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A Systematic Study of Human Gait Analysis Using Machine Learning Approaches

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***Abstract*—** The prime objective of this paper is to comprehend the human gait in biometric and biomedical applications. Human gait recognition is recognizing people from the manner in which they walk. It is identified with acquiring biometric data, for example, identity, gender, ethnicity and age from people walking patterns. Likewise, biomedical data can be acquired like individual's illness, body abnormality. In the walking process, the human body shows general periodic motion, particularly upper and lower limbs, which reflect the person's unique movement pattern. Contrasted with different biometrics modalities, gait can be acquired from distance and is hard to hide and camouflage. Gait has been topic in PC vision with extraordinary advancement accomplished in ongoing ten years. In this paper, we give a survey over state-of-art gait innovation; focus on different factors in gait methodology and ongoing advances in biomedical engineering.

***Keywords*—** Human gait, Gait recognition, Biometrics, Biomedical.

I. INTRODUCTION

The recognition of individuals by their physiological or behavioral qualities is called biometrics. Biometric systems are utilized progressively to recognize individuals and regulate access to physical spaces, information, services, and to different rights or benefits, including the capacity to cross international borders.

Digital technology has empowered us to store and process biometric data consequently without mediation or with our minimal input. The renewed spotlight on security in the past few years has brought the biometrics investigation into spotlight. Late advancements in the biometric research have brought face, iris and fingerprint recognition from research labs to everyday life. Biometric recognition systems are being introduced as access control systems for granting access to offices, residential buildings and even laptop computers. [1]

Gait is essentially related with human being's way of walk. This includes movement of arms, legs, thighs, hips, lower limb, upper limb, feet, and so on. Most ordinarily proposed techniques in view of gait make utilization of videos as an example dataset for comparison. Additionally, mechanical advances in image/video processing have familiar us with feature recognition, extraction and numerous such related advances which have ended up being a point of reference in computer vision. Due to these progressions more center is moved to enhance gait analysis furthermore, related strategies for biometric recognition systems.

Umpteen examination on biometrics officially demonstrated that no single biometric methodology can ensure error free recognizable proof or verification of human being. In any case, it is likewise demonstrated that if numerous biometric modalities are utilized at same time then framework demonstrated enhanced results. Likewise because of the fundamental points of interest of gait Biometrics over other biometric modalities listed below this area is in pace of advancement and execution:

1. Gait is behavioral biometric which can be seen from a distance.
2. It is conceivable to extract gait patterns from low resolution images which are not the situation with Iris and Face biometrics likewise they require frontal view.
3. It is combination of skeletal structure, muscular activity, body weight, limb lengths, bone structures, this complexity makes Gait hard to emulate guaranteeing great security.
4. Despite changes in body weight, injuries and disease, contemplates have demonstrated that Gait still gives oppressive recognition.

Previously, understanding late researches in gait analysis, let us first analysis how gait biometric framework takes a shot at broad level. Following algorithm is normally followed, as clarified in Fig. 1. :

1. Human being's way of walking is caught and taken as input to a gait recognition framework through continuous streaming.
2. It is then pre-processed to expel any noise from the steam of input images.
3. Targeted region of interest and features are extracted from the input tests and these are contrasted and the base lined input tests from database.

At the last, human being is distinguished and if not recognized at that point database is refreshed with new updates which will be utilized in future to compare. Gait analysis existing in literature is characterized in light of Gait data Captured and Gait Recognition techniques. The previous is additionally named Sensor Based and Video Based Categories while Based on Recognition the techniques are classified Model Base and Model Free approaches. [2].

