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A Survey On Human Testimonial By Gait Recognition

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***Abstract*—The purpose of this Project is to detect humans based their Walking styles. Identification of a person based on gait has created a sphere of curiosity in computer vision domain due to its high recognition capability even at a far distance. The main aim of the project is to develop automatic biometric system to identify a person based on his Gait. Biometric identification like fingerprints, retina, palm and voice recognition needs subject's permission and physical attention and it takes long time to complete the process. But for Human Gait recognition it works on the gait of walking subjects to identify people without them knowing or without their permission, because each gait is unique, the recognition algorithms encounter new data every time they are used. The more gait variants the system sees, the better it analyses future data. Here, Gait recognition technology uses several sources or capture devices — video cameras, motion sensors, and so on — to acquire data, with the development of Computer Vision techniques, there are many approaches to human identification by movement in video, using natural biometric characteristics (the human skeleton, silhouette, change while walking) and abstract features. we first extract the gait features from image sequences using the Feature Module. Features are then trained based on the frequencies of these feature trajectories, from which recognition is performed. The identification of human activities in a video, such as a person is walking, running, jumping, jogging etc are important activities in video surveillance.**

***Key Words*— Vision techniques, Gait recognition, automatic biometric**

I. INTRODUCTION

A. About Gait Recognition

Human gait recognition using the model-free approaches can be done through the analysis of moving shape and motion of the subject's body. Gait recognition biometrics is a lesserknown but a powerful biometric recognition method, in which subjects can be identified with their manner of walking. The theory behind this recognition system is that every person has a unique gait. It has also been a common experience that a familiar person can be recognized by his/her gait from a distance. Increasing influence of biometrics in today's personal recognition needs has also led researchers to leverage capabilities of gait recognition. It is one of the few recognition methods that can identify people from a distance and can improve accuracy when used with other security and surveillance techniques. Identification is one of the most important aspects in security. Biometrics is one of the techniques that can be used to identify an individual. For example, fingerprint recognition is used for identifying people from each other by using their fingerprints. In addition to fingerprint recognition, other biometrics include ear, vein, retina and gait recognition. Gait recognition, identifying a person's body movement, is also a technique of biometrics. In gait analysis, a person's movement describes personal way of walking and that means it could be used for identifying a person. Gait recognition is a biometric technique that is used for identifying biological and behavioural specification. Gait recognition technology methods divide into two; first one is holistic-based method and the second one is model-based method. Holistic-based approach relies on extracting statistical features of motion-based while model-based method identifies body parts to create a 3D gait model.

Human gait may depend or many biological, habitual and external factors, these factors can be categorized in the following:

- Physical factors: such as height, weight and physique of the person
- Intrinsic factors: person's sex (M/F), age
- Extrinsic: clothing, terrain, footwear, etc.
- Physiological: proportions of body

Psychological: emotions affecting the gait, personality type Following parameters are taken into account for the analysis of human gait: Length of step, Length of stride, Speed, Dynamic Base, Hip Angel, Foot Angle, Squat Performance are some of the parameters taken into account for while designing the system for the analysis of human gait. With the development of Computer Vision (CV) techniques, there are many approaches to human identification by movement in video, using natural biometric characteristics (the human skeleton, silhouette, change while walking) and abstract features. A gait recognition system uses the shape of

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the human body and the way it moves in order to identify it. The software, using CV algorithms, detects a human silhouette on video and analyzes its movements. These data create a human behavioural model.

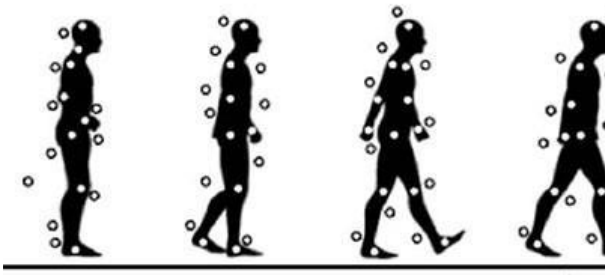

fig: Gait recognition systems can establish identity and identify people by mapping the unique manner they walk with.

