A Survey on Gait Analysis versus other Security Techniques

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Abstract- Gait Analysis is a new profound human sensor which focuses on human locomotion. The word 'gait' means the manner of walking. It is a highly secured technique in which a person's gait is stored offline in a database and for security reasons the previous data is matched with the present one in order to grant access to a highly secured area. Before considering human locomotion, many other parameters like age, height, weight, health, speed etc. are taken into account. This paper focuses on how Gait Analysis can be used in the field of security in comparison with other existing techniques. Previously and presently, Gait Analysis is being used in animation movie making, visual world creation etc. Its use can be expanded to various other fields like medical sciences, biometric identification etc. in order to provide benefit to the human beings.

Index Terms- Biometric Identification, Gait Analysis, Human Sensor, Parameters, Facial Recognition, Iris Recognition, Retina Scanner.

I. INTRODUCTION

When a computer is connected to the internet, it automatically welcomes all the zillions of viruses, thefts and other malicious attacks present on the web. Various firewalls and antivirus are invented to protect our assets from the malicious web. But most of them can be easily breached. On the contrary, gait analysis is entirely different because human locomotion is the last thing in the world that can be copied to access a human being's privacy. Virtual world creation and animation movie making were some fields where Gait Analysis is being used extensively since many years. This paper emphasizes on the working behind this technique in the newly used fields.

II. LITERATURE REVIEW

Gait Analysis technique has been surveyed by many authors and scientists in various field and various algorithms rendering approximate calculations have been derived. Davrondzhon Gafurov [4] surveyed that biometric systems are more reliable and in demand as compared to other devices. Gait Recognition in biometric system makes it even more relevant and trustworthy. Gait Recognition in biometric System can be achieved in three ways: - Floor Sensor, Machine Vision and Wearable Sensors. Each of which has its own applications, advantages and disadvantages. Davrondzhon Gafurov et. al. [5] suggested a biometric authentication based on a person's gait. In this case, Gait movements are recorded using a physical device attached on the lower leg. Acceleration in vertical, forward-backward & sideways, direction was recorded and a combination of these acceleration is used for authentication.

According to R.J.Jefferson et. al. [7], two walking systems were emerged for paralyzed patients: The hip guidance orthosis (HGO) or "Para walker" was developed by Gordon Rose et. al. The reciprocating gait orthosis or RGO was developed by Roy Douglas. Aged people often fall which sometimes results into severe injuries. N.Shibuya et. al. [1] reported a custom-designed Wireless Gait Analysis Sensor system (WGAS) to detect falls in elderly people. The performance of WGAS was evaluated using a Support Vector Machine (SVM). To perform Gait Analysis, the way of data acquisition is complex and devices developed so far are expensive and difficult to operate. Ji-jian Hou et. al. [2] designed a new system for data acquisition in Gait Analysis which can be used to analyze human gait under every circumstances. With the help of embedded nodes, the systems consist of a network of nodes. There experiment was successful and was used to acquire several gait parameters like stride length to improve gait under different diagnostic conditions. Gait Analysis technique can be performed at a distance and cameras attached on the rooftop in case of tall buildings cannot capture the gait features accurately. Ryo Kurazume et. al. [3] proposed shadow biometrics in which the gait parameters can be extracted from the shadow of the person. Images were taken from an oblique angle with the ground such that information from both perspectives i.e. body and shadow areas can be considered from two different viewpoints – Sun and camera. Information from both the perspectives collectively determined the exact rate. If the walking direction differs from the Sun's position, then the rate of data accuracy decreases. Gait Researchers are working on the "change in walking direction" problem, since change in walking direction shall decrease robustness.

III. RESEARCH PROBLEM

In today's tech savvy world, security is of primary concern. Be it in any field, we keep security at the top in our priority list. However, the security measures are nowadays not as safe as they were when it is was invented. To crack them is not impossible, therefore to protect them; a highly secured measure should be taken. To overcome these problems, a new measure is required which can maintain and improve security level. This paper aims to deliver the fact that Gait Analysis is one of the secured human sensors invented till now.

IV.   OBJECTIVE

The key motive of this paper is to compare Gait Analysis with other invented technologies or sensors to prove that Gait Technique is more secured. Gait Analysis has expanded its boundaries to fields like Biometric System and Medical Sciences and is providing benefits to the human being. This paper compares and analyses Gait technique with other devices like fingerprint scanner, retina scanner, iris scanner, signature recognition, facial recognition, voice recognition and hand geometry. In this paper a brief working regarding its process in the field of security has been explained.

V.   RESEARCH METHODOLOGY

Gait Analysis is the study of human locomotion, using the human organ of observers augmented by instruments used for measuring body movements, body mechanics and muscles activity (Fig. 1). It is a highly secured human sensor in comparison with the pre-existing ones. Parameters evaluated during the process of Gait Analysis are:-

- Foot Angle:-The angle in which the foot is kept while working.

