TED UNIVERSITY

2023 Fall Term

CMPE 491 Senior Project

High-Level Design Report

FocuZone

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1. Introduction

Nowadays, Attention Deficit Hyperactivity Disorder, also known as ADHD, has become quite common. With the development of technology, the increasing presence of distracting factors in human life has become an obstacle for ADHD patients to perform their daily tasks. Our project, FocuZone, is a mobile application that aims to help people with ADHD to manage their daily tasks without getting disturbed with the application's four main features. These features include a to-do list feature which users can view their daily tasks together and mark them as they are completed, a study assistant which is a timer where users can do their task session by session with the Pomodoro technique, a feature that measures the sound level in the environment and tells you whether you are in an environment with a distracting sound level, and a feature that analyze the photo of the environment, after uploading the photo to the application, this feature detects distracting items and colors that will recommend changing their location. FocuZone is a mobile application that combines these four important features in a single application, and it offers a unique focus zone to its users.

1.1 Purpose of the System

Individuals with ADHD can come across problems with focusing while studying or working in general. Even though ADHD can be cured with medication, we aim to help them with their problems in their daily lives. This application will be used to help individuals with ADHD to focus while they are studying, with features to-do list, study assistant, sound level measurement, environment photo analysis. For example, with the help of analyzing features the user can help themselves out by finding better working environment than the current one they are in, this can be done by using the sound level meter and environment photo analysis.

The application will be working under 2 different topics, one of them helps users keep track of their activities and work by using the to-do list feature and the study assistant to remind them of their work or activities. Under the to-do list feature, the user can keep a list of their daily work. They can add and remove their tasks and mark the task as completed when they are done. On the other hand, the study assistant will provide a pomodoro system. The pomodoro system will have personalized study periods. The user can set timers for break

and work, creating a working schedule. When a cycle is completed, the user gets alerted that it's time for a break or work.

The other part in this system will help users by analyzing their work environments by using a Sound Level Meter and with a Working Environment Photo Analysis feature. The sound level meter will analyze the noise of the environment that user is going to study/work, if the noise is too high the user will be able to see that the environment is not suitable for studying. Besides the sound level meter, the Working Environment Photo Analysis feature will help the user analyze the working environment for distractions by scanning for distracting colors and objects.

With the usage of the systems mentioned above, the users will have a better and more productive experience while studying. They will be able to schedule their daily work and work in a better environment, helping them reduce the effects of ADHD.

1.2 Design Goals

1.2.1 Usability

Our application FocuZone was designed with great emphasis on ease of usability and the design of a user-friendly system. In this application, which we developed especially for users who have problems with distraction, one of our biggest design goals was to aim to provide user interfaces with uncomplicated pages and colors that will not distract the attention of ADHD patients. It is a great priority for us that the user can find what they are looking for without any difficulty and get the benefit from the application easily and as fast as possible while using the application.

1.2.2 Reliability

Since FocuZone is an application that serves in the field of health, the calculations and results in our features have been prepared in accordance with various research and academic theses. For example, in the sound level meter feature, sound levels are scaled as distracting or normal as a result of research, and in the study environment photo analyzer feature, distracting colors and objects are determined as a result of research and will be integrated into the application as a result of teaching these studies to the machine learning and then it will handle with image processing.

1.2.3 Security

Users will be able to log in to the application only with their e-mail addresses and passwords, and during the first registration phase, a confirmation e-mail will be sent to their e-mail addresses. User information, usage statistics and images shared by the user with us in the study environment photo analyzer feature will be encrypted in our database system server. And third-party access will never be allowed.

1.2.4 Privacy

User information and statistics will not be visible to any other user and will not be shared with other companies.

1.2.5 Performance

The features in the application will be finished in the allocated time. In order to provide the user with a better user experience, all features will be completed in a short time without taking up the user's time. To do list and study assistant will work instantly, the sound level meter will be completed as soon as it takes the average sound in the environment within the specified time, and the study environment photo analysis will share the analysis results with the user in a short time.

1.2.6 Efficiency

FocuZone needs to get the input from user fast and it has to give response as fast as possible to the user, so that it takes less time, and the user can reach efficient usage of the application.