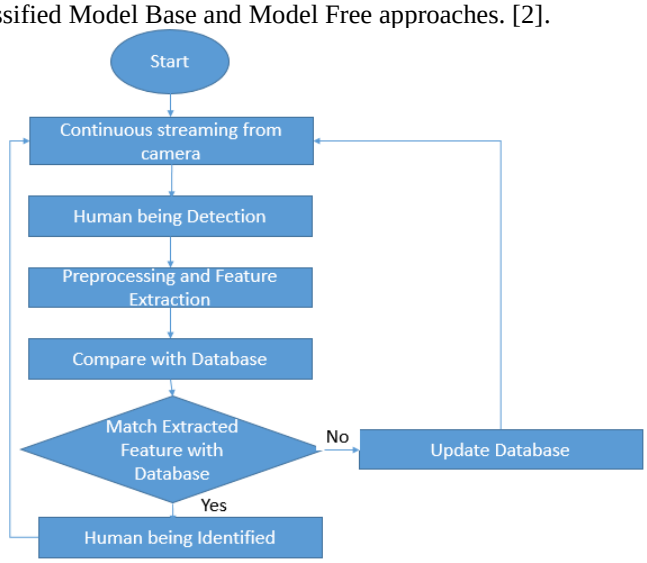

Fig. 1. Basic gait biometric system

II. UNDERSTANDING OF HUMAN GAITS

A. What is Human Gait?

Gait recognition is a rising biometric technology which includes individuals being recognized absolutely through the analysis of the way they walk. This includes movement of arms, legs, thighs, hips, lower limb, upper limb, feet, and so forth [3] Johansson in 1970 named gait as, "a specific way or manner of proceeding onward foot". He demonstrated that humans can rapidly distinguish that a pattern of moving lights, called a moving light display (MLD), relates to a walking human [4]. Be that as it may, at the point when given a static image from the MLD, humans are unfit to recognize any structure whatsoever. His commitments allows one to view movement one to view movement extracted from other logical information. Johansson additionally proposes an arrangement of gestalt decides that humans use to interface the moving specks and induce structure. [4]

The characterized human walking as "the translation of the focal point of mass of the body from one point to another in a way that requires the minimum energy" which is too named as human locomotion [5]. To understood that this analysis requires gigantic measure of data which is of little incentive to orthopaedic specialist except if it were incorporated to develop an idea of locomotion from which deduction can be drawn also, connected to analysis of clinical problems which every day defy specialist. He considered five essential determinants of human locomotion (i.e. Pelvic rotation, Pelvic tilt, Knee flexion, Foot and Knee instruments, and Lateral pelvic movement) and its association with pathological gait which assisted specialist in analysing disorders of locomotion with more prominent exactness.

Paper [6] Characterizes gait to be the organized, cyclic mix of movements that outcome in human locomotion. They characterized gait recognition to be the recognition of a few striking property, e.g. character, style of walk, or pathology, in view of the planned cyclic movements that outcome in human locomotion. They made the qualification between gait recognition and quasi gait recognition in which a notable property is recognized in view of features obtained while a subject is walking, however the features are not innately part of the gait. For instance, skeletal measurements might be estimated amid gait and used to recognize a person. Nonetheless, skeletal measurements might be estimated different ways, and are thusly not a property of the gait.

Papers [6] [4] distinguish the following three vital properties in the human perception of gaits.

- Frequency entrainment: The different segments of the gait must share a typical frequency.

- Phase locking: The phase relationships among the segments of the gait remain around consistent. The lock varies for various kinds of locomotion, for example, walking versus running.

- Physical plausibility: The movement must be physically plausible human movement.

III. LITERATURE SURVEY

M. Hofmann et al. [8], Author present a new spatiotemporal representation for Gait Recognition, which we call Gradient Histogram Energy Image (GHEI). Similar to the Gait Energy Image (GEI), data is averaged over full gait cycles to

decrease noise. As opposed to GEI, where silhouettes are averaged and in this manner only edge data at the limit is utilized, our GHEI computes gradient histograms at all areas of the original image. Accordingly, also edge data inside the person silhouette is captured. Also, we demonstrate that GHEI can be enormously enhanced utilizing precise segmentation methods (we utilize α-matte segmentation). We demonstrate awesome viability of GHEI and its variations in our examinations on the large and generally utilized HumanID Gait Challenge dataset.

E. Hossain et al. [9], propose a novel human-identification scheme from long range gait profiles in survelliance videos. We research the part of multi-view gait images gained from multiple cameras, the significance of infrared and visible range images in finding identity, and part of soft/secondary biometric (strolling style) in improving the precision and robustness of the identification frameworks. Experimental evaluation of a few subspace based gait feature extraction approaches (PCA/LDA) and learning classifier methods (MLP/SMO) on various datasets from a freely accessible gait database CASIA, demonstrate that it is conceivable to do huge scale human identity recognition from gait data captured in different view-focuses, with numerous cameras and with use of subtle soft/secondary biometric data.

S. Gabriel-Sanz et al. [10], concentrated on the appraisal of gait recognition on a constrained scenario, where limited data can be extract from the gait image sequences. Specifically, author interested in accessing the execution of gait images when just the lower part of the body is procured by the camera and only half of a gait cycle is accessible (SFootBD database). Hence, various state-of-art feature approaches have been taken after and connected to the information. A correlation with a standard and perfect gait database (USF database) is additionally carried out utilizing comparative experimental protocol. Results demonstrate that great recognition execution can be accomplished utilizing such constrained information data for gait biometric (around 85% of rank 5 identification rate and 8.6% of EER).

