Design and Implementation of a Social Network Using Firebase

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Abstract **– With the rapid advancement of smartphones in recent years, application stores have experienced significant daily growth and dynamic activity. Modern smartphones, characterized by their originality, widespread usage, and powerful computing capabilities, have become an ideal platform for real-time information exchange and quick access via mobile devices. This paper explores the development potential of Android Studio in combination with Firebase as a back-end service. Given the continuous rise in the popularity of social networks, the developed application is designed to function as a type of social networking platform. Its main goal is to promote the sharing of information, provide quick and convenient access to content, encourage interaction among users, and deliver an easy-to-use platform for individuals to showcase themselves.**

Keywords **– Android Studio, Firebase, social networking service, activity.**

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1. Introduction

Driven by major technological progress in recent years, a range of electronic devices — including mobile phones and tablets — has appeared, becoming an essential part of everyday life. With the emergence of new trends, information spreads rapidly, making it easily accessible on the internet. Over the last decade, mobile phones and computers have undergone a monumental transformation, revolutionizing modern life and work. Smartphones have evolved from simple communication devices to multifunctional pocket-sized computers with powerful processors and high-resolution displays. The proliferation of mobile applications has opened new avenues for entertainment, productivity, and communication. Similarly, computers have witnessed significant advancements in processing power, storage capacity, and graphics capabilities, enabling seamless multitasking and immersive gaming experiences. The convergence of mobile technology and computing has facilitated unprecedented connectivity and accessibility, shaped the modern digital landscape, and transformed human interaction with technology on a global scale.

Nowadays, the quickest and most convenient source of information is social media, with social networks serving an essential and diverse function by influencing many areas of daily life. Some of the key importance of social networks in the modern world include communication and connectivity, information sharing, business and marketing, networking and professional development, social activism and awareness, entertainment and content consumption, personal expression and creativity, support, and community building, [1], [2], [3]. Despite their numerous benefits, it is essential to recognize that social networks also come with challenges, such as privacy concerns, misinformation spread, and potential negative effects on mental health. As social networks continue to evolve, understanding how to use them responsibly and critically is crucial for navigating the digital landscape effectively [3], [4], [5], [6].

Mobile social networks (MSN) are online platforms designed for interaction, communication, and sharing among users through mobile devices such as smartphones and tablets. These networks enable individuals to interact with friends, family, and acquaintances, building a sense of community and promoting real-time communication irrespective of geographic locations. Mobile social networks often offer features such as instant messaging, photo and video sharing, status updates, and group discussions, making them an integral part of modern social interactions on the go. In [7] the authors have reviewed the widely used MSN platforms and innovative approaches for current MSN applications and services, along with an overview of the leading mobile operating systems where MSNs are deployed. In [8] the authors have presented a survey on social network analysis techniques, visualization, structure, privacy, and applications.

Social networks are typically designed to work seamlessly across multiple operating systems, such as Windows, macOS, and Linux, to ensure a broad user base across different desktop platforms [9], [10]. Additionally, mobile social network applications are commonly developed for operating systems such as Android and iOS, catering to the widespread use of smartphones and tablets. Cross-platform development frameworks are often employed to streamline the process and create apps that can run on multiple operating systems with minimal adjustments, [11], [12], [13], [14].

Considering that people today seek the fastest and most reliable information on important events, current promotions, and news, the concept for the application "P" emerges. This application allows users to access timely information, stay connected with distant contacts, communicate more easily with friends, and gain new knowledge.

The paper is about the application "P," covering the technologies used for its development, the implementation process, and how the application functions.

2. Used Technologies

The choice of technologies was made under the influence of two factors. First, popular, and highly efficient technologies were used, which are widely adopted due to their effectiveness. The second reason is the availability of development tools.

Regarding the back-end part, the choice falls on another popular solution, the Firebase platform, which is also free for smaller systems. The free plan offers features such as Analytics, App Indexing, Authentication, Cloud Messaging, Crash Reporting, Dynamic Links, Invites, Notifications, Remote Config, a Realtime Database (restricted to 100 active connections and 1GB of data), and 5GB of Cloud Storage.

Since both Android Studio and Firebase are owned by Google, Firebase integration has been introduced into Android Studio. Moreover, one of the crucial reasons for choosing these technologies is how well they work together and the previous experience working with them.

