"StrokeAuth: Enhancing Mobile Security through Dynamic Stroke Pattern Authentication"

Rishikar Chittimalla

Abstract

In the realm of mobile security, traditional authentication methods such as PINs, passwords, and biometrics, while prevalent, often fall short in terms of security and user convenience. This study introduces an innovative user authentication system that leverages machine learning to analyze and learn from the unique stroke patterns users create while drawing lines on a mobile device's touchscreen. The system presents a user with a white canvas and instructs them to draw a line from a start dot to an end dot, positioned variably across the canvas in different attempts. By examining the intricacies of each stroke—such as speed, pressure, and curvature—the proposed model aims to capture the distinctiveness of individual user interactions. This paper details the conceptual framework, development, and potential efficacy of this authentication method, emphasizing its machine learning backbone, data collection strategies, and the anticipated improvements in security and user experience.

Introduction

Current authentication methods are susceptible to various forms of compromise, including shoulder surfing, smudge attacks, and the limitations inherent in static credentials like passwords and PINs. Moreover, biometric solutions such as fingerprint and facial recognition, while more secure, raise privacy concerns and can be rendered ineffective by physical changes or environmental factors. This research introduces an authentication system that dynamically engages users in drawing a line from a predefined start point to an end point, which varies in position. Unlike static methods, this approach exploits the unique, complex patterns of user interaction, which are difficult to replicate or guess. The system employs machine learning algorithms to analyse these patterns, capturing nuances such as stroke speed, pressure sensitivity, angle, and curvature, which collectively contribute to a highly individualized user profile.

Methodology

The study employs a multi-phase approach, beginning with the collection of stroke pattern data from a diverse participant pool. Participants are prompted to engage with the authentication interface under various conditions to simulate real-world use. This data serves as the foundation for training a robust machine learning model, which is iteratively refined and tested for accuracy in distinguishing between legitimate users and unauthorized attempts.

Data Types:

1. During each drawing session, the system collects high-resolution data points along the drawn line, including:

2. Time stamps for each point along the stroke, capturing the speed and rhythm of the drawing motion.

3. Spatial Data: X and Y coordinates for each point, providing the trajectory of the stroke.
4. The size of the touch contact area, which can vary with pressure and drawing angle.

Data Preprocessing;

1. Normalization: Adjusting the data to a common scale to prevent features with larger ranges from dominating the model's predictions.
2. Smoothing: Applying filters to reduce noise in the data, especially for the spatial coordinates, to obtain a more accurate representation of the stroke.
3. Segmentation: Dividing each stroke into smaller segments for more detailed analysis, which can be particularly useful for complex patterns.

Feature Extraction:

1. Features like the total time taken to complete a stroke, average speed, and variations in speed throughout the stroke. Temporal patterns often reveal the user's natural rhythm and hesitations.
2. Spatial features encompass the overall shape of the stroke, including start and end points, curvature, and changes in direction. Advanced techniques like Fourier transforms can be used to capture the shape characteristics in a more generalized form.
3. Statistical measures like mean, variance, and standard deviation across different data points provide a summary of the stroke patterns. Geometrical features might include the total length of the stroke, angles formed at critical points, and the area covered by the stroke trajectory.