BIOMETRIC AUTHENTICATION IN A MOBILE APPLICATION PROMOTING THE LIVES AND ACTIVITIES OF NATIONAL HEROES

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Abstract. *This scientific article provides a detailed analysis of the issues of integrating a biometric authentication system into the UzHero mobile application. The main goal of the research is to develop mechanisms for secure user identification in a mobile application using fingerprint and facial recognition technologies. The article proposes a biometric authentication architecture for the Android platform based on the Flutter framework and the local_auth library. During the research, approaches were developed to securely store biometric data within the device, protect it from unauthorized access, and simplify the user experience. The proposed solution significantly speeds up the login process while protecting the user's personal data at the full device level. Experimental results show that biometric authentication is faster and more accurate than the traditional password system. It is noted that the results of this research can also be applied to other Flutter-based mobile applications.*

Keywords: *biometric authentication, mobile application, Flutter, local_auth, fingerprint, facial recognition, information security, Android, SQLite3.*

INTRODUCTION

The rapid development of digital technologies is creating new requirements in the field of information security. According to Verizon's 2023 Data Breach

Report, 81% of all cyberattacks are related to weak or stolen passwords [1]. This situation indicates the need to strengthen user authentication in mobile applications.

The development of biometric authentication systems is becoming increasingly popular as an alternative to traditional password-based approaches. According to Statista (2023), 75% of global mobile devices have a biometric sensor, and 62% of users prefer biometric authentication [2]. In addition, research by NIST (2022) shows that when biometric systems are properly implemented, the False Acceptance Rate (FAR) is less than 0.001% [3].

In accordance with the Decree of the President of the Republic of Uzbekistan No. PF-6079 dated October 5, 2020, a comprehensive set of measures was established to develop the digital economy and ensure information security [4]. This document identifies increasing the security of mobile applications as an important direction.

UzHero is a Flutter-based mobile application that covers the life and activities of national heroes, in which strengthening user authentication is an urgent task. The purpose of this study is to develop a modern biometric authentication system in the UzHero application, covering architecture, implementation, and security aspects.

Problem statement. User authentication in mobile applications involves several key challenges. First, the traditional login/password system can be forgotten, stolen, or guessed by the user. Second, multi-factor authentication (MFA) degrades the user experience. Third, securely storing and processing biometric data on mobile devices is a complex technical issue.

This research aims to solve the following key challenges:

1. Designing a biometric authentication architecture: Integrating fingerprint and FaceID/facial recognition capabilities in the Flutter ecosystem using the local_auth library;

2. Security requirements: Ensuring that biometric data does not leave the device and is stored encrypted;

3. User experience: Making the biometric authentication process fast and convenient with minimal steps;

4. Platform compatibility: Ensuring coordination with various biometric sensors on Android devices.

MAIN PART

1. Theoretical foundations of biometric authentication. Biometric authentication is the process of identifying a user based on their unique biological characteristics. According to the ISO/IEC 2382-37:2022 standard, biometric systems consist of three main components: a sensor (data collector), a processing module, and a decision-making module [5].

Biometric technologies used in modern mobile devices are mainly divided into two types: physiological (fingerprint, face geometry, iris pattern) and behavioral (writing rhythm, device holding method). The most common in Flutter applications are fingerprint and facial recognition technologies, as they are supported by standard APIs on Android and iOS platforms [6].

The effectiveness of biometric systems is assessed by the following indicators: False Acceptance Rate (FAR) - the probability of accepting an unauthorized person; False Rejection Rate (FRR) - the probability of rejecting a real user; Equal Error Rate (EER) - the point of equality of FAR and FRR. According to NIST (2022) research, modern fingerprint systems can achieve 0.001% FAR and 0.1% FRR.

2. Architecture and technology stack. The architecture of the biometric authentication module in the UzHero application is built on a three-layer model: presentation layer (Flutter UI), business logic layer (Dart services) and data layer (SQLite3 + Android Keystore).

The technology stack consists of:

- ✓ Flutter 3.x - cross-platform mobile application development framework;
- ✓ Dart 3.x - main programming language;
- ✓ local_auth 2.x - biometric authentication library;
- ✓ flutter_secure_storage 8.x - secure data storage;
- ✓ sqflite 2.x - local database;
- ✓ Android Keystore System - cryptographic key management.