Android is presently the most widely used mobile operating system, built on the Linux kernel and optimized for use across a wide range of devices, including smartphones, tablets, and laptops, netbooks, smart books, e-book readers, and even wristwatches. Although Android is a distribution of Linux, it deviates from most standard Linux distributions. For example, Android does not have a standard X Window System or a standard set of GNU libraries, which means it cannot run applications developed for other standard Linux systems. Running applications on Android is not done directly; instead, applications run in an environment that is isolated from the rest of the system, receiving only a portion of the system's resources. This restricted access prevents them from accessing unnecessary parts of the system, thereby improving the security and stability of the system [15], [16]. The Android architecture is described in [17], [18].

The Java programming language [19], is the primary technology used for developing Android applications. Java Development Kit (JDK) is an implementation of the Java platform provided by Oracle in the form of a package of binary files designed for developers to create Java software solutions on various hardware and software platforms. JDK includes the Java Virtual Machine (JVM) and all related resources that enable the development and execution of Java software.

In addition to the JDK package, the most important software is the Android SDK. This package contains a debugger, emulator, documentation, code examples, and instructions. It is essential to note that each version of the Android operating system is defined by its own API (Application Programming Interface) level. For each API, there are two platforms: the SDK platform and the Google API interface. The Google API interface extends the SDK with functions that enable interaction with Google services, such as Google Maps libraries, and more. Android Studio serves as the official integrated development environment (IDE) for the Android platform. It serves to organize the application files, manage packages, and test the application on real devices or emulators.

The Firebase Platform offers a complete solution for building back-end infrastructure for both mobile (iOS and Android) and web applications. It provides a unified SDK and a central console for developing and managing apps [20].

Firebase includes several key components: AdMob – integration with Google AdMob, Analytics – A dashboard for monitoring user behavior, demographic segmentation, and campaign effectiveness, Authentication – tools for user sign-in through email, Facebook, Google, and other providers, etc., Crash Reporting - tracking application errors on all devices, Database - NoSQL database that stores data in JSON format, Links – direct users to specific destinations within the app, Hosting – provides a globally distributed CDN for web applications, Indexing – allows the app to be indexed for Google search, Invites – lets users share app information with others, Cloud Messaging – originally introduced as Google Cloud Messaging (GCM) and now referred to as Firebase Cloud Messaging (FCM), which enables the reliable delivery of messages across platforms; Notifications – providing tools for the creation, scheduling, and management of user-targeted notifications; Offline Capabilities – supporting local data caching, thereby allowing applications to function seamlessly without an active internet connection; Real-time Database – ensuring that data is stored and synchronized in real time across users and devices; Remote Config – permitting developers to dynamically adjust application behavior or user interface elements without necessitating a new version download; Cloud Storage – enabling the storage and retrieval of diverse file types, including images, audio, and video; Data Synchronization – ensuring that any modifications on a device are transmitted to Firebase and automatically propagated across all linked devices.

The Firebase SDK supports programming in C++, Java, JavaScript, JavaScript/Node.js, Objective-C, and Swift. Google added numerous helper libraries: FirebaseUI, Geofire, Firebase Queue, FirebaseJobDispatcher, and others. Firebase also supports input of large JSON data and integration with ElasticSearch.

From the mentioned technologies, is used the FirebaseUI helper library, and the components Authentication, Database, Storage, and Cloud Messaging.

Many applications based on this platform consist solely of client-side code, and nothing else is required for their functionality except the Firebase platform. Such applications require minimal integration with backend systems but do not demand significant data processing or complex user requirements. In this architecture, the application itself consists of static content, while all dynamic content and user data are stored and retrieved from Firebase [21].

3. Application “P”

The main idea behind this project is the implementation of an application that resembles today's social networking services. The “P” application provides free online services that enable users to engage in diverse forms of communication with the global community while also offering opportunities for self-presentation. Due to the fast-paced lifestyle, social networks have become the simplest way of communication. They provide a sense of belonging to a community and the ability to showcase oneself in a desired light. They have changed the way people communicate over the Internet, as email is now less commonly used.This application facilitates connections with individuals residing at a distance, promotes enhanced social interaction, streamlines communication with friends, and provides opportunities for acquiring new knowledge.

The application itself is designed to function like most of today's familiar mobile applications, such as Facebook, Instagram, LinkedIn, etc.

