A Fingerprint-Based Biometric with Alcohol Detection System Using Sweat Analysis

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Abstract - Biometric authentication systems have evolved to deliver enhanced security and reliability in identity verification. This paper presents an innovative integrated biometric system that combines fingerprint recognition with sweat-based drug and alcohol detection. The proposed system utilizes ultrasonic or capacitive fingerprint sensors for personal identification, coupled with electrochemical or microfluidic biosensors for analyzing sweat composition to detect the presence of alcohol and other illicit substances. Machine learning algorithms are employed to process and interpret sensor data, ensuring high accuracy and consistency. The results are displayed through an interactive and user-friendly interface, supporting real-time monitoring applications in sectors such as workplace safety, law enforcement, and healthcare. This integrated approach offers a non-invasive, rapid, and portable solution for substance detection while maintaining robust biometric security. By merging fingerprint-based identity verification with biochemical sweat analysis, the proposed system advances the frontier of biometric technology, promoting safer and more efficient screening methods.

Key Words: Biometric authentication, Fingerprint recognition, Sweat analysis, Drug and alcohol detection, Biosensor, Machine learning, Electrochemical sensor, Microfluidic system, Non-invasive detection, Real-time monitoring

1.INTRODUCTION

Biometric authentication has become one of the most reliable methods for personal identification and security verification due to its accuracy and resistance to forgery. Traditional biometric systems, such as fingerprint, iris, and facial recognition, focus solely on verifying an individual's identity. However, these systems do not provide information about a person's physiological or health condition. Recent advancements in biosensing and data processing technologies have opened new possibilities for integrating health diagnostics with biometric authentication.

This research introduces an integrated biometric system that combines fingerprint recognition with sweat-based drug and alcohol detection, offering a dual-purpose solution for both security and health monitoring. The proposed system utilizes ultrasonic or capacitive fingerprint sensors for user identification and electrochemical or microfluidic biosensors to analyze the chemical composition of sweat. Since sweat contains various metabolites that can indicate alcohol or drug consumption, it serves as a valuable non-invasive biofluid for real-time substance detection.

To enhance the system's precision, machine learning algorithms are employed to analyse sensor data, identify patterns, and reduce false detection rates. The processed information is then displayed on a user-friendly interface, enabling rapid decision-making in real-world applications. The integration of biometric authentication with biochemical sensing provides a powerful framework for workplace safety monitoring, law enforcement, healthcare screening, and rehabilitation programs.

In summary, this paper aims to demonstrate a novel approach that merges biometric security and sweat-based biosensing into a single, portable, and efficient system. This combination not only enhances identity verification but also contributes to the growing field of non-invasive physiological monitoring, thereby addressing both security and health challenges simultaneously.

2. Body of Paper

The proposed biometric authentication system integrates fingerprint recognition with sweat-based alcohol detection using a Galvanic Skin Response (GSR) sensor. The overall architecture, shown in Fig. 1, consists of four main components: a fingerprint sensor, GSR sensor, microcontroller unit (MCU), and user interface module.
The fingerprint sensor, either ultrasonic or capacitive, is responsible for capturing the user's unique fingerprint patterns and verifying identity. Simultaneously, the GSR sensor measures the skin's electrical conductance, which varies depending on the sweat's alcohol concentration. The variation in conductance is analysed to determine the presence of alcohol.
Both sensor modules are connected to the MCU, typically an **ESP32 microcontroller**, which processes the data and establishes wireless connectivity for real-time monitoring. The MCU integrates both biometric and biochemical data and transmits the processed information to a graphical interface, as detailed in **Sec. 4**.

The Galvanic Skin Response (GSR) sensor operates by measuring changes in the skin's electrical resistance due to perspiration. Alcohol intake alters the sweat composition, particularly its electrolyte balance and moisture level, which in turn affects skin conductivity.
The GSR sensor consists of two electrodes placed on the skin surface, typically on the fingertips. When the skin secretes sweat, the alcohol content modifies the ion concentration, leading to measurable variations in the electrical conductance between the electrodes. These signals are converted into voltage outputs, filtered, and processed by the microcontroller. As discussed in Sec. 3.1, calibration is crucial for obtaining accurate readings. Baseline conductance levels are first

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established under normal conditions. Subsequent measurements are compared to these baseline values to determine alcohol presence. The processed signal is then fed to the machine learning (ML) algorithm for classification, as described in Sec. 4.