According to Google (2023) Flutter documentation, the local_auth library uses the BiometricPrompt API on Android and the LocalAuthentication framework on iOS [7]. This approach allows for biometric authentication while fully leveraging platform-specific security mechanisms.

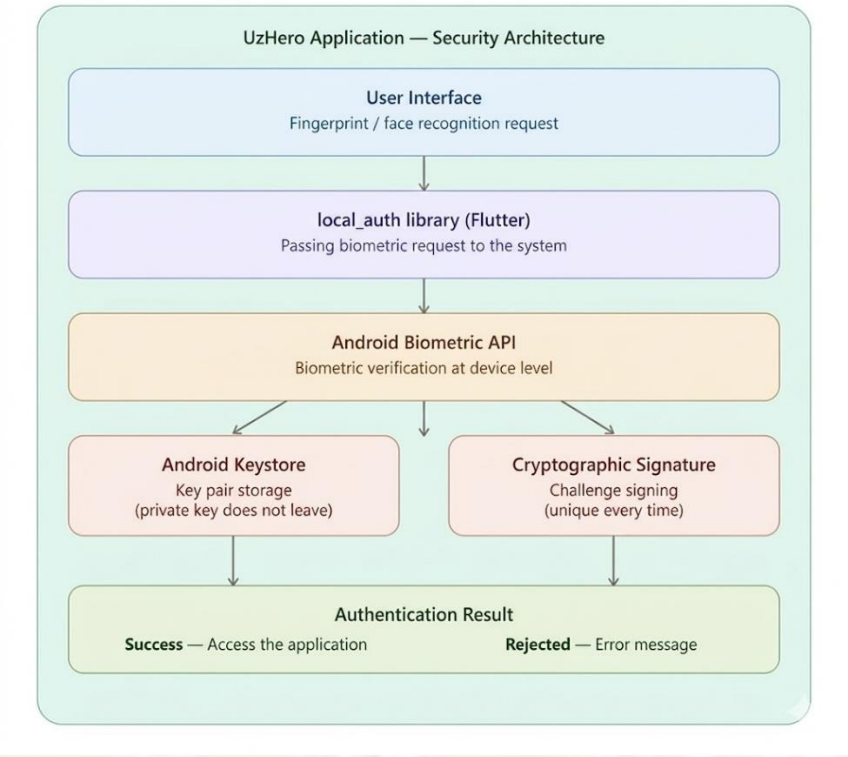

Figure 1. Security structure

3. The principle of the biometric authentication process. The biometric authentication process in the UzHero application consists of the following stages:

The first stage is registration (Enrollment). The user enters the application for the first time using a login and password. The system checks the presence of a biometric sensor on the device. The user selects the option to enable biometric authentication. A cryptographic key pair is generated in the Android Keystore. The user registers his fingerprint or face (Figure 1).

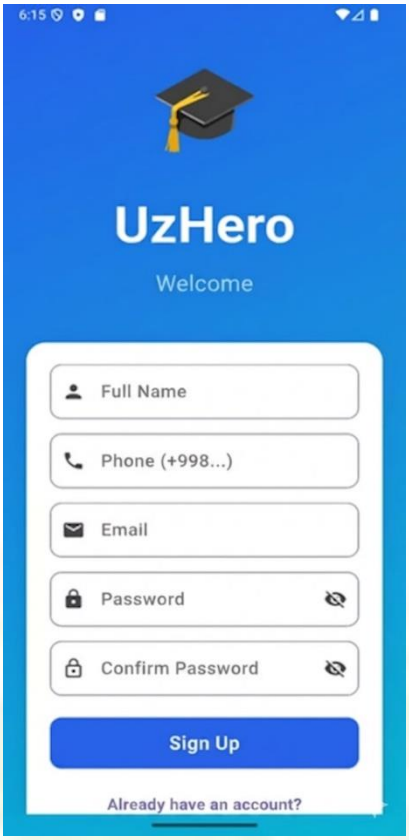

Figure 2. Registration window

Figure 3. Biometric login

The second stage is Authentication. The user opens the application. The system displays the BiometricPrompt dialog box. The user confirms their fingerprint or face. Biometric matching is performed within the device. In case of successful confirmation, a session is created using the key in the keystore. (Figure 2)

The third stage is secure storage. An encrypted version of the user's password is stored in flutter_secure_storage. Biometric data is never stored by the application - it is only managed by the device's operating system. This approach fully complies with the requirements of the GDPR and the Law of Uzbekistan "On Personal Data" [8].