1.2.7 Maintainability

FocuZone is designed for easy maintenance with a modular architecture that allows for simple updates and improvements, although it is not designed to be highly coupled, it is designed to keep changes in one feature from not affecting other features.

1.2.8 Availability

The application must be ready and available for the user wherever the internet is available.

1.3 Definitions, acronyms, and abbreviations

Database: A database is a structured collection of data organized for efficient retrieval, storage, and management.

Authentication: The process of verifying the identity of a user, system, or entity to ensure that they are who they claim to be.

ADHD: Which we can briefly explain as a disease that negatively affects human life by causing many problems such as hyperactivity and attention deficit that can start from a young age, we generally try to minimize the distraction caused by this in our application.

Dialog: These structures are similar to the pop-up structure on the web, which offers the user options to give certain alerts or perform certain directions and actions on Android. It is used in different ways in our application.

Mobile Application: These applications are produced to meet people's specific needs and to enable this to be done from the phone that they can access most quickly.

Image Processing: With this process, the relevant image is analyzed with the help of artificial intelligence, and this part will be used when analyzing the working environment in our application.

1.4 Overview

FocuZone is an application that will offer a unique experience to all users, whether they have ADHD or not, who face distractions in performing their daily tasks, or simply need of a regular study/work routine. FocuZone, which combines many features in a single application, provides a range of usage from students to employees. We are always a click away for the purpose and enthusiasm of creating a focus zone for all kinds of users whose aim is to focus on.

In this report we delve into a detailed analysis of FocuZone's system design model. This analysis includes an examination of the current software architecture, the proposed software architecture, subsystem decomposition, hardware/software mapping, persistent data management, access control and security, global software control, boundary conditions, and subsystem services. Through these examinations, we aim to provide a comprehensive understanding of FocuZone’s system design model.

2. Current Software Architecture

Our current software architecture is currently progressing similarly to the microservices architecture model, as we develop it piece by piece. Although our entire system is not yet complete, the basic software of some parts is working. The entire user authentication section is finished. We did this section using the Firebase Authentication system and by using this system in our application, we made the login, registration and I forgot my password sections work properly.

Apart from this, the basic framework of our application is also finished. Although what we mean by the basic skeleton is not fully filled, the structure of our classes and general use cases are ready, but they have not been filled in software yet. The to-do list feature, one of the basic features in the application, is just starting and among other features, only our sound level meter feature has been completed. Since the sound meter level feature does not keep a backend record, we created and completed it first and it is now working without any problems. Apart from this, a profile section has also been created, but since some data will be shown in this section, the data in it is only for show for now and will be replaced with real data later. We also added a logout button in this profile dialog. This button is currently working and performing the logout process. At the same time, we are making improvements in the backend section and improvements in image processing and image detection. Our current software architecture is progressing in this way, and we still do not have a completely finished architectural structure, but we will solve this in line with our goal by making separate developments.

3. Proposed Software Architecture

3.1 Overview

We have designed the architectural structure of the system we will install in a way that can be modified later, allowing us to detect and fix errors more quickly, and providing a separate development environment in the subsystems to be separated. In this architectural structure, each of the features that make up our application is intended to form a whole as a subsystem. These subsystems are among the features in our application such as the to-do list, study assistant, sound level meter, working environment photo analysis, notifications, image processing, database management, user authentication, and interface. will be responsible.

In this project, we generally followed the microservices architecture model. The reason why we chose this architectural model is that although all the features in our application aim to prevent distraction and increase focus, each feature works independently. Each of our features has a structure within itself and does not directly affect other features, but all of these features serve the main purpose of our application. Since the features in our application can work independently of each other, we develop them separately, and if an error occurs in any of these features in the future, we aim to solve this error in the relevant microservice so that it will not directly affect the other features. For these reasons, we decided to follow the microservices architecture.

3.2 Subsystem Decomposition

It would be correct to divide the main headings of our application's subsystems as follows:

- Mobile application subsystem, which contains many features and each of them will work like a microservice.
- Notifications subsystem will be created due to some features in our application sending notifications.
- The image processing subsystem that our application will use in the working environment analysis feature.
- Data management subsystem where all data is stored and managed.
- User authentication subsystem that manages user login and registration in our application.

