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Human gender recognition using gait data andsupervised learning

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Abstract *The Internet of Things (IoT) has been integrated into various as- pects of our daily lives, making living easier. The rising application of machine intelligence in research problem-solving is centred on decision-making, and such advanced algorithms boost system performance results. Biometric identi- fication is also advancing, thanks to significant advances in IoT-based research and development. Aside from the more well-known biometric features, such as the iris and fingers, several investigations are being conducted on the char- acteristics of human movement activity in order to use it as a prospective biometric marker. The planned research was carried out utilising a standard database that was compiled using several sensors that collected data from both male and female volunteers. The experiments in this paper were carried out to demonstrate how a Multi Layer Perceptron based algorithm can be used to construct a reliable automated authentication system for human gender recognition based on gait signature.*
Keywords *Gender Identification Gait Data Human Gender Recognition Supervised Classification*

I. Introduction

The majority of sophisticated research in smart biometric systems focuses on authenticating and validating people's authenticity using numerous elements such as facial recognition, iris scanning, thumb impression, and so on. The study of how a person walks is also indicative of his personal attributes or gender, giving this field of research a new lease on life. Gait is defined as "a way of walking". Human gait, on the other hand, is much more than that; it is a distinctive feature of a person. It is determined, among other factors, by a person's weight, length, shoes, and posture, as well as their natural mobility. As a result, gait can be utilised as a biometric measure to distinguish between known and unknown subjects. The study related to human gait has a wide range of applications in domains such as computer animation, robotics, bio- metrics, biomechanics, and human-computer interaction, among others. When compared to other human activities, human gait data is one of the most com- plex. Gait may be detected and quantified at a low resolution, allowing it to be used in a variety of scenarios where the system's resources are insufficient to accommodate face or iris data for person identification. However, there are several significant obstacles in recognising gait from complex visual data, such as data segmentation of the foreground from the backdrop scene of a walking subject, as well as fluctuations in the camera's varied viewing angles in relation to the walking subjects, and so on.

The classification of genders is one of the most intriguing topics in gait data study. Gender classification can be done using a variety of other traits and technologies, such as face recognition and speech recognition, but in some circumstances, gait data has become a popular sector for gender categoriza- tion. Model dependence and a silhouette-dependent approach are two separate circumstances that can be taken into account for gait-based gender identifi- cation. The model-based technique usually produces a mathematical model that takes into account real-time changes in human walking signs, whereas the silhouette-based approach makes use of gait feature silhouettes, which are rather simple. The goal of the proposed research is to determine the effect of feature scaling and principal component analysis in improving the accuracy and performance of machine learning algorithms for gender recognition from gait data. Section II describes the different literature reviews of prior research based on this vertical, Section III discusses the data used for the done exper- iment, Section V discusses the experimental setup along with the outcomes, and Section VI provides the conclusion.

II. Literature Survey

The first studies on the analysis of human gait data were conducted in surgery
[9] and psychology [2], [7]. The patient's walking pattern was taken into ac- count when selecting an appropriate treatment in surgical applications. Data was taken at a close range in this case. Murray
[9] divided several aberrant gaits into various groups from a pathological standpoint in order to find ap- propriate therapies.

Several studies have found that gait is a reliable indication of gender and personal identification. Johansson used lights attached to various regions of the human body in [7] to show viewers the sequence of light movement while a person moves. Observers were able to determine the subject's gender and,in some cases, the subject's identity. Cutting et al. [3] used MLD as used by
to investigate human perception of gait and display the results on person identification and gender classification.

, [8] are examples of additional studies in which the accuracy gained was close to 70%. Goddard [4] developed a connectionist system for gait recog- nition using joint positions obtained from MLD. The researchers introduced an automated technique for gender classification based on human gait data in [10]. In this study, a three-stage classification was carried out: first, a moving body was detected from sequences of images, then features of human gait were gathered from various points on the body and angles of the joints, and finally, analysis of the extracted features was carried out for gender classification from the gait data. For this study, the researchers employed SVM and neural net- work classifiers. The gender classification system utilised by the researchers in
[11] was based on visual attributes. In this study, the crossrace gender classi- fication was done with a high level of accuracy. In [6], gyroscope sensors and accelerometers were incorporated in cellphones to capture gait data through some applications. It was possible to get a very good categorization result. The same model produced fairly consistent results when applied to two separate datasets acquired using different devices.

