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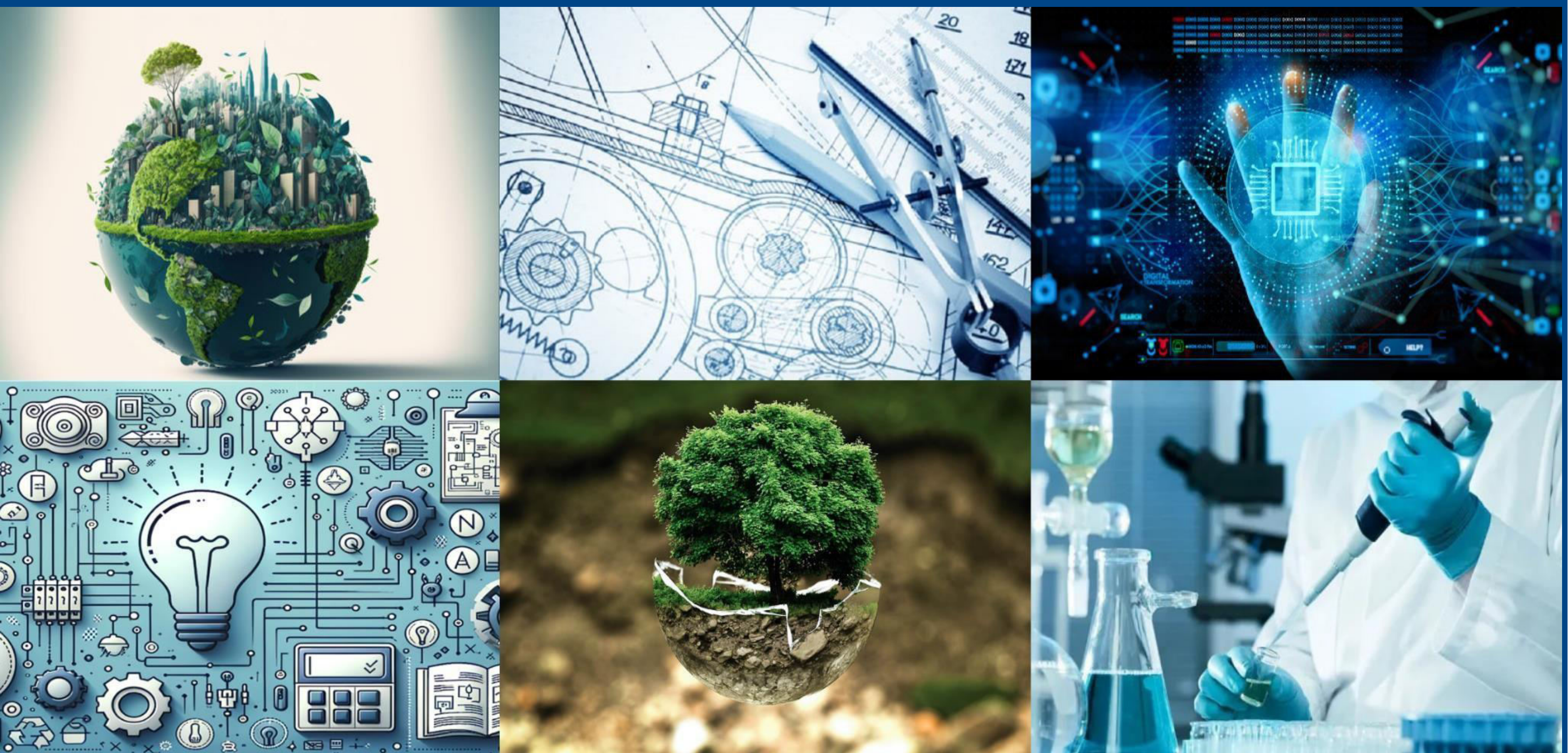

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Human Identification from Free Style Walk using Posture Gait

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ABSTRACT: Human identification through gait analysis has emerged as a promising biometric approach due to its non-intrusive nature and ability to function without subject cooperation. Unlike traditional methods such as fingerprint or facial recognition, gait recognition offers distinct advantages for surveillance and security, particularly in scenarios where direct interaction with individuals is not feasible. This report presents a posture-based gait recognition framework designed to identify individuals during free-form walking, including complex movements such as turning and changing directions.