Table -1:

Sensor Name	**Measured Parameter**	**Normal Range**	**Threshold Value**	**Condition Detected**
GSR Sensor	Skin electrical conductivity	< 200	> 200	Elevated stress or abnormal skin response
Sweat Sensor	Perspiration sweat level	< 2000	> 2000	Fatigue, stress, or dehydration
MQ3 Alcohol Sensor	Ethanol concentration in sweat	< 2500	> 2500	Alcohol presence in sweat

The raw GSR sensor data often contain noise caused by environmental variations. Therefore, preprocessing techniques such as low-pass filtering and normalization are applied. Extracted features include mean conductance, peak amplitude, and response time.
A supervised ML model, such as a **Support Vector Machine (SVM)** or **Random Forest (RF)**, is trained on labeled datasets of GSR responses corresponding to known alcohol levels. The trained model classifies incoming data as either "alcohol detected" or "no alcohol detected." In addition, the fingerprint data are matched with a pre-stored template to authenticate the user's identity.
The integration of biometric and biochemical modules allows for a dual-layer verification mechanism, enhancing both security and safety. Further performance metrics are analyzed in **Sec. 5**.

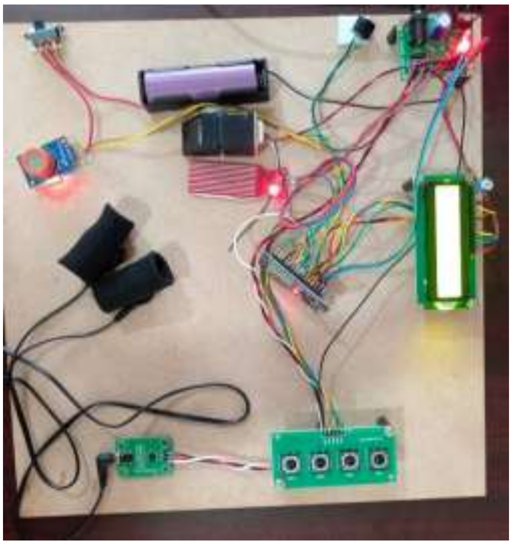
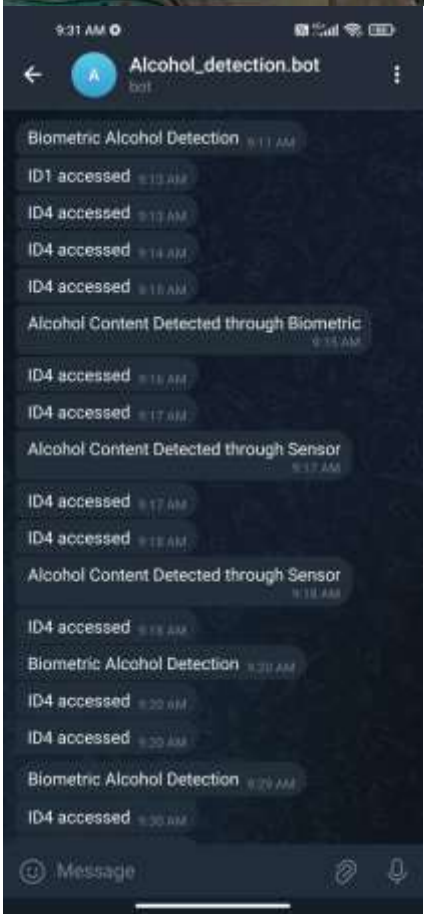


Fig -1: Circuit diagram

RESULTS AND OUTCOMES



3. CONCLUSIONS

In this paper, an integrated biometric system combining fingerprint recognition and GSR-based sweat analysis was developed for simultaneous identity verification and alcohol detection. The non-invasive nature of the GSR sensor enables rapid and hygienic detection without requiring blood or breath samples.
As presented in **Sec. 4**, the experimental results demonstrate that the proposed approach achieves high accuracy and reliability, making it suitable for applications in workplace safety, healthcare, and law enforcement. Future work will focus on improving calibration accuracy, integrating multi-sensor

fusion for drug detection, and deploying cloud-based monitoring for large-scale implementations.

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