III. Details of the Data

The suggested approach employs data from multi-modal wearable sensing de- vices for the tests aiming at determining gender from human gait. A 30m range was set, and 16 people were requested to participate in the common activity of walking. 7 female and 9 male participants were requested to participate in the exercise in order to avoid gender biases in the data collected. The collected data [5] was utilised to derive a number of specific gait metrics for further analysis.

IV. Experiment and Results

The experiment for the proposed work has been conducted in a supervised learning based approach. Out of the different types of learning algorithms of this modality, the Multi Layer Perceptron algorithm has been chosen for this work as it is a very basic form of the Neural Network. The Neural Network based learning techniques are more advanced than the conventional algorithms due to their ability to mimic the neurological sequences of the human nervous system.

For the experiments, the selected data set was distributed into the train and test sets. The former was used for developing a trained classifier with the knowledge of the events and their consequences. The test set was utilized for judging the capability of the said classifier in terms of some standard metrics. The data segregation was done in a 70:30 ratio.

IV.1 Metrics of Performance Evaluation

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (1)$$

where, True Positive (TP) represents those instances which denote Male and were classified as Male; True Negative (TN) denotes the instances which denote Female were actually classified as not Male; False Positive (FP) represents the instances of Female data which were wrongly classified as Male data; False Negative (FN) means those instances of Male data which were wrongly classified as Female.

IV.2 Experimental Results

On performing the said experiments, it was observed that the MLP classifier was capable to accurately classify the data with 96.8% accuracy. The lack in this performance has been studied with the help of the confusion matrix in terms of TP, TN, FP and FN. The matrix has been illustrated with the help of a heatmap in figure 1.

In the figure, the TP, TN, FP and FN values have been converted to respective percentage values in reference to the total data. We find that the MLP classifier is capable of identifying Male as a Male 94% of the times correctly, while 6% of the times, the Males are classified as Females when gait data is used for gender identification. On the other hand, the mis-classification rate of Female as Male is only 1%, while 99% of Females are properly classified as Female.

Thus, we observe that the proposed automated system is largely capable of minimizing errors in gender identification, and can be effectively deployed as a gait-data based tool for automated gender identification.

V. Conclusion

The applications aimed at providing smart, automated solutions to the dif- ferent research-oriented problems in human life, can be effectively used in domains such as agriculture, industry, healthcare, etc. The current work has demonstrated how the automated identification of human gender can be easily resolved based on the extraction of hidden patterns from human gait data. It

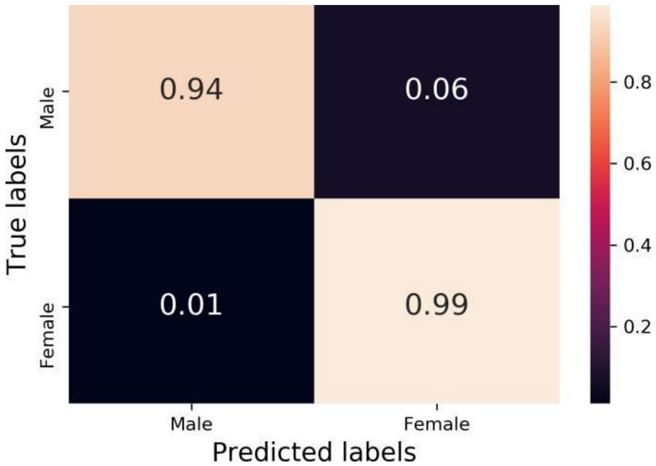

Fig. 1 Heatmap for the performance of MLP algorithm

has been observed on experimentation that the Multi-Layer Perceptron based classification system performs with a high accuracy about 97% by learning from the human gait features. This work can be further extended by the in- clusion of more data and features, as well as the implementation of more advanced algorithms that can result in better system performance towards developing a real-time gender identification system.

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