Mobile Application Subsystem: This subsystem is our subsystem with which the user interacts directly through his mobile device. We can also consider this subsystem as the main subsystem where, in addition to things such as user login and introduction screens, features such as to-do list, study assistant, sound level meter, working environment photo analysis, and systems such as notification and database depending on these features are presented to the user. This subsystem should also have a simple and stylish interface because this is the part where our project meets the most users, compared to other subsystems.

Notifications Subsystem: Although this section runs on the mobile application subsystem, it is actually a system that works on its own and has certain rules. This system is a subsystem that allows communication with the user by using some features in our application by sending some notifications to the user's phone, depending on certain rules, even when the application is not running.

Image Processing Subsystem: This subsystem is a basic subsystem that will be used in our working environment analysis feature. This system is a subsystem that will analyse the photographs received from the user and send feedback to the mobile application subsystem to show the user situations such as creating a colour scale and detecting objects that may cause distraction as a result of these analyses.

Data Management Subsystem: We designed this as a subsystem where general management operations of many of the data held in our application are carried out. It is the subsystem where the user's data is kept, the data to be used in the to-do list feature, the study assistant feature, and the working environment analysis feature, and some data to be taken from here and displayed on the profile screen are kept and managed. This subsystem is our subsystem that sends data to the mobile application subsystem and enables the application to run for the user.

User Authentication Subsystem: This is our subsystem in the process that starts with the user creating an account at the first main entrance of the application. The system here works on the basis of the Firebase authentication system. It is our subsystem where the user verifies his/her own account after the e-mail sent to his/her e-mail after becoming a member and the user's identity is verified.

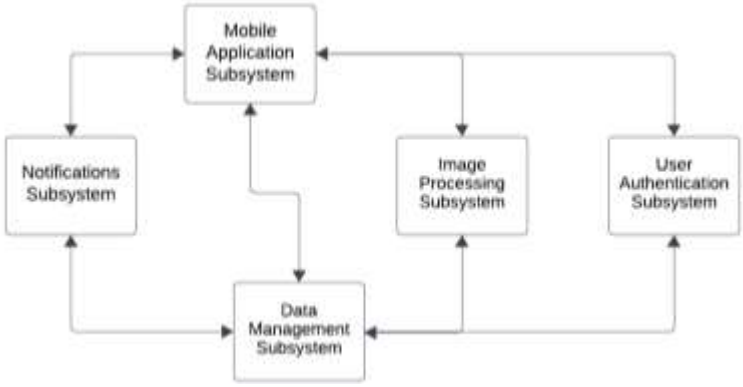

Figure-1 Subsystem Block Diagram

3.3 Hardware/Software Mapping

The software architecture of our project mostly requires software components. However, it also requires some hardware components. The hardware and software mapping of our project is explained below.

Hardware Components:

- Smart mobile devices (tablets, phones…) that support Android operating system. However, in order to increase the functionality of our application and to effectively benefit from all the features that our application offers to users, some features of mobile devices must also be working properly.

- **Microphones:** Our project uses the microphones of mobile devices to measure the sound level in the environment. Therefore, the sensors of the mobile device must be working properly.
- **Screen:** A high-resolution screen will provide a user-friendly display of the user interface.
- **Processor and Memory:** With a powerful processor and sufficient memory, complex operations such as image processing will be performed faster.

Software Components:

- Our mobile application is developed using Java and Kotlin software languages in the Android Studio development environment.
- Python and OpenCV library for image processing implementation.
- Python and Pandas library for machine learning and data processing.
- Firebase Realtime Database for storing and retrieving data (database management)
- XML in the Android Studio development environment is used in the designs of the UIs in our mobile application.