To utilize the core functionalities of the application, users are required to either register or log in. Once authenticated, they gain access to a range of features, including viewing posts shared by others, expressing feedback through likes and comments, searching for and adding friends, exchanging private messages, updating their personal information, and accessing data shared by their connections. When sending friend requests, liking a post, commenting on a post, or sending a message from one user to another, a notification is sent to the user for whom the action is intended. This way, the other user receives information from their friend. Depending on the type of notification received, users may interact with it to be redirected to a designated page. For instance, if the notification signifies an incoming message from a specific user, selecting it will directly navigate the recipient to the corresponding message.

3.1. Registration Screen

If the user does not have a pre-existing profile, they must first register. Registration is done by filling out a form that requests user information. The user clicks on the link *'Don’t have an Account, need a new Account?'* and the page for entering the required data opens (Figure 1).

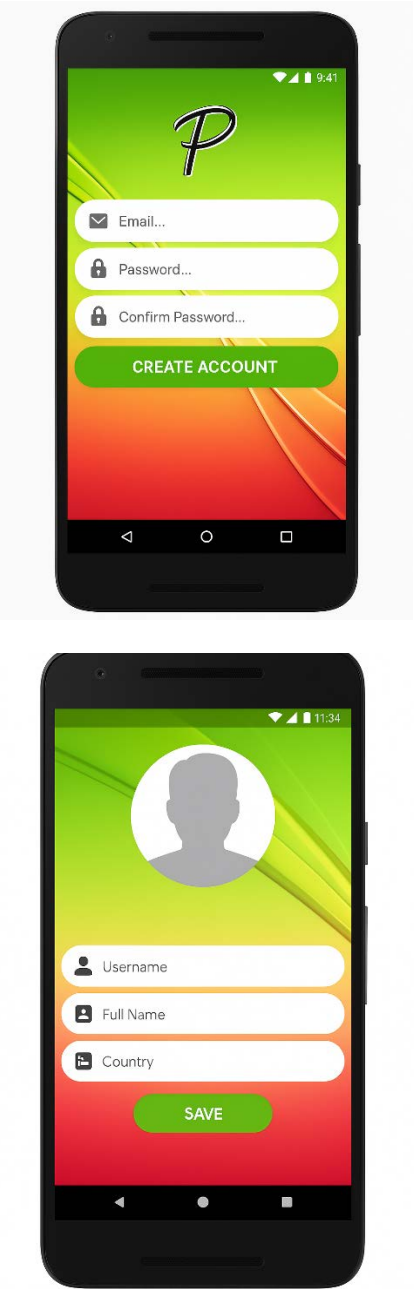

Figure 1. Registration screen

3.2. Login Screen

Logging in is enabled using the user account, as well as login via a Google profile by clicking the button at the bottom of the screen. Users with a valid account may authenticate by entering their email and password and selecting the “Login” button. If the email or password is invalid, an error message appears. Once the user has registered, in subsequent uses, the application only requests login data, i.e., email and password.

The case of forgotten passwords has also been handled. If a user forgets their password, they can enter their email and click the "Send Email" button to receive a password reset message. If an incorrect email is entered or it does not belong to any user, an error message is displayed. If the email is correct and there is a user with that email address, a message with a link to reset the password will be sent.

3.3. Main Screen

After successful login, the main screen opens, from where other parts of the application can be managed. After logging out, the home screen opens, just like on the first startup.

In the top left corner, there is an icon for opening and closing the navigation section. The navigation can also be opened and closed by swiping the screen right and left. In the top right corner, there is a button for adding new posts. The main interface presents a feed of posts that users may engage with by expressing approval through likes and contributing feedback via comments, (Figure 2).The navigation section is divided into 9 sections, (Figure 3):

- The initial section of the image provides an overview that includes the profile picture and full name of the user currently logged into the application.
- The second section of the navigation, labeled “Add New Post,” provides access to a page where users can upload an image and include a description in order to create a new post.
- The third part, "Profile," allows viewing data about the currently logged-in user.
- The fourth part, "Home," displays the main page.
- The fifth part, "Friends," shows the list of friends.
- The sixth part, "Find Friends," displays the search field used to search for users of the application, with the option to add them as friends.
- The seventh section, titled “Messages,” enables users to view their list of friends and provides the functionality to send them direct messages.
- The eighth part, "Settings," allows the logged-in user to change their data.
- The ninth section, labeled “Log Out,” provides users with the option to terminate their session and exit the application.