B. *About Kinect Sensor*

The Kinect sensor was designed to change the way you play with game consoles in homes. It was the first device that allowed us to operate a console, without direct contact with a controller. Only through its visual systems are we able to control the functionalities of the device. It was launched in 2009, at the Electronic Entertainment Expo 2009. Its original name was "Project Natal". It can be defined as a free game and entertainment controller and its creator was Alex Kipman. Microsoft decided to develop it for the Xbox 360 game console. In 2011 the second version for PC with Windows 7 and Windows 8 came out. The characteristic that makes it different is the ability to recognize gestures, voice commands and objects in images. It is an innovative technology, behind which there is a combination of cameras, microphones and software. All of this is contained within Kinect. All these data were loaded into a neural network for image processing. After training, it recognized people by their gait with close to 100% accuracy. The work of the ML system is based on the principle of deep residual learning, enabling the identification of a person through the spatial and temporal characteristics of their footprint. We use Kinect sensor to capture the video surveillance. The characteristics makes it difficult is the ability to recognize gestures, voice commands and objects in images. It is an innovative technology, behind which there is a combination of cameras, microphones and software. All of this is contained within Kinect. Basic parts of Kinect sensor are RCB color video camera, IR emitter, Depth chamber, Microphone set, Tilt motor. Once the sensors capture the information, they are immediately processed by artificial intelligence software. It is able to classify the different objects that are within a scene. It recognizes humans by its head and limbs. But what really equips this intelligence device is the software. Kinect is capable of capturing an incredible amount of data. Always setting your goal on the things that move in your environment. Thanks to the processing of this data through an artificial intelligence algorithm and machine learning methods, Kinect can map the visual data it obtains through its sensors. The goal is to be able to detect human beings and understand what position each detected person is in. Kinect understands how a human being moves and assumes, for example, that we are unable to turn our heads 360º and other impossible actions that we can perform. This is very simple for us, but for a machine it involves a long learning period. The Kinect contains three vital pieces that work together to detect your motion and create your physical image on the screen: an RGB color VGA video camera, a depth sensor, and a multi-array microphone. The camera detects the red, green, and blue color components as well as body-type and facial features.

How do Gait Biometrics Work: Gait biometric systems capture step patterns using video images and then convert the collated data into a mathematical equation. Gait as a biometric measure can be influenced by several factors, including footwear, terrain, fatigue, and injury. The primary determinant of gait is the size of the human skeleton. Terrain also plays a role it can cause changes in a person's speed. In gait analysis, a person's movement describes personal way of walking and that means it could be used for identifying a person. Gait recognition is a biometric technique that is used for identifying biological and behavioural specification. Gait recognition technology methods divide into two; first one is holistic-based method and the second one is model-based method. Holistic-based approach relies on extracting statistical features of motion-based while model-based method identifies body parts to create a 3D gait model. Injuries and footwear are also significant if a person walks barefoot, their gait changes; if a person has been injured, the effect on the gait can be unpredictable. In addition, the system needs to analyse the development of a person's muscles and how tired they are. The system can recognize a person it already knows with almost 100 percent accuracy, and the error rate was just 0.7 percent.

II. LITERATURE REVIEW

The research papers help us to find the existing models and guide us to develop a new thesis by overcoming the problems which have been found out.

[1] A Novel Algorithm of Gait Recognition Haitao Liu, Yang Cao, and Zengfu Wang Department of Automation, University of Science and Technology of China, Hefei 230027, Anhui, China As one of the biometrics, gait recognition has

many advantages such as from a distance, lower quality video, hard to disguised comparing with others. However, nearly all studies on gait recognition are 2D methods based on analysis of image sequences captured by a monocular camera. This paper presents a novel 3D method for automatic gait recognition by analyzing the changes of a 1D silhouette signal. Binarized silhouette of a moving individual is firstly achieved. Secondly contour is extracted for next stereo matching. Afterward 3D contour is obtained through a step of contour based stereo matching.