A. O. Lishani et al. [11], proposes a supervised feature extraction technique which can choose discriminative features for human gait recognition under the variations of clothing and carrying conditions and thus to enhance the recognition performances. The proposed strategy depends on the utilization of Haralick's texture features separated locally from three areas of Gait Energy Images. The execution has been assessed utilizing CASIA Gait database (dataset B). The experimental utilizing one-against-all SVM classifier yields attractive results when contrasted with existing and similar methods.

S. C. Bakchy et al. [12], proposed a developed technique for gait identification utilizing the feature Gait Energy Image (GEI). It is executed utilizing Kohonen Self-Organizing Mapping (KSOM) neural network. GEI representation of gait contains all data of each image in one complete gait cycle and requires less storage and low processing speed. As just a single image is sufficient to store the important data in GEI feature, the recognition process is less easy than any other feature of gait recognition. Gait recognition has a few limitation like viewing angle variation, walking speed, clothes, carrying load and so forth. Robust View Transformation Model (RVTM) is utilized to take care of the issue of viewing angle. RVTM transforms the viewing angle information from different angle to particular angle. RVTM improves recognition performance.

W. G. Bhargavas et al. [13], Identification of a person based on gait has made a circle of interest in computer vision space because of its high recognition capacity even at a far separation. Vision based position recognition can support Human Computer Interaction (HCI) efficiently. Gait recognition innovation can be utilized in numerous regular civilian and high security applications like car parks, banks, military bases, railway stations and airports. The fundamental point of the task is to build up the automatic biometric framework to distinguish a person in view of his Gait. This can be executed by recognizing the subject from the video outline, vital feature extraction utilizing skeleton data got from Microsoft Kinect sensor and classification against the database.

Z. Wu et al. [14], studied a CNN-based gait recognition method, with an extensive empirical evaluation in terms ofvarious recognition tasks, preprocessing approaches and network architectures. With this method, we have updated the best recognition rates on three challenging datasets, showing its robustness to viewpoint and walking condition variations, and its generalization ability to huge datasets and complex backgrounds.

TABLE I: Comparison between existing methods

Ref.	Dataset	Finding	Features Extraction	Method Used	Recognition rate
M. Hofmann et al. [7], 2012	HumanID Gait Challenge	Author presented a new and highly efficient feature extraction method for person identification. By taking HOG features instead of silhouettes in the Gait Energy Image representation, a basic pattern recognition framework easily outperforms the current state of the art.	Gait	GHEI method	56%
E. Hossain et al. [8], 2012	multi-view gait database (36 degrees, 90 degrees and 126 degrees view points)	Author evaluation of several subspace based gait feature extraction approaches (PCA/LDA) and learning classifier methods (MLP/SMO) on different datasets from a publicly available gait database CASIA, show that it is possible to do large scale human identity recognition from gait information captured in multiple view-points, with multiple cameras and with usage of subtle soft/secondary biometric information.	3 different views for gait	PCA and LDA	82.5%
S. Gabriel-Sanzet al. [9], 2013	USF database (130 users and 9893 gait image)	Evaluation of gait recognition systems over data with limited information (SFootBD) has been carried out. For this, six state-of-the-art feature approaches (AEI, MSCT, GFI, GEl, EGEI and MPCA) have been applied to the gait data. Similar experimental work has been followed over an ideal gait database (USF database) in order to compare results.	Gait	MPCA and EGEI methods	85.64%
A. O. Lishaniet al. [10], 2014	CASIA database	Author proposed method is based on the use of Haralick's texture features extracted locally from three regions of Gait Energy Images. The performance has been evaluated using CASIA Gait database (dataset B). The experimental using one-against-all SVM classifier yields attractive results when compared to		SVM classifier	93%