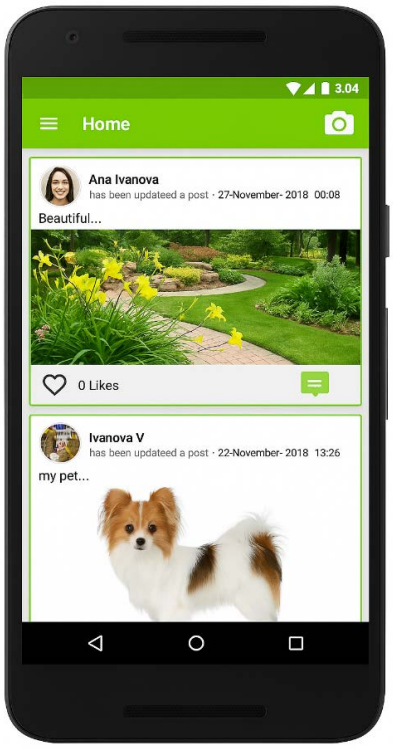

Figure 2. Main screen

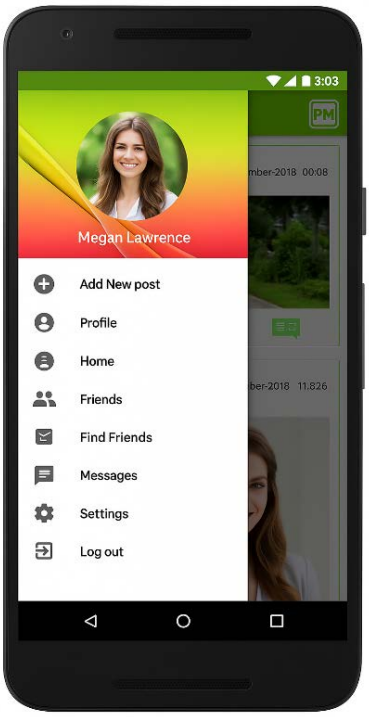

Figure 3. Navigation part

- Logged-in User - When you successfully log in, the application will remember the logged-in user. When the application is launched, if the user is already logged in, the main screen opens immediately without showing the login screen. This ensures that the user does not have to log in every time they open the application. The user can log out using the method described earlier.
- Adding a Post – By selecting the second section of the navigation menu, “Add New Post,” the user is directed to a page that allows the upload of an image accompanied by a descriptive caption. Clicking the "Update post" button will publish the post on the main page. The posts are displayed in descending order.
- Friend List - The "Friends" section of the navigation panel displays all the friends of the currently active user. Besides showing all the friends, it also provides information about the time when a particular friendship was established.
- Search for Friends - The "Find Friends" feature allows users to search for other users who have profiles on the application. After performing a search, you can view information about a specific user you are looking for. Simultaneously, you have the option to send them a friend request or cancel a friend request that you have already sent.
- Settings - The "Settings" section allows the currently logged-in user to change their profile information. The user can modify their profile picture, status, username, first name, last name, country of origin, birthdate, gender, and relationship status.
- Exit the Application - By clicking on the "Log out" section, the user can log out of the application, and the home page will appear.

4. Implementation

In this section, the structure of Android Studio, Firebase Database, and Firebase Storage will be described, along with important components of the software logic.

4.1. The Structure of the Android Studio Project

The basic elements of an Android project are the following (Figure 4).

Gradle Scripts: This group contains configuration files related to building the application. When the application is started, Gradle generates files that pertain to the application's logic. Gradle Scripts use Domain Specific Language (DSL) for configuration.

Manifests: This group includes the AndroidManifest.xml file, which contains comprehensive details about the application, its activities, and the permissions it requires.

Java: This group comprises the .java source files, systematically organized into packages. It encompasses all programmed activities that govern and define the application’s workflow.

Res (Resources): This group contains XML files, strings, images, and other resources, organized into relevant folders.

To summarize, an Android project consists of Gradle Scripts for building and configuration, Manifests for detailed app information, Java files for activities and logic, and Res for various resources used in the app.