[2] A survey paper on Individual recognition using gait energy image by J.Han; Bir Bhanu published by IEEE In this paper, we propose a new spatio-temporal gait representation, called Gait Energy Image (GEI), to characterize human walking properties for individual recognition by gait. To address the problem of the lack of training templates, we also propose a novel approach for human recognition by combining statistical gait features from real and synthetic templates. We directly compute the real templates from training silhouette sequences, while we generate the synthetic templates from training sequences by simulating silhouette distortion.

[3] Mogan, Jashila Nair & Lee, Chin-Poo & Lim, Kian & Anbananthen, Kalaiarasi. (2022). Gait-ViT: Gait Recognition with Vision Transformer. Sensors (Basel, Switzerland). 22. 10.3390/s22197362. Gait is one of the most reliable biometrics due to its advantages, such as being perceivable at a long distance and difficult to replicate. The existing works mostly leverage Convolutional Neural Networks for gait recognition. The Convolutional Neural Networks perform well in image recognition tasks; however, they lack the attention mechanism to emphasize more on the significant regions of the image. The attention mechanism encodes information in the image patches, which facilitates the model to learn the substantial features in the specific regions. As for the classification, the first element of the sequence is sent to the multi-layer perceptron to predict the class label. The proposed method obtained 99.93% on CASIA-B, 100% on OU-ISIR D and 99.51% on OU-LP, which exhibit the ability of the Vision Transformer model to outperform the state-of-the-art methods.

[4] Masood, Hajra & Farooq, Humera. (2021). An Appearance Invariant Gait Recognition Technique Using Dynamic Gait Features. International Journal of Optics. 2021. 1-15. 10.1155/2021/5591728. The shape of the human body varies according to the subject's clothing and carrying conditions. The clothing choice changes every day and results in higher intraclass variance and lower interclass variance. Thus, gait verification and gait recognition are required for person identification. The standard deviation of Cross-Correlation Score lies in the range of 0.12 to 0.2 and reflects a strong correlation in Dynamic Gait Features of the same class. We achieved 98.5% accuracy on Support Vector Machine based gait recognition. Additionally, we develop a multiapproach-based gait dataset that captures the effects of South Asian Native Clothing (SACV-Gait dataset).

[5] Chen, Xin & Luo, Xizhao & Weng, Jian & Luo, Weiqi & Li, Huiting & Tian, Qi. (2021). Multi-View Gait Image Generation for Cross-View Gait Recognition. IEEE transactions on image processing: a publication of the IEEE Signal Processing Society. PP. 10.1109/TIP.2021.3055936. Cross-view gait recognition is a challenge task because view variance may produce large impact on gait silhouettes. The development of deep learning has promoted cross-view gait recognition performances to a higher level. However, performances of existing deep learning-based cross-view gait recognition methods are limited by lack of gait samples under different views. In this paper, we take a Multi-view Gait Generative Adversarial Network (MvGGAN) to generate fake gait samples to extend existing gait datasets, which provides adequate gait samples for deep learning-based cross-view gait recognition methods.

[6] Li, Guodong & Guo, Lijun & Zhang, Rong & Qian, Jiangbo & Gao, Shangce. (2022). TransGait: Multimodal-based gait recognition with set transformer. Applied Intelligence. 1-13. 10.1007/s10489-022-03543-y. In this paper, we propose a new multi-modal gait recognition framework based on silhouette and pose features to overcome these problems. Joint features of silhouettes and poses provide high discriminability and robustness to the pedestrians' clothing and carryings. Furthermore, we propose a set transformer model with a temporal aggregation operation for obtaining set-level spatio-temporal features. The temporal modeling approach is unaffected by frame permutations and can seamlessly integrate frames from different videos acquired in different scenarios, such as diverse viewing angles. Under the most challenging condition of walking in different clothes on CASIA-B, the proposed method achieves a rank-1 accuracy of 85.8%.