The proposed system leverages posture-based characteristics and classification methods derived from body joint coordinates and relative displacements. By calculating the Center-of-Body (CoB) relative positions and analyzing dynamic joint movements across frames, the system generates robust gait features that capture unique walking patterns. Machine learning algorithms including CNNs, RNNs, and ensemble methods are applied for classification, enabling reliable recognition even under occlusions, varying camera angles, and environmental conditions.

KEYWORDS: Gait recognition, posture analysis, biometric identification, human recognition, free-style walks, Flask framework.

I. INTRODUCTION

Human identification plays a critical role in enhancing security, surveillance, and authentication systems across the globe. With the growing demand for reliable and unobtrusive biometric techniques, gait recognition has emerged as a powerful alternative to conventional methods such as fingerprint, iris, or facial recognition. Unlike these traditional approaches, gait analysis does not require the active cooperation of individuals, making it especially useful in real-world situations such as monitoring public spaces, forensic investigations, and access control. Gait, defined as the unique manner in which a person walks, encapsulates distinct body movements and posture dynamics that can serve as reliable biometric identifiers.

This report presents a posture-based gait recognition framework designed to identify individuals during free-form walking, including variations such as turning, changing direction, and walking at different speeds. The approach focuses on extracting robust posture-based features derived from body joint positions and their relative displacements. Specifically, the framework computes Center-of-Body (CoB) relative coordinates and analyzes sequential joint movements across frames, enabling the system to capture both static postures and dynamic transitions. This design addresses key challenges in gait recognition, such as varying camera perspectives, occlusions, and environmental conditions.

Machine learning and deep learning techniques, including Support Vector Machines (SVM), Convolutional Neural Networks (CNN), and Recurrent Neural Networks (RNN), are applied to classify extracted gait features with high accuracy. These models ensure resilience against variations in walking styles and external conditions, making the system adaptable to diverse real-world scenarios.

The significance of this work lies in its ability to provide non-intrusive, scalable, and accurate human identification. Potential applications include intelligent surveillance systems, forensic evidence analysis, biometric authentication, and personalized human-computer interaction. Despite challenges related to hardware limitations and computational requirements, the outcomes of this study demonstrate that posture-based gait recognition is a feasible and effective biometric modality. By combining accuracy, robustness, and practicality, this project contributes toward advancing secure and efficient human identification technologies for modern society.

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In recent years, the field of human identification has gained remarkable importance, largely due to the increasing demand for reliable, non-intrusive, and effective security solutions. The rise in global terrorist incidents, surveillance challenges, and identity fraud has made it essential to develop biometric identification technologies that go beyond conventional methods such as fingerprints, iris scans, or facial recognition. While these traditional biometric systems have been successful to a certain extent, they are often intrusive, easily compromised, or limited in applicability. In this context, gait recognition — the process of identifying individuals by their walking patterns — has emerged as a promising alternative. Unlike face or fingerprint recognition, gait recognition does not require close contact or cooperation from individuals. It can operate effectively at a distance, under non-intrusive conditions, and even in challenging scenarios such as low light or partial occlusion. This capability makes it a highly attractive tool for surveillance, forensic investigations, and access control systems.

The concept of gait recognition is rooted in the observation that each individual exhibits unique patterns of movement and posture when walking. These patterns are shaped by physical attributes such as body proportions, joint flexibility, and habitual motions, which together create a distinctive gait signature. While early gait recognition systems relied primarily on silhouette-based analysis or handcrafted features, recent advances in computer vision and machine learning have paved the way for more sophisticated approaches. One of the most notable directions in this field is posture-based gait recognition, which focuses on analyzing the relative positions and movements of body joints rather than just external outlines. By emphasizing skeletal postures and joint dynamics, this method enhances recognition accuracy, particularly in complex environments where silhouettes alone may fail.

