3. Review on Gait Recognition Using Artificial Intelligence, Drishty, Jasmine Gill, IJSR,2015
4. A Survey Paper on Human Gait Recognition Techniques, Miss Kalpana Soni, Miss Amrita Singh,2016
5. Biometric System using Gait Feature Analysis and Comparison, Nishtha Gupta, Delhi,2017
6. Deep Learning for Monitoring of Human Gait: A Review, Abdullah S. Alharthi, Syed U. Yunus, Krikor B. Ozanyan,2019
7. The Systematic Review on Gait Analysis: Trends and Developments, Nithyakani P, M Ferni Ukrit,2020
8. Survey of Human Gait Analysis and Recognition for Medical and Forensic Applications, Shantanu Jana, Nibar Das, Subhadip Basu, Mita Nasipuri, Jadavpur University, India,2021
9. A Survey on Gait Recognition using Wearable Sensors, Mikalya Freitas, California State University, Long Beach,2022



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