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Smart Security Systems for Real-Time Human Identification Through GAIT Mechanism

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Abstract: The rapid evolution of technological landscapes has necessitated more sophisticated security solutions, with gait analysis emerging as a promising biometric identification technique. This innovative approach leverages individuals' unique walking patterns as a distinctive personal identifier, utilizing advanced computational methods. By integrating Sequential modeling for temporal data processing and MediaPipe Pose for precise pose prediction, the proposed system demonstrates remarkable accuracy and robustness in individual recognition. The methodology capitalizes on the nuanced biomechanical characteristics of human locomotion, transforming walking patterns into a reliable biometric signature. Preliminary research indicates significant potential for future developments, with anticipated enhancements including hybrid biometric integration and multi-person detection capabilities. This approach represents a significant stride in non-invasive, behavioral biometric technologies, offering promising applications across security, surveillance, and personalized authentication domains.
Keywords: Automated gait analysis,Real-time human identification,Biometric identification, Sequential modeling, MediaPipe Pose.

I. INTRODUCTION

The gait refers to an individual's manner of walking. It serves as a biometric characteristic that can be utilized for personal identification. In contrast to other biometric traits like fingerprints, facial recognition, iris patterns, and palm prints, gait possesses distinct advantages, including the ability to be captured without physical contact, difficulty in imitation, and its effectiveness for identifying individuals over long distances [1]. A person's gait is defined as their unique style or pattern of walking. Gait analysis serves as an essential method for comprehending the intricacies of human movement and for diagnosing conditions related to movement. Such systems can yield objective and measurable data regarding various gait parameters, including joint angles, range of motion, and walking speed. Nevertheless, instrumented gait analysis tends to be costly, invasive, and time-consuming, necessitating specialized equipment and trained professionals. Consequently, it is primarily conducted in research laboratories or clinical environments, limiting its accessibility to the public. Markerless gait analysis employs pose estimation techniques that utilize computer vision and machine learning algorithms to derive human poses from video recordings, enabling the tracking of joint and limb movements in two-dimensional or three-dimensional spaces. This process generally involveskey body points, such as joints, and monitoring their movements over time. By examining these movement patterns, one can ascertain various gait parameters, including step length, walking speed, and joint angles [2].

II. RELATED WORK

The domain of gait recognition has experienced significant technological advancements, driven by innovative computational methodologies and machine learning techniques. Pioneering research by Chang et al. [1] introduced marker-free pose estimation, revolutionizing biomechanical analysis by enabling non-invasive movement identification. This breakthrough established a paradigm shift in biometric identification by extracting unique locomotion characteristics without specialized tracking equipment. Subsequent work, such as GaitNet [4], leveraged AutoEncoder architectures to disaggregate locomotion data, while 3D Convolutional Neural Networks (3D-CNN) [5] achieved remarkable accuracy through sophisticated skeletonization techniques.

Further advancements have integrated interdisciplinary approaches, incorporating exhaustive angle calculations and diverse classifier methodologies like Support Vector Machines [3], which reached identification precision of up to 91%. Deep learning models have proven instrumental in capturing both temporal and spatial locomotion characteristics, enhancing biometric analysis. Emerging trends explore hybrid feature extraction techniques, sensor fusion, and advanced temporal data processing, aiming to develop robust identification systems adaptable to real-world complexities.

The convergence of computer vision, biomechanics, and AI continues to refine gait recognition technologies, emphasizing context-aware recognition systems capable of adjusting to diverse conditions and individual variations.

Future research aims to integrate multi-modal biometric systems, leveraging advanced neural networks and dynamic temporal modeling for near-instantaneous, high-accuracy identification. This evolution marks a transformative shift from basic movement tracking to sophisticated biomechanical analysis, highlighting the immense potential of computational intelligence in understanding human locomotion.As these systems mature, they promise to redefine standards in security and smart environment interactions.Their continued advancement also paves the way for more resilient and adaptive identity verification solutions in real-world scenarios.

III. OBJECTIVE

Aims to develop an innovative biometric identification system using gait analysis for secure and reliable human recognition. By leveraging advanced pose estimation and machine learning, it ensures non-intrusive, user-friendly video-based identification while enhancing accuracy and resistance to forgery. The system prioritizes privacy by avoiding direct biometric traits and offers a scalable, real-time solution for security, healthcare, and surveillance applications.Additionally, it opens new avenues for continuous authentication and behavioral monitoring without compromising user comfort or consent.