- Speed:-Speed here refers to walking speed.

- Step Length:-The difference of length between right foot and left foot while walking.

- Progression Line:-The line maintained while walking.

- Arms Movement:-The movement of arm

  corresponding to the gait.

- Cadence - It is the walking rate. It is calculated in steps per minute.

- Stride Length – The distance between successive points of the initial contact of the same foot.
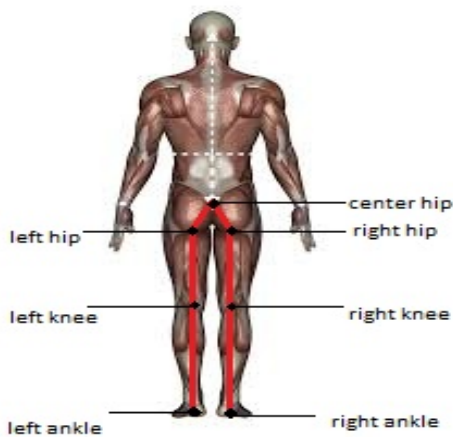

Figure 1: The identified joints on lower extremities by the Kinect sensor.

Biometric System is by far considered as the best identity verification device. Its results are 100% true and its demand is increasing day by day. Gait Recognition in Biometric Systems is a new technology surveyed by Davrondzhon Gafurov [4] .Gait Analysis in Biometric System will make it unbreachable. According to [4], Biometric gait recognition is of three categories: machine vision (MV), floor sensor (FS) and wearable sensor (WS). In MV technique, gait is captured using a video recorder from a distance. Techniques such video and image are processed to gain features for purpose like recognition by using gait. The main advantage of MV-based gait biometric is to capture image from a distance. For example: - Used for surveillance and forensics.

In FS, a pair of sensors is placed on the floor. It is used to measure features which are related to gait, when a person walks on the ramp (Fig. 2). It is used in access control application and is usually placed in front of doors in the building. Such systems are used as a part of multimodal biometric system.
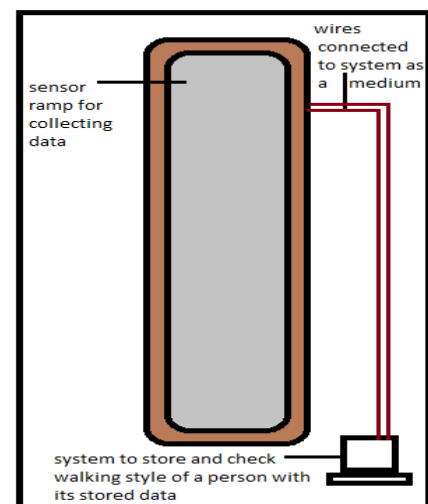

Figure 2: Block diagram of sensor mat

Wearable sensor approach uses Motion Recording (MR) sensors which can be worn anywhere in the body. The MR sensor records the gait acceleration which is further used for authentication. Wearable sensor is advantageous as compared to other biometric models since the way it collects gait information is unnoticeable and is mostly used in portable electronic devices.

Gait Analysis in the field of medical sciences has proved to be a success, especially for paralyzed patients. In [7], two designs of walking orthosis were practically emerged and surveyed. The Hip Guidance Orthosis was developed by Gordon Rose. This design is also known as the "Parawalker". Another design is the Reciprocating Gait Orthosis, developed by Roy Douglas.

Vicon motion analysis system and videotape were used to acquire values. The latter was used to determine basic Gait parameters like stride length, cadence etc. whereas the former was utilised for complete biomechanical assessment. Four television cameras were interfaced to minicomputers which record the levels of ankle, mid-foot, hip, knee and trunk support. RGO with a rollator and HGO with crutch was used to collect data and compare the two orthosis system.The processed data was then combined to provide average values of the relevant

parameters. One of the major aims of this paper is to list the benefits of Gait Analysis over other sensors involving different human traits. The benefits are as follows:-

• **Distance Based Identification:** It identifies a person by analysing his or her gait features from a distance. Identification based on distance is one of the prime advantages. But systems like fingerprint recognition, face recognition and iris recognition fails to detect an individual.

• **Analysing Low Quality of Data:** CCTV footage generates low quality images and is difficult to recognize an individual. It can be analysed with the help of gait biometrics to detect any person. Due to low quality of image it is impossible to examine an individual.

• **Poor Brightness:** It works in poor illumination conditions as well. It is not easy to check individual's recognition in such scenario, but identification based on motion is possible when light amount is less.

• **Not easy to cheat:** Copying a person's gait is the last possible thing in this world. Hence it is difficult for anyone to copy another individual's walking style and therefore it can be considered as the most secured human sensor invented so far.