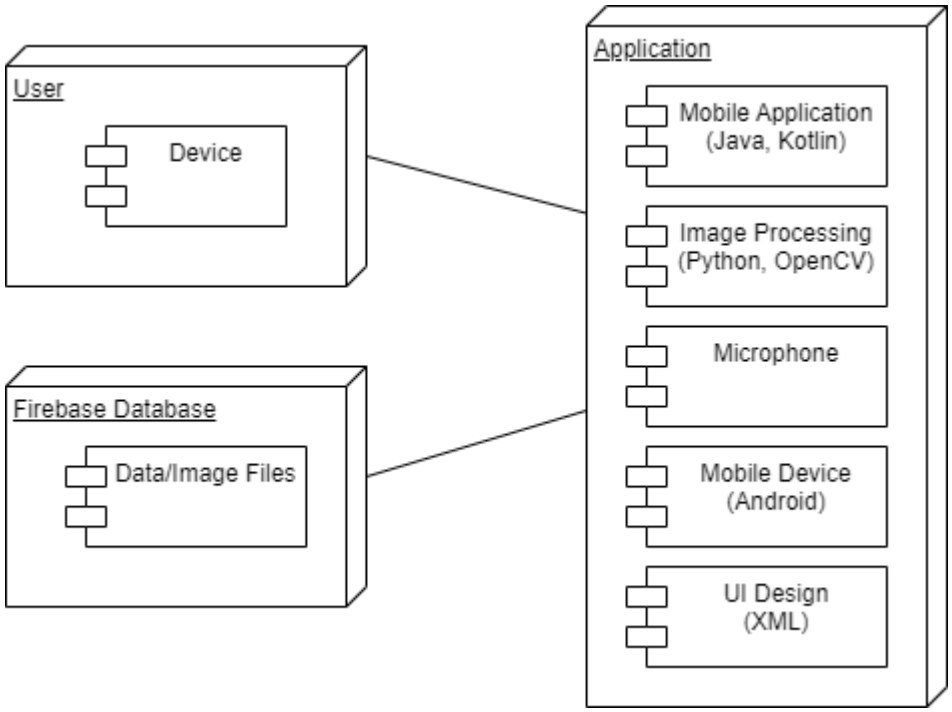

Figure-2 Visualization of Hardware/Software Components

3.4 Persistent Data Management

In FocuZone, most of the data needs to be persistent so the data will have longer lifetime rather than disappearing after a single execution. For this reason, we will be storing some of the data in a Database. We will be using Firebase, Google's Mobile and Web App Development Platform, as a relational database to store our persistent data. Since Firebase can be used as a Realtime Database users can access and modify their information across multiple devices.

Persistent data will include both the to-do list items that have been created by the user, the results of the environmental photo analysis feature and the login credentials of the user. When the user uses one of the said features the results will be saved to the database and can also be displayed from their device.

In summary, FocuZone using Google's Firebase for persistent data management will be enough to provide users with reliable and synchronized experience from multiple devices. With the storage of personal data securely the application will be helping users increase their productivity and managing their ADHD.

3.5 Access Control and Security

FocuZone will prioritize security and access control as it is one of the most important aspects in software architecture. We will be protecting user data and ensuring a secure user experience. User authentication will be achieved through secure login and register credentials using the authentication methods of Firebase since we are going to keep the data there.

Access Control:

Controlling the access methods is an important step in software development as it is required to let users know and get permissions from them to use some of the features in the application.

Users will be required to login or register to the app to use all the features. User credentials will be kept in Firebase using the firebase authentication systems. Firebase SDK Authentication is an authentication method that uses emails and passwords. It requires users to add their email addresses and create their passwords for authentication. It also includes sending password reset emails.

After the login is done, users will be required to accept notifications to able to be sent to their phone. This part is necessary as it is required to inform users about sending notifications so that users can control receiving notifications from the app while they are not using it.

The users won't be able to use sound level meter functionality without permitting access to their device's microphones. The application will ask for permission from the user when they

try to use the sound level meter for the first time. With the access, the functionality will function like it's supposed to.

Another feature that will need permissions from the user is Working Environment Photo Analysis as it is required to analyze photos from the user's photo gallery to function as it intended. This, like the notification system, falls into the category of access control as it is dependent on the user's determination to access the necessary information in the phone.

Security:

Since we are not gathering that much of data from the user the only thing, we need to keep secure is the password and email address of the user. This will be done by using Firebase's own security system. Also, since the application will be asking for permissions for any notification or gallery usage before using them, we will be notifying the user about the usage of these features.

3.6 Global Software Control

Global Software Control is important to keep our project running smoothly. There are many subsystems in our project. Interaction and coordination of subsystems with each other is ensured with global software controls. Each subsystem will be coordinated to work in harmony with each other. In this way, the integrity and harmony of the overall system will be guaranteed. For example, the camera data collection subsystem for "Study Environment Analysis" collects image data from the gallery and transmits it to other subsystems. The image processing subsystem then analyzes this data and detects elements that may cause distraction. Then, the user interface subsystem displays the received data in a user-friendly interface and transfers it to the user. Thus, these subsystems complete the process from receiving images from the gallery to processing and presenting them to the user.