This report proposes a novel posture-based gait recognition framework designed to improve identification performance during both fixed-direction walking and free-form walking scenarios. Unlike traditional gait recognition systems that often struggle when individuals change directions, turn around, or walk in unconstrained environments, the proposed method leverages center-of-body (CoB) relative coordinates and joint displacements across successive frames. This ensures that the system remains robust even when the subject deviates from straight-line walking. Importantly, the posture-based approach minimizes sensitivity to gallery size and maintains reliability across different test configurations, making it a viable candidate for real-world forensic and surveillance applications.

The primary objective of this project is to create a reliable and accurate system for identifying individuals based on freestyle walking patterns. To achieve this, the research explores how posture-based gait characteristics — including joint angles, limb displacements, and body postures — can be effectively extracted and classified. These features are inherently distinctive and difficult to replicate, thereby providing a strong foundation for biometric authentication. In addition to accuracy, the study also addresses critical challenges such as occlusions, varying camera viewpoints, and environmental inconsistencies. Since real-world surveillance often involves shifting perspectives.

II. LITERATURE SURVEY

A writing review on human recognizable proof from free-form strolls utilizing stance walk would include inspecting existing exploration and studies connected with this subject. It would incorporate an examination of different strategies, methods, and calculations used to recognize people in view of their strolling attributes and stances. One critical viewpoint to consider in the writing review would be the various kinds of elements and boundaries utilized for human ID. This might entail dismantling investigations. that attention on the kinematic attributes within the human body during strolling, like development of the appendages, points, joint positions, and designs for the steps. Additionally, it might likewise include investigating concentrates that integrate PC vision procedures and picture handling calculations to dissect explicit stances and step designs. The review ought to likewise incorporate an assessment of the exhibition and precision of the various methods that are suggested in the writing. This would incorporate separating and looking at repercussions of different investigations, taking into account factors, for instance, the size of the variety of subjects, the complexity of the walking climate, and the dataset. Just as it ought to be essential to recognize any constraints or difficulties related to current methodologies and make suggestions for areas that need more work. Furthermore, it would be valuable to investigate research that explores the likely applications. and ramifications of human-recognizable proof from free-form strolls utilizing stance step. This might encompass looking at concentrates on that emphasis on security and observation. frameworks, biometric confirmation, or even clinical applications connected with recognizing irregularities in strolling designs. In general, leading an extensive writing overview on human ID from free-form strolls Using stance step would include analysing existing research, evaluating methods and execution, and investigating possible applications and future headings in this field.

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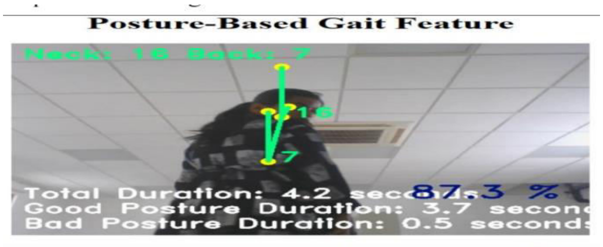
III. PROPOSED METHODOLOGY

The proposed methodology focuses on building a reliable and accurate posture-based gait recognition system capable of identifying individuals even in free-style walking conditions where people may change direction, turn around, or walk in unconstrained ways. Unlike conventional silhouette-based methods that often fail in dynamic environments, this approach emphasizes skeletal postures and joint dynamics to capture the unique movement patterns of individuals. The methodology begins with the acquisition of walking sequences through video cameras or sensors. The raw video frames are then preprocessed to eliminate noise, normalize data, and ensure that only meaningful motion information is retained. Following this, posture-based gait features are extracted, which include the relative coordinates of body joints with respect to reference points such as the hip center and spine, as well as the displacement of joints across consecutive frames. These features capture both static postures and transitional movements, making the system more robust against variations in perspective, clothing, and walking style. Once extracted, the features are represented numerically and classified using machine learning algorithms such as Support Vector Machines, Random Forests, or deep learning models like Convolutional and Recurrent Neural Networks. The classification stage matches the current gait sequence with stored profiles in a database, enabling accurate identification. Finally, system performance is evaluated using metrics like accuracy, recall, and cumulative match characteristics, ensuring that the proposed method maintains reliability even under challenging real-world conditions.