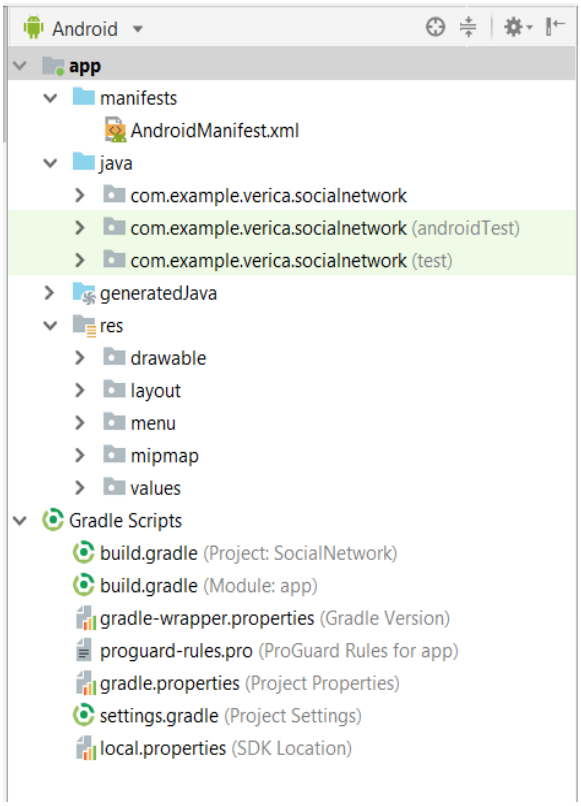

Figure 4. The structure of the Android Studio project

- Activities: An activity is a component of the application that allows the user to access the screen, so that the user can interact with the application through the screen. Each activity displays a window in which the graphical interface is drawn. An Android application usually contains many activities. There is one main activity that is invoked when the application is launched. Each activity can activate another activity, and when this happens, the current activity stops being visible to the user and is placed on the stack.
- Graphic elements: When creating this Android application, two formats were used for storing images: .png and .jpg. The first format (.png) is used for icons, while the other format (.jpg) is used for photographs.

4.2. Structure of Firebase Cloud Storage

Cloud Storage is designed for applications that need to store and use user-generated content, such as images or video recordings.

It offers a powerful, straightforward, and cost-effective service for storing objects. The Firebase Cloud Storage SDK provides Google's security backup for uploading and downloading files for Firebase applications, regardless of network quality. It can be used to store images, audio-video content, or other user-generated content. On the server side, Google Cloud Storage is used to access the same files.

The following image, Figure 5 represents the structure of Firebase Cloud Storage used in the application.

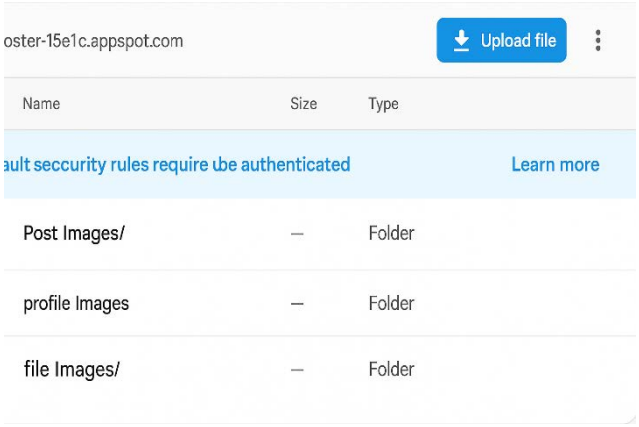

Figure 5. The structure of the Android Studio project

5. Conclusion

In recent years, Android technology has gained significant popularity due to its effective development methods and the increased usage of mobile devices with this operating system.

The Firebase platform continues to evolve, and its functionality has been enhanced from version to version. Being able to integrate with a wide range of programming languages, it has become a highly popular solution for complete projects.

This effort showcases the development possibilities of Android Studio, utilizing different types of activities and background services. Additionally, by using just four components of the Firebase platform, its capabilities are presented, along with some of the potential applications of these technologies.

The application “P” seeks to illustrate the potential enabled through the integration of these technologies. By eliminating the requirement for a dedicated server or separate database, a fully comprehensive solution has been realized.

The primary objective of this application is to integrate users into contemporary digital lifestyles while ensuring the rapid and convenient delivery of essential information. The 'P' application is just one more example of an app that embraces the era of hyper-mobility.

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