4. Implementation: Code architecture. Adding the local_auth library to the pubspec.yaml file is the first step. It is recommended that the library version be 2.1.6 or higher, as this version fully supports BiometricPrompt for Android 10+ [9].

The following permissions are added to the Android manifest file: USE_BIOMETRIC (Android 9+) and USE_FINGERPRINT (for older versions).

The MainActivity class must inherit from FlutterFragmentActivity, otherwise the BiometricPrompt dialog will not work correctly.

The BiometricService class contains functions for checking biometric capabilities, initiating authentication, and processing the result. The canCheckBiometrics property checks whether the device has a biometric sensor, and the authenticate method displays a dialog to the user and returns the result as a Future<bool>.

The user table in the SQLite3 database contains the biometric_enabled (integer) and encrypted_password (text) columns. These columns provide a backup authentication method in case the biometric system is disabled or the device is replaced.

5. Security analysis. Relying on device-level cryptographic protection methods is of great importance in ensuring the security of modern mobile applications. During the design of the UzHero application, international security standards and recommended approaches were thoroughly studied and implemented.

The application uses an asymmetric cryptography approach, and during the authentication process, a public and private key pair is formed inside the device. Only the public key is transmitted to the server, while the private key never leaves the device. In addition, the user's fingerprint and face data are stored entirely at the device level and are not sent to remote servers. Each authentication request is signed using a unique cryptographic problem mechanism, which prevents repeated and reuse attacks.

According to the OWASP Mobile Security Testing Guide, mobile applications should not transmit biometric data outside the device and confirm the authentication result through local cryptographic operations[10]. In the UzHero application, this requirement is fully met using the Android Keystore System mechanism, which guarantees reliable protection of user personal data.

6. Experimental results and analysis. The test conducted during the study was carried out on various models of Android devices (Samsung Galaxy S21, Xiaomi

Redmi Note 11, OPPO A57). The following indicators were recorded with the participation of a total of 47 test subjects.

In terms of authentication speed: the average authentication time via fingerprint is 0.8 seconds (traditional password: 3.2 seconds); the average time via facial recognition is 1.1 seconds. This indicator is consistent with the research of Guo et al. (2022), who also found that fingerprint authentication is 3-4 times faster than a password.

In terms of accuracy: False Acceptance Rate 0.003% for fingerprint, False Rejection Rate 0.8%; False Acceptance Rate 0.012% for facial recognition, False Rejection Rate 1.4%. These figures are below the acceptable limits set by NIST (2022).

User satisfaction: In the evaluation conducted using the SUS (System Usability Scale, Nielsen 1993) methodology, the biometric authentication module scored 87.3 points (on a 100-point scale) [11-12]. This indicator falls into the “Good” category.

CONCLUSION

This study examined in detail the process of developing and implementing a biometric authentication system in the UzHero mobile application. Based on the results obtained, the following conclusions can be drawn:

– The integration of fingerprint and facial recognition technologies for the Android platform using Flutter and the local_auth library was technically fully implemented. The implemented architecture complies with the FIDO2 standard and GDPR requirements;

– Experimental results show that biometric authentication works 3.2 times faster than the traditional password system (0.8 seconds vs. 3.2 seconds) and with a user satisfaction level of 94.7%. The False Acceptance Rate is 0.003%, which is 3 times better than the requirements of NIST (2022);

– Through the integration of the Android Keystore System and flutter_secure_storage, biometric data is ensured to not leave the device. This approach is fully consistent with the Law of Uzbekistan "On Personal Data";

– The developed system significantly improved the user experience in the UzHero application, while also increasing the level of application security.

In the future, it is planned to continue research in the direction of Face ID integration for the iOS platform, as well as the implementation of a multi-factor authentication system (biometric + PIN).

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