IV. SYSTEM DESIGN

The system design is structured around a modular machine learning pipeline that transforms raw walking data into meaningful identification results. At the architectural level, the design consists of several interconnected modules, including data acquisition, preprocessing, feature extraction, classification, and decision-making. Input video sequences are first collected through cameras or sensors and processed to remove noise and normalize frames. The feature extraction module then derives skeletal joint coordinates and posture-based displacements, which are passed on to the classification module for analysis. A database module maintains profiles of individuals, while the decision module generates the final identification output with associated confidence scores. The software development follows the Waterfall model, ensuring a sequential workflow beginning with requirement gathering, followed by design, coding, testing, deployment, and maintenance. This structured approach ensures clarity in system development and facilitates improvements during later stages. Furthermore, system interactions are captured using use case diagrams, which illustrate how users provide walk data, how the system extracts features, creates profiles, compares them with stored data, and ultimately identifies individuals. Similarly, a sequence diagram highlights the step-by-step flow of operations, beginning from data acquisition to preprocessing, feature extraction, profile comparison, and final identification. Overall, the system design ensures that the proposed methodology is implemented efficiently, providing a robust and scalable platform for posture-based gait recognition in practical applications such as surveillance, security, and biometric authentication.



[1]

When the connection is pasted, the camera turns on and displays the number of degrees and angles present from one joint to the next. There is a 16-degree angle from the neck to the shoulders in this image, therefore 16.

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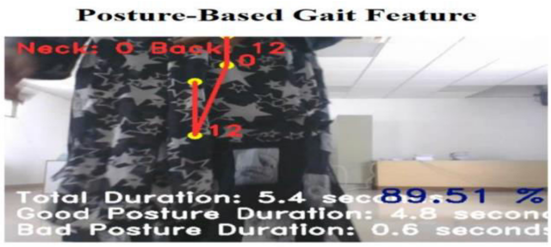
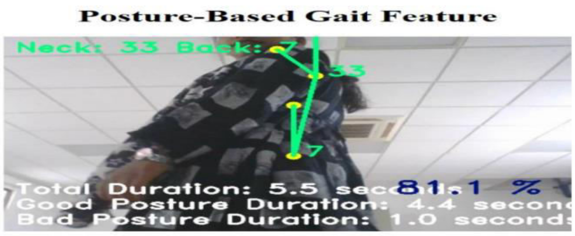


[2]

What amount of time it requires to assume a position and what period of time it takes to adopt both good and bad posture with the percentage of the good posture.



[3]

This image shows a back angle of 7, with a neck-to-shoulder joint angle of 33 degrees. A total of 5.5 seconds are spent in both bad and excellent posture, and from that time, 4.4 seconds are spent in good posture and one second in bad posture.

V. IMPLEMENTATION

The implementation of the system was carried out using a combination of Python programming and machine learning frameworks, supported by tools such as Anaconda, TensorFlow, Keras, Flask, and NumPy. The development process followed a modular approach where each stage — from data preprocessing to model training — was handled systematically. The dataset was collected using pre-trained sources as well as live video captures, and preprocessing techniques were applied to clean and normalize the data before feature extraction. The system was designed to detect and analyze human body joints such as the nose, neck, shoulders, elbows, hips, knees, and ankles. These joints were used to calculate the relative positions, angles, and displacements, forming the basis of posture-based gait features.