		existing and similar techniques.			
S. C. Bakchyet al.[11], 2016	CASIA-B multiview dataset	Proposed method compares the recognition performance with template based feature extraction which needs to process each frame in the cycle. Author use GEI which gives all possible information about all the frames in one cycle and results in better performance than other feature of gait analysis.	Gait	KSOM neural network	57%
W. G. Bhargavaset al.[12], 2017	200 video sequences	Gait identification system is implemented using skeleton information obtained by the Kinect sensor. The database is created for 20 persons consists 10 video sequences for each person. System performance is tested with Kinect sensor fixed at a one position in both indoor and outdoor environment. The new method has been introduced for feature value selection. Support Vector Machine algorithm is used for classification.	Gait	SVM algorithm	93%
Z. Wu et. al.[13], 2017	OU-ISIR gait dataset	A CNN-based gait recognition method, with an extensive empirical evaluation in terms of different recognition tasks, pre-processing approaches and network architectures. With this method, Author have updated the best recognition rates on three challenging datasets, showing its robustness to viewpoint and walking condition variations, and its generalization ability to large datasets and complex backgrounds.	Gait	CNN	91%

IV. CONCLUSION

Here, we have introduced the comprehensive study of human gait biometrics, approaches included, different affecting factors for gait recognition and applications of gait investigation in biomedical engineering. Different recent advancement in gait recognition are featured. Biomedical applications of gait are depicted on broad level. We have discovered that notwithstanding of the advancement in biometric technologies, gait is still in early stage and there is enormous extent of research. Real areas where research can be focused are highlight extraction procedures; different search optimization techniques for enhancing the speed of identifying human from a tremendous database. Likewise, because of progressions in database innovation, there is a test in integrating it with current gait biometric framework.

REFERENCES

[1] R. D. Green and L. Guan, "Quantifying and Recognizing Human Movement Patterns from Monocular Video Im-ages-Part II: Applications to Biometrics," IEEE Transac-tions on Circuits Systems for Video Technology, Vol. 14, No. 2, 2004, pp. 191-198.

[2] Davrondzhon Gafurov., A Survey of Biometric Gait Recognition: Approaches, Security and Challenges, NIK-2007 conference.

[3] L. Wang, H. Z. Ning, T. N. Tan and W. M. Hu, "Fusion of Static and Dynamic Body Biometrics for Gait Recog-nition," IEEE Transactions on Circuits and Systems for Video Technology, Vol. 14, No. 2, 2004, pp. 149-158.

[4] Bobick, A., Johnson, A.: Gait recognitin using static activity-specific parameters. In: Computer Vision and Pattern Recognition 2001. Volume I., Kauai, HI(2001).

[5] J. B. dec. M. Saunders, V. T. Inman and H. D. Eberhart, "The Major Determinants in Normal and Pathological Gait," The Journal of Bone and Joint Surgery, Vol. 35-A, No. 3, 1953, pp. 543-558.

[6] Jeffrey E. Boyd, James J. Little, "Biometric Gait Recognition", Springer-Verlag Berlin Heidelberg, pp. 19–42, 2005

[7] M. Hofmann and G. Rigoll, "Improved Gait Recognition using Gradient Histogram Energy Image," 2012 19th IEEE International Conference on Image Processing, Orlando, FL, 2012, pp. 1389-1392.

[8] E. Hossain and G. Chetty, "A multi-modal gait based human identity recognition system based on surveillance videos," 2012 6th International Conference on Signal Processing and Communication Systems, Gold Coast, QLD, 2012, pp. 1-4.

[9] S. Gabriel-Sanz, R. Vera-Rodriguez, P. Tome and J. Fierrez, "Assessment of gait recognition based on the lower part of the human body," 2013 International Workshop on Biometrics and Forensics (IWBF), Lisbon, 2013, pp. 1-4.

[10] A. O. Lishani, L. Boubchir and A. Bouridane, "Haralick features for GEI-based human gait recognition," 2014 26th International Conference on Microelectronics (ICM), Doha, 2014, pp. 36-39.

[11] S. C. Bakchy, M. R. Islam and A. Sayeed, "Human identification on the basis of gait analysis using Kohonen self-organizing mapping technique," 2016 2nd International Conference on Electrical, Computer & Telecommunication Engineering (ICECTE), Rajshahi, 2016, pp. 1-4.

[12] W. G. Bhargavas, K. Harshavardhan, G. C. Mohan, A. N. Sharma and C. Prathap, "Human identification using gait recognition," 2017 International Conference on Communication and Signal Processing (ICCSP), Chennai, 2017, pp. 1510-1513.

[13] Z. Wu, Y. Huang, L. Wang, X. Wang and T. Tan, "A Comprehensive Study on Cross-View Gait Based Human Identification with Deep CNNs," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 39, no. 2, pp. 209-226, 1 Feb. 2017.