[7] Luo, Jun & Wu, Haonan & Lei, Lei & Wang, Huiyan & Yang, Tao. (2021). GCA-Net: Gait contour automatic segmentation model for video gait recognition. Multimedia Tools and Applications. 81. 10.1007/s11042-021-11248-6. This paper presents a novel gait contour automatic

segmentation model (GCA-Net) for gait recognition in videos. To improve the segmentation and edge fitting accuracy, we firstly use the dilated convolutions in the residual block to enhance the feature representative ability of the ResNet backbone, and then an edge detection module is added to the model which can make the predicted gait contour closer to the actual boundaries and therefore improve the edge fitting result. The experiment results show the effectiveness of the proposed method. The edge detection module can increase the performance by 5.4% and the residual block with dilated convolution can further increase the performance by 0.4%. More important, the proposed model can be directly integrated into existing gait recognition methods and automate video gait recognition.

[8] Li, Na & Zhao, Xinbo. (2022). A multi-modal dataset for gait recognition under occlusion. Applied Intelligence. 1-18. 10.1007/s10489-022-03474-8.
In this paper, OG RGB+D dataset is presented to cope with this crucial limitation of other gait datasets. It includes the common walking conditions under occlusion in daily life, that is, those daily walking conditions in which people's normal walking patterns are occluded, including self-occlusion caused by views, occlusion caused by clothing or objects, and mutual occlusion between people. The dataset provides multi-modal data to support different types of methods, collected by multiple Azure Kinect DK sensors using synchronous data acquisition system.

[9] Nie, Xuan & Li, Hongmei. (2022). Gait recognition based on margin sample mining loss. Multimedia Tools and Applications. 1-19. 10.1007/s11042-022-13019-3.
In this paper, we solve the above problems based on two aspects. Firstly, a gait recognition method based on MSM Loss is proposed. In this way we are able to extract more discriminative spatio-temporal features; Secondly, we also introduce a new input method, which makes each input sequence more closely related, thus improving the gait recognition rate. Finally, the proposed method is verified on the CASIA-B and OU-MVLP dataset. In CASIA-B, the average recognition rate is obtained under the walking conditions of normal, with bags and with clothes. With rank-1 accuracy under LT, the method proposed in this paper can reach 96.4% under NM, 89.1% under BG and 71.2% under CL.

[10] Davis, James. (2001). Visual Categorization of Children and Adult Walking Styles. 10.1007/3-540-45344-X_43.
For the analysis, we coordinate a minimalist point-representation of the human body with a space-time analysis of head and ankle trajectories to characterize the modality. Together the properties of relative stride length and stride frequency are shown to clearly differentiate children from adult walkers. The highly correlated log-linear relationships for the stride properties are exploited to reduce the categorization problem to a linear discrimination task. Using a trained two-class linear perceptron, we were able to achieve a correct classification rate of 93--95% on our dataset

[11] Fathima, Sithi & Valanarasi, A. (2016). Human gait recognition using relevance vector machine classifier. 564-568. 10.1109/ICACCCT.2016.7831703.This Work aims to develop a system capable of Human gait recognition by using model free approach. The gait database consists of silhouettes i.e., outer frame of the human body. These silhouettes are affected by noises and discontinuities. So, pre-processing of silhouettes is required. These feature vectors are used for training and testing by using Relevance Vector Machine Classifier. RVM classifier efficiently identifies the person. The silhouettes are taken from Institute of Automation Chinese Academy of Science (CASIA), China. By using robust algorithm, the quality in human silhouettes is initially improved in order to increase the gait recognition rate of a person. The proposed method produced 90% of recognition rate.