IV. PURPOSE

The main purpose is driven by the need to improve security, privacy, and convenience in identification systems, with significant social and economic benefits. By providing a non-intrusive solution, it enhances public safety, supports privacy preservation, and offers cost-effective scalability across various applications. Additionally, it contributes to more efficient resource allocation and long-term operational savings.

V. PROPOSED SYSTEM

The proposedsystem has been developed to make the biometric system easy to use. So, the tried starting phase of the system leverages gait analysis for real-time, non-intrusive human identification using video input. It extracts key skeletal features like height, shoulder width, hip width, knee and elbow angles, height-width ratio, and shoulder-to-hip ratio to create a unique biometric profile. Using a sequential machine learning model, the system ensures accurate identification while preserving privacy by avoiding direct facial or fingerprint data. Designed for security, healthcare, and surveillance, it offers a scalable, forgery-resistant solution for biometric authentication.

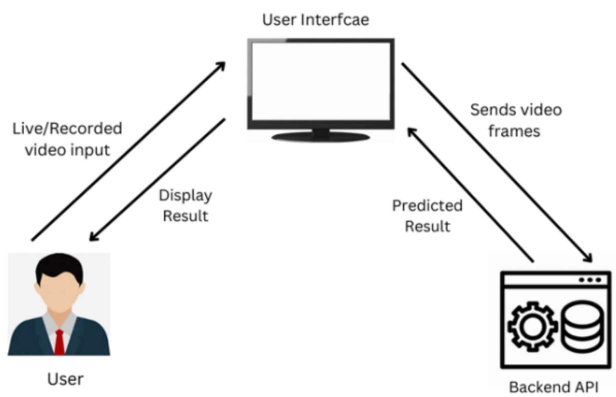

Fig 1:System Structure

VI. METHODOLOGY

The camera is the important device that is used to get the live feed of the human walking. The captured video is sent to the backend for further processing. Splitting the video stream into frames and then extracting the required parameters of the person from the frame using the mediapipe model. Then the extracted information is stored in table format with the target attribute of the person's name. After that, process the data by analysis and remove the unnecessary data. Data will be trained to build a model using the machine algorithm. For the prediction, the same process will be done till extraction. Then each frame of extracted data is given to the model for the prediction to get the result.

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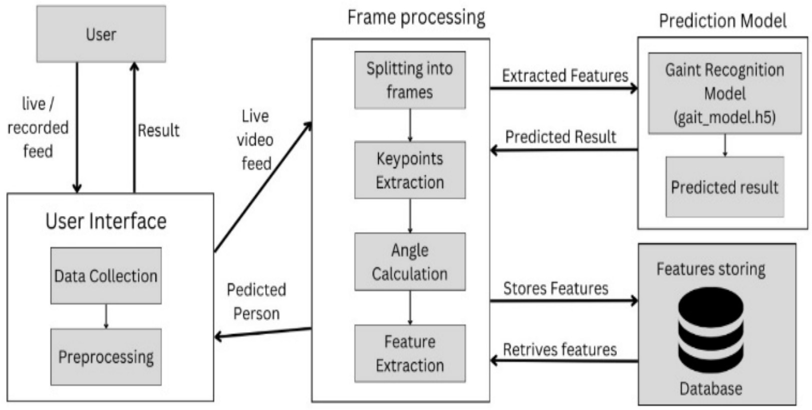

Fig 2: Depicts the Method of Extracting the feature and processing data.

VII. IMPLEMENTATION

The various steps involved in the process of Identifying person through walking patterns are as follows.

1) Data Acquisition: The data acquisition phase uses a camera to stream video over local networks, with OpenCV retrieving frames. This flexible setup supports various devices and networks, ensuring optimal video parameters for efficient gait recognition data collection.
2) Pre-processing: Pre-processing is a crucial stage that prepares raw video data for biomechanical analysis. Captured frames are cleaned and standardized to reduce noise, normalize lighting, and improve image quality. MediaPipe Pose is used for accurate skeletal detection, identifying body landmarks with high precision and efficiency. The pre-processed frames provide a clean and reliable input stream, setting the stage for feature extraction and further analysis.