On the other hand, the software control system receives the user's requests and transmits these requests to the appropriate subsystems. For example, if the user makes a request regarding the "Sound Check" feature, it will go to the sound check subsystem, or if the user makes a request regarding the "To-Do" feature, it will go to the to-do subsystem. Thus, regular, and systematic coordination of many existing subsystems will be ensured.

The software control system will continuously monitor the overall performance of the system to consider critical metrics such as response times, resource usage, and error rates. It detects whether there is a situation that could endanger the system. In addition, it aims to detect possible problems in advance and take precautions to increase the efficiency of the system. Thus, it is extremely critical for the user's requests to be fulfilled without any problems and all data to be analyzed without errors.

It aims to address the errors encountered by the system and to resolve these instantly monitored situations by reporting them. At the same time, it will help find solutions for possible problems we may encounter in the future, based on these errors. Thus, there will be an effective error detection process. With this system, efficiency will increase, and performance will be brought to the optimal level.

3.7 Boundary Conditions

Boundary Conditions will be kept under three different conditions.

• Initialization

• Termination

• Failure

These conditions will define the boundaries of the application in an order. This order is necessary as it will define what will happen when the user is using the application from their personal device.

3.7.1 Initialization

To use the application the user is expected to download the app to their mobile device. When the download is complete the users are expected to register to the application if they don’t have an account or login to the application if they already have an account. The registration can be done by using any e-mail address of their choice with assigning a password for safe keeping. To use the application an internet connection is necessary so that features such as, environmental photo analysis and to-do list can work properly. The user will be notified if there is no internet connection while logging in or using the

app. When the user successfully logs into the app the authentication token will be saved and can use the app without logging in again for a certain amount of time.

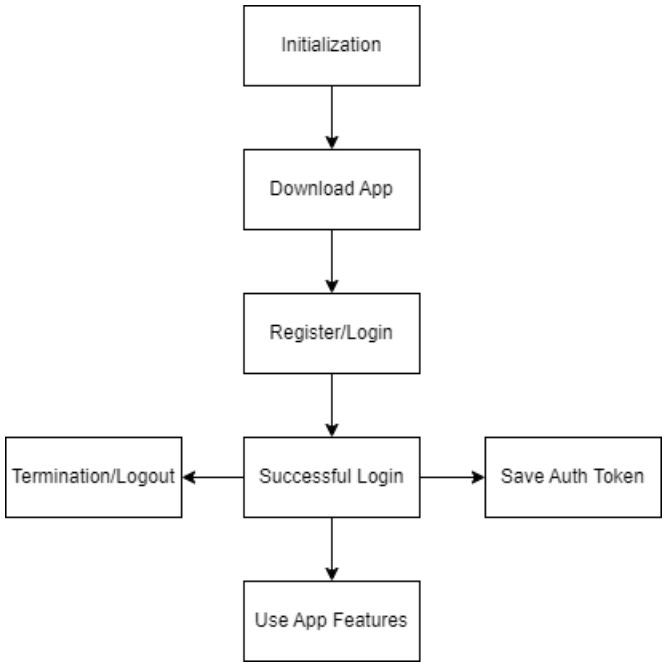

Figure-3 Initialization Diagram

3.7.2 Termination

The user can logout of their account whenever they want, they also will be logged out automatically if the authentication token is not valid anymore after a certain amount of time. The app features can be used whenever the user wants if the device has an internet connection. Sound Level Meter and the Environmental Photo Analysis feature will be available to use when there is no analysing in process.

3.7.3 Failure

While using the system the user may came across some errors such as a login error while logging in and an internet connection error if the device does not have an internet connection. The users will be informed about the cause of the errors if they encounter any.