The basic working of Gait Analysis in the field of security is as follows:-

Firstly, an offline data of a person will be stored in the database. This data constitutes of parameters like age, health, weight, gender, and other relevant gait parameters. *Secondly*, when that person needs to go through to a restricted area, the person walks through a ramp consisting of micro sensors and monitoring camera whose purposes is to monitor, store and verify the current walking style of that person which is simultaneously verified with the previously stored offline data. If both the data is matched then only that person is allowed to enter else he/she will be restricted. (Fig. 4)
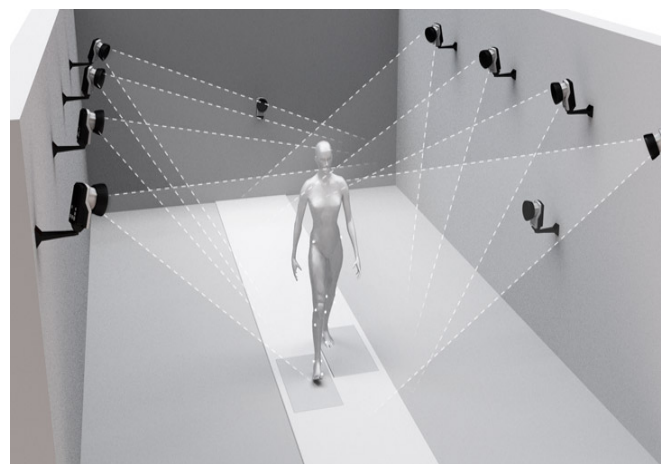

Figure 3: a) Hip Guidance Orthosis   b) Reciprocating Gait
Orthosis   Orthosis

Figure 4: Basic Setup of Gait Analysis

VI. ANALYSIS

While comparing Gait technology with other security measure's it is justified that till now Gait analysis technique is much more secure as compare with all currently working security techniques like face recognition ,voice recognition etc.

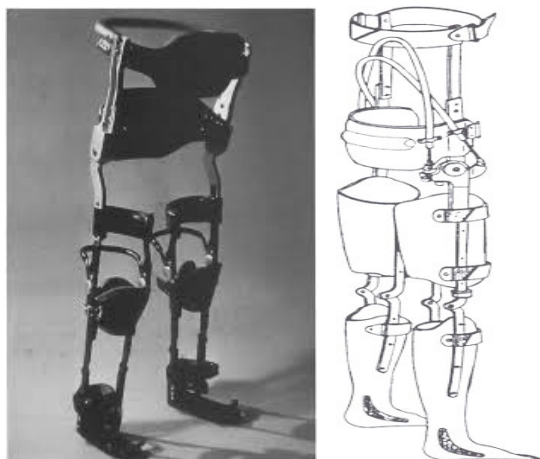| Technique	Advantages	Disadvantages
Face Recognition	Non- troublesome Cheap technology	It is affected when there is a change in lighting.
Voice Recognition	Non- troublesome Less expensive technology.	It has a drawback, with voice parameter's issue such as an illness can change a person's voice, therefore correct identification is difficult ,Low accuracy
Signature Recognition	Non-troublesome, Cheap technology.	It is designed to monitor subjects which are based on the quality of signature.
Retinal Scanning	Very highly correct.	Very troublesome very costly
Iris Recognition	Very highly correct.	Troublesome , It store more memory of data, Very expensive
Fingerprint Scanning	Very highly correct, Easy to use.	It has a drawback with skin related factor such as dryness or dirty finger's skin.
Hand Geometry	A unique hardware is use; it can be easily integrated into systems.	Very costly.

VII.   CONCLUSION & FUTURE WORK

This paper represents a brief acknowledgement about a profound sensor called "Gait Analysis". In this, gait patterns are recorded by using sensor which is attached to the body. The advantage of this technology over other types of biometric modalities is the ability to enable unobtrusive user authentication.

We have successfully managed to analyze bones movements in the region of human ankle from physical and medical aspects. It is a future technology whose concept is just introduced in some of the recent movies and is yet to commence in reality, the work is under progress. We also compared this technology with other security measures, and gave a brief about its benefits in different fields along with the working process behind this technology which helps in improving and maintaining the security is described in the paper. This technology is a concept in paper, whose implementation is yet not accomplished. Researchers are trying to practically implement it for increasing the level of security such that it cannot be breached. In future, this technology may be merged with cloud computing based frameworks to provide Security as a Service (SEAAS) just like existing services of cloud i.e. PaaS, SaaS, IaaS to make it easily affordable for its prospective customers such as Retail Database owners, E-Commerce website companies, Personalized Search Engines etc. to reduce the chances of leakage of important personal or organizational information to intruders/ competitors

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