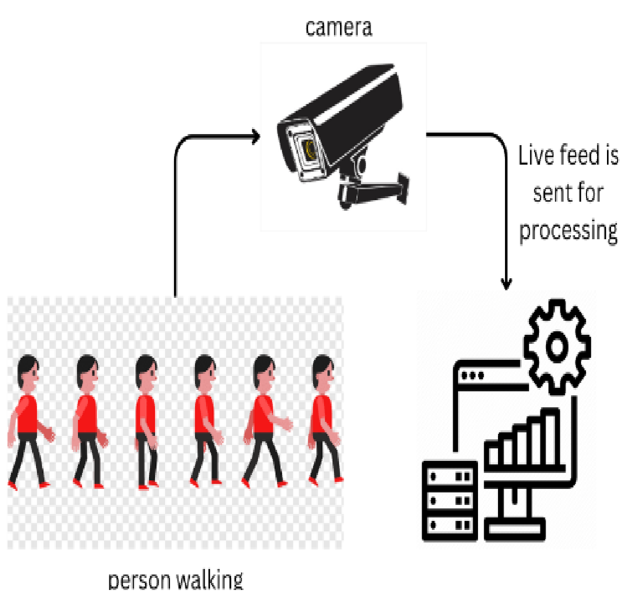

Fig 3:Live capture of person walking

3) Feature Extraction: Feature extraction uses MediaPipe Pose to transform raw skeletal data into meaningful biomechanical signatures. The module analyzes detected keypoints, converting movement patterns into quantifiable characteristics. By calculating metrics like joint angles, limb orientations, and body proportions, the system captures unique locomotion signatures. These features are organized into structured data formats, enabling detailed representation of human movement and supporting advanced pattern recognition techniques.

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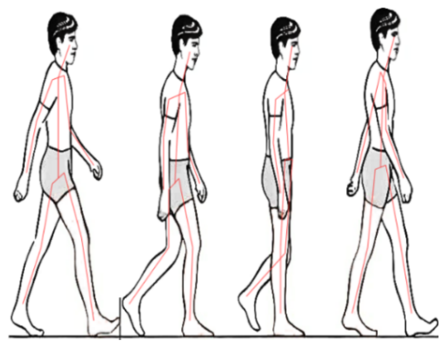

Fig 5: Feature extraction through skeleton

4) Model Training and Testing:Model Training and Testing involves preparing the extracted gait features (such as joint angles, body ratios, and posture data) for input into a machine learning model. The features are standardized using StandardScaler to improve training efficiency, and the target variable (person names) is label-encoded for classification. A Sequential neural network is trained with a multi-layer architecture, including Dropout layers to reduce overfitting. The model is evaluated on a separate test set (20% of the data) to assess its accuracy and generalization to unseen data. After training, the model is saved for future use, and its performance is measured using accuracy metrics to ensure reliable gait recognition.
5) System Integration and Output: Combining all the above stages into a single cohesive system for deployment. Outputs the recognized individual or the analyzed gait patterns.

VIII. RESULT

The proposed system tests the model by identifying the person through walking in front of the camera. However, under the current limitations, it can identify the person only if they are within a specific range and sufficiently illuminated. This constraint may affect the system's performance in low-light conditions or crowded environments. Environmental factors such as shadows, background clutter, and uneven lighting can introduce noise in pose estimation, potentially reducing recognition accuracy. Moreover, variations in walking speed or direction may also impact the consistency of feature extraction. Addressing these limitations in future iterations can help improve robustness and make the system more adaptable to real-world deployment..The accuracy of the model is displayed below

