# Abstract

This project aims to enhance biometric verification systems by integrating advanced deep learning techniques with the analysis of mouse and keystroke dynamics. The proposed approach will utilize 3D Convolutional Neural Networks (3D CNNs) to capture the spatial and temporal characteristics of mouse movements, transforming these into image-like representations of strokes that also incorporate time-based components. These features will then be fed into separate Long Short-Term Memory (LSTM) networks, which will analyze the sequential nature of the data before combining them into a unified LSTM for accurate authentication.

The project will take keystroke dynamics a step further by incorporating mouse dynamics, focusing specifically on the time and speed of navigation between clicks within defined screen regions. Additionally, the system will introduce context-aware adjustments, dynamically adapting authentication thresholds based on the user's current tasks, thereby improving both the efficiency and accuracy of verification.

To ensure the system is robust against variations in user interaction, the project will use Length-normalized Path Signature (LNPS) to achieve scale and rotation invariance in mouse dynamics. By comparing user movements across different regions of the screen, LNPS will help maintain consistent authentication results, regardless of changes in speed or angle. This method allows for a more reliable comparison of movement patterns, accommodating differences in user interaction style or device orientation.

Furthermore, the system will integrate both mouse and keystroke dynamics, extracting features such as key press duration, flight time, typing speed, and mouse acceleration. A Gaussian Mixture Model (GMM) will be applied to model these features, capturing the multiple behavioral modes of the user. During the authentication process, the system will calculate the likelihood that the test data fits the user's GMM, making a decision based on a predefined threshold.

To refine the system's ability to detect subtle user behaviors, the project will incorporate advanced feature engineering techniques, including the division of the screen into nested rectangular regions. This segmentation strategy will allow for a more detailed analysis of user interactions within specific areas of the screen, thereby enhancing the granularity and accuracy of the biometric verification process.