4. Subsystem Services

4.1 Mobile Application Subsystem

Since this subsystem is a system that interacts directly with the user, it aims to provide the user with an easy-to-use interface along with the services it contains. The services and their functions used in this subsystem are as follows:

- This subsystem contains a service that manages the user's authentication and provides promotional functions. When the user first enters the application, he goes through a series of introductory screens and learns the application in general terms. Afterward, they can switch to the login, register, and forgot password screens. These screens, generally use the user authentication service. The part I will really talk about this service will be the user authentication subsystem part.
- There is a to-do list service in this subsystem. Thanks to this service, the user will be able to easily create a daily plan and follow the progress of this plan. The notification service is also included in this feature. When the end time specified by the user for a task determined in the daily plan approaches, the user is warned with a notification thanks to the notification service.
- There is also a study assistant service in this subsystem. Thanks to this service, the user will be able to keep work and rest intervals in periods. Thanks to this service, the user will be able to work more efficiently.
- Another service in this subsystem is the sound level meter service. This service gives feedback to the user as to whether the environment is at a sound level suitable for operation, as a result of its own calculations based on the ambient sound received from the phone's speakers.
- The working environment analysis service in this system performs certain analyses on the photo sent by the user to the application's database and then sends some data to this screen by detecting the colour scale of the environment and distracting objects in the environment.

- There is also a profile service in this subsystem. Thanks to this service, the user opens a dialog showing the total tasks he has done so far, how many hours he has studied in total, and how many periods he has studied in total. At the same time, thanks to this service, the user can also log out of his account.

4.2 Notifications Subsystem

Thanks to this subsystem, the user can see the warnings from the application through notifications, even if the application is not open, and we aim for the user to get maximum efficiency from the application. The services used in this subsystem are as follows:

- In the To-do list feature, there is a real-time notification server that will send notifications to the user even if the application is not open when the task completion time specified in the tasks created by the user is approaching. Thanks to this service, notifications regarding the study assistant feature can also be managed by this service.
- In order to use this real-time notification service, the notification permission service is required. Thanks to this service, when the user logs in to the application for the first time, a warning is sent to the user and asks for permission to open or not open notifications. This service is of great importance as it is of great importance to have notification services turned on in our application.

4.3 User Authentication Subsystem

This subsystem has a subsystem feature that is used when the user becomes a member for the first time, logs in to his account, or wants to change his password. This subsystem generally goes through an approval process that works via e-mail, and we also use the Firebase Authentication service here. The services available in this subsystem are:

- When the user becomes a member for the first time, the membership confirmation e-mail service works. This service sends a confirmation e-mail to the user's e-mail. When you click on the confirmation link in this e-mail, that account is now approved and opened for use. If the membership confirmation process is not completed, that membership is not completed, and login cannot be made.

- Another service in this subsystem is the password change service. When the user forgets his password, a password change e-mail is sent to the relevant section of the application. After the password change e-mail reaches the user, the user is directed to a site where the password will be changed via the link in the e-mail, and the user can renew his password from there.
- This subsystem membership login service is also included. If the user has verified his account, he can easily log in to his account from the login screen, but if he has not, he will encounter a warning on this screen to verify his account.

4.4 Image Processing Subsystem

This subsystem has a subsystem feature that is used when the user wants to determine to what extent the colours in the environment the user will work in will cause distraction. Also, the user can use this subsystem in order to detect distracting objects in the working environment. This subsystem generally goes through an approval process when used a notification system that shows up asking for gallery access. Then the user will select the picture that they took of the environment for the analysing.

- When the user accesses this subsystem for first time, a notification asking for permission will be displayed for the user to accept. When the user allows the gallery access to their phone, they will be able to select the picture they are going to analyse for the extent colours and distracting objects in the environment. If the user does not accept the gallery access notification, then they won't be able to use this subsystem.
- This subsystem will involve an internal service that will extract the colour scale of the working environment. Then depending on analysed results a message shows up and informs the user about if the area is appropriate for working or not.
- This subsystem will involve another internal service that will determine the distracting objects in the working environment. After the analysing is done the system will show the distracting objects in a square and the user will be able to see the resulting objects.

4.5 Data Management Subsystem

The data management subsystem serves as a center where transactions related to the data contained in the application are controlled and supervised. This subsystem serves as the storage location for data received from various features of the application. It will be the storage place for many important information such as the user's personal information such as email and password, tasks in the to-do list, work assistant functions and the results obtained from the work environment analysis used to detect distracting objects.

- The subsystem securely stores the user