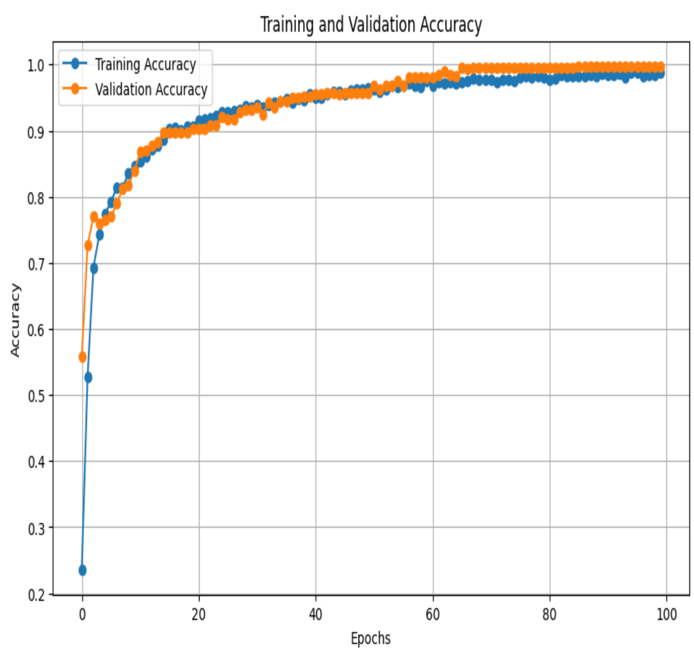

Fig 6: Model accuracy graph

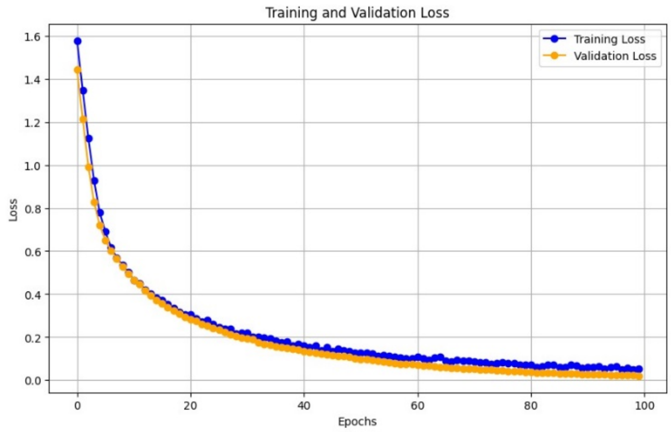

Fig 7:Loss graph

The graph shows training (blue) and validation (orange) loss decreasing over 100 epochs, indicating effective learning. Both curves converge at low values, suggesting good generalization without overfitting.

IX. CONCLUSION

The system provides a non-intrusive and precise method for identifying individuals through gait analysis, utilizing the sequential model for processing temporal data and mediapipe pose for extracting skeletal keypoints. It guarantees privacy by refraining from using direct biometric traits, making it appropriate for security, healthcare, and surveillance. But it has some limitations. To build an efficient way, this system needs proper setup of the instruments, and it needs high-end devices. Future improvements include the integration of hybrid biometric technologies, the ability to detect multiple individuals simultaneously, and the development of advanced deep learning models to enhance accuracy, scalability, and real-time performance in various settings.

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REFERENCES

[1] Hii, Chang Soon Tony , Kok Beng Gan, Nasharuddin Zainal, Norlinah Mohamed Ibrahim, Shahrul Azmin, Siti Hajar Mat Desa, Bart van de Warrenburg, and Huay WoonYou. “Automated Gait Analysis Based on a Marker-Free Pose Estimation Model.” Sensors (2023).
[2] Amin, Tahir, and Dimitrios Hatzinakos. “Determinants in Human Gait Recognition.” Journal of Information Security (2012).
[3] Fathima, S. M. H. Sithi Shameem, R. S. D. Wahida Banu, and S. Mohamed Mansoor Roomi. “Gait Based Human Recognition with Various Classifiers Using Exhaustive Angle Calculations in Model Free Approach.” Circuits and Systems (2016).
[4] Zhang, Ziyuan, Luan Tran, Feng Liu, and Xiaoming Liu. “On Learning Disentangled Representations for Gait Recognition.” IEEE Transactions on Pattern Analysis and Machine Intelligence 44.1 (2022).
[5] Supraja, P., Tom, R.J., Tiwari, R.S. et al. 3D convolution neural network-based person identification using gait cycles. Evolving Systems 12, 1045–1056 (2021).
[6] Kim, J.-W., Choi, J.-Y., Ha, E.-J., and Choi, J.-H. “Human Pose Estimation Using MediaPipe Pose and Optimization Method Based on a Humanoid Model.” Applied Sciences 13.4 (2023): 2700.
[7] S. M. H. Sithi Shameem Fathima1, R. S. D. Wahida Banu, S. Mohamed Mansoor Roomi, “Gait Based Human Recognition with Various Classifiers Using Exhaustive Angle Calculations in Model Free Approach,” 2016
[8] Jong-Wook Kim, Jin-Young Choi, Eun-Ju Ha and Jae-Ho Choi, “Human Pose Estimation Using MediaPipe Pose and Optimization Method Based on a Humanoid Model,” 2023

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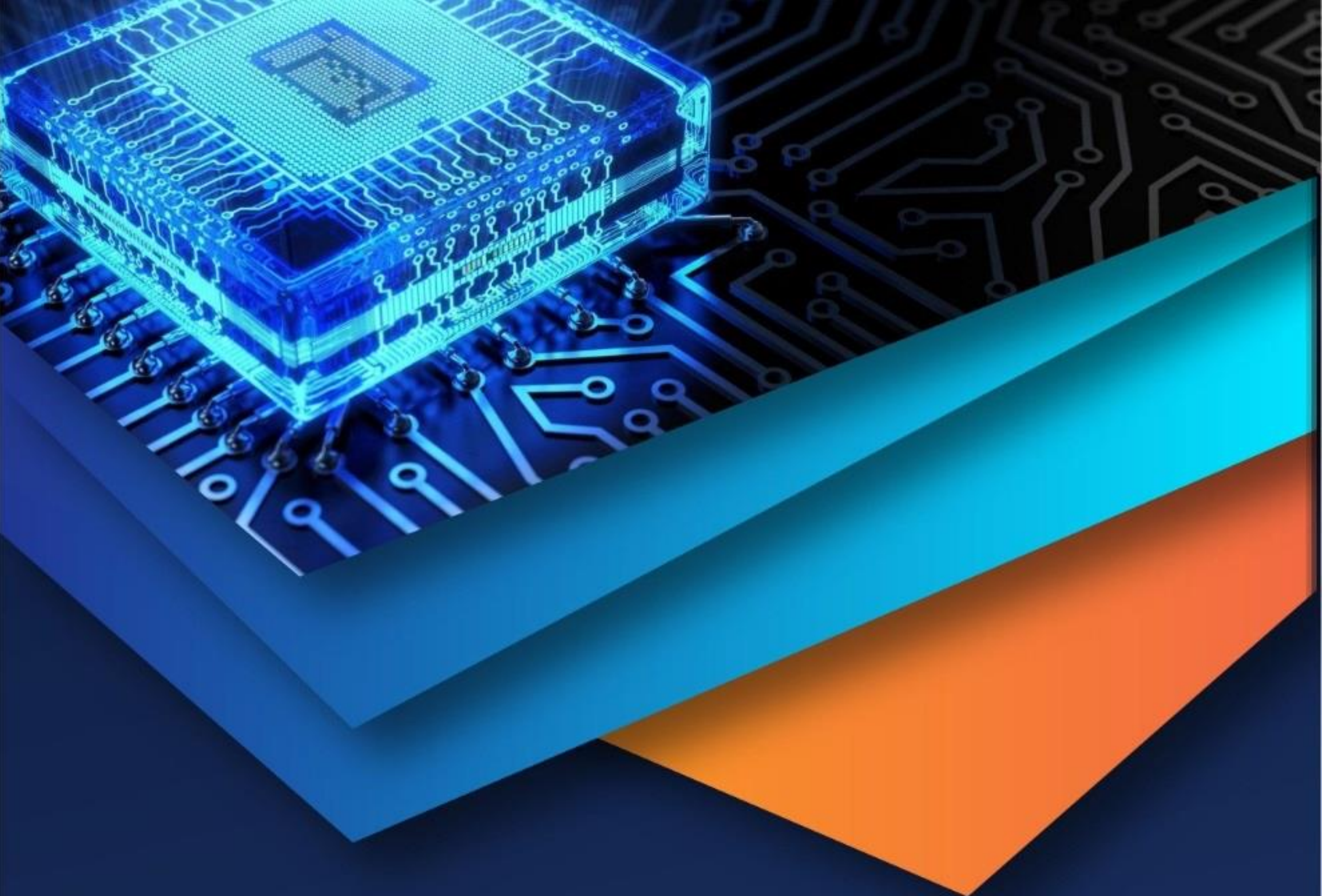

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