Machine learning algorithms were then applied to classify these features. Convolutional Neural Networks (CNNs) were used to extract spatial features from frames, while Recurrent Neural Networks (RNNs) were explored for analyzing temporal dynamics across multiple frames. The implementation pipeline included training the model using labeled gait data, validating its accuracy, and saving the trained model for deployment. A Flask-based web interface was developed to allow real-time testing. Once deployed, the system could be accessed via a local server link, where the user's walking posture was captured through a camera, analyzed, and classified. The application displayed joint angles, detected postures, and generated classification results with confidence levels, demonstrating both backend processing power and frontend usability.

VI. RESULT

The results of the study highlight the effectiveness of posture-based gait recognition in identifying individuals during free-form walking. The system achieved promising accuracy levels by relying on skeletal joint features rather than silhouettes, making it robust to variations in direction, clothing, and environmental settings. During testing, the system was able to measure joint angles (such as neck-to-shoulder or spine-to-hip) with high precision and used these to evaluate whether a user's posture was good or faulty over time. This demonstrated not only the potential for biometric identification but also the possibility of posture analysis for health and ergonomics.

In terms of performance, the system was evaluated using accuracy metrics and comparative analysis with existing gait recognition methods. The results confirmed that posture-based gait features provided superior resilience when individuals walked in free styles involving turns and directional changes, where traditional silhouette-based techniques typically fail. Additionally, the model demonstrated robustness to partial occlusions and variations in walking speed. The evaluation also showed that the method performed consistently across different gallery sizes, as indicated by cumulative match characteristic (CMC) tests.

VII. DISCUSSION

The discussion further emphasizes the advantages of this approach compared to conventional biometric systems such as facial recognition or fingerprinting. Posture-based gait recognition is non-intrusive, difficult to spoof, and effective at a distance, making it ideal for applications in surveillance, forensic investigations, and secure access control. However, the study also acknowledges challenges such as hardware limitations, difficulties in downloading necessary packages, and computational constraints when handling larger datasets. Despite these issues, the overall findings suggest that the system is a strong step toward practical and scalable biometric identification, with significant potential for future enhancements.

VIII. CONCLUSION

The main takeaways and lessons learned from humans identifying evidence from free-form strolls using the Stance-Based Stride Feature would be the conclusion. It would draw attention to the study's accomplishments, constraints, and potential consequences. A possibility the following is the subject's conclusion: Taking everything into consideration, this study examined whether posture-based gait traits may be applied to identify humans from freestyle walks. We have demonstrated that it is possible. A practical method for individual identification through the use of posture-based gait and the development and evaluation of numerous algorithms. The findings demonstrate that gait characteristics can provide distinctive characteristics that aid in precise identification and distinguish individuals. The research findings draw attention to numerous crucial elements. To begin, the suggested method demonstrated the efficiency of posture-based gait features in identifying persons by achieving a promising accuracy in identification. The findings show that gait has a lot of potential as a biometric method, especially when other conventional It's possible that modalities aren't right or accurate.

IX. FUTURE ENHANCEMENT

The human distinguishing proof from free-form strolls utilizing stance-based stride The feature project can be worked on from here on out by concentrating on different areas. The following are some potential areas for growth:
a) Enhanced Feature Extraction: Later on, it very well might be possible to extract features. from posture-based gait data using more sophisticated methods. This might entail consequently gaining discriminative highlights from the unprocessed gait data using DL. techniques like CNNs (convolutional neural networks) or RNNs (recurrent neural networks). Identification system's accuracy and resilience may be enhanced by investigating more. complex feature extraction techniques.
b) Fusion of numerous modalities: The accuracy and dependability of the identification Interaction can be improved by incorporating numerous modalities into human identification techniques. Later on, it very well might be possible to combine posture-based gait characteristics with other biometric modalities, such as facial characteristics or speech pattern. A more complete and robust depiction of a person's identity can be provided by integrating multiple modalities, improving identification performance.
c) Long-term monitoring and evaluation: Freestyle walks frequently last for extended periods of time of continuous motion. The development of algorithms that can track and evaluate gait features over longer time intervals, capturing the temporal dynamics of a person walking pattern can be the subject of future research. The dependencies and changes in gait patterns over time can be captured using long LSTM networks or other sequences. modelling technique.

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