[12] Turchet, Luca & Bresin, Roberto. (2015). Effects of Interactive Sonification on Emotionall Expressive Walking Styles.IEEE TransactionaffectiveComputing.10.1109/ TAFFC.2015. 2416724. This paper describes two experiments conducted to investigate the role of sonically simulated ground materials in modulating both production and recognition of walks performed with emotional intentions. The results of the first experiment showed that the involved auditory feedbacks affected the pattern of emotional walking in different ways, although such an influence manifested itself in more than one direction. The results of the second experiment showed the absence of an influence of the sound conditions on the recognition of the emotions from acoustic information alone. Similar results were found in both experiments for musically-trained and untrained participants. Our results suggest that tempo and sound level are two acoustical features important in both production and recognition of emotions in walking.

[13] Semwal, Vijay & Gaud, Neha & Lalwani, Praveen & Bijalwan, Vishwanath & Alok, Abhay. (2022). Pattern identification of different human joints for different human walking styles using inertial measurement unit (IMU) sensor. Artificial Intelligence Review. 55. 10.1007/s10462-021-09979-x. To perform the walking task, in the

current work, human gait data of six different walking styles named brisk walk, normal walk, very slow walk, medium walk, jogging and fast walk is collected through our configured IMU sensor and mobile-based accelerometers device. To capture the pattern for six different walking styles, data is extracted for hip, knee, ankle, shank, thigh and foot. A total six classes of walking activities are explored for clinical examination. The accelerometer is placed at center of the human body of 15 male and 10 female subjects. The model classification accuracy is obtained as 87.4%, 88% and 92%, respectively.

[14] Srinivasan, Purushothaman & p.rajeswari, & P., Sripriya. (2022). Implementation of Human Walking Action GAIT Recognition Using Hidden Markov Model and Radial Basis Function Neural Network. 5. 416-419. This paper presents the importance of RBF to identify the human GAIT.GAIT is one of the biometrics that can be measured at a distance and useful for security surveillance and biometric applications. The attraction of using GAIT as a biometric is that it is non-intrusive and typifies the motion characteristics specific to an individual. The proposed system attempts to recognize people by modelling each individual's GAIT using HMM. The HMM is a good choice for modelling a walk cycle because it can model sequential processes.

III. PROBLEM IDENTIFICATION

In various research papers, the detection of human being is done by applying Machine Learning and CV algorithms. When these algorithms are applied on the gait recognition of humans then the authentication of human being is done very fast and a higher accuracy without knowing them or without their permission.

As many forms of recognition systems exist in real time implementation like face recognition, fingerprint recognition, and other biometrics include ear, vein, retina. Gait analysis is future recognition system for authenticating a person. Gait analysis is done by taking the walking style of an individual by considering the gait cycle. The gait recognition system has a greatest advantage then other recognition systems because its being unobtrusive and distance recognition.

IV. REVIEW FINDINGS

1) Based on the above reviews we are able to find the problems in the existing systems and feature that are to be improved in to the proposed system.

2) The reviews helped us lot about the technologies not only the technologies and how the gait recognition is reaching in various applications.

3) From the reviews we realized how important gait recognition biometric and how fastly the gets biometred without involvement of the humans.

4) Computer vision algorithms play vital role to transfer the video data to picture format and analysis a human based on gait.

V. CONCLUSION

Human gait can be captured with video camera, sensors and even with radar waves and unique pattern can be extracted out of this gait data. Human beings have some ability to identify people with their gait even if their face or other features are not visible. It becomes possible because people repeat a specific pattern while they walk. This pattern is developed over time and dependent on many physical and behavioural factors. This manner of walking or gait can produce statistically significant data if mapped correctly and help recognize people. It produces High Accuracy system, High security recognition and also support 3D recognition. The gait is digitized using high-resolution sensors and cameras. The system then analyses all the data, including weight distribution, gait speed, and three-dimensional features of each walking style. Here we use Kinect sensor to capture the gait of humans. Gait recognition technology is less touchy-feely than other biometric verification systems such as retinal scans or fingerprints. Thus, it is non-invasive and can be applied without user consent. Moreover, the success rate of this technology is high the error rate is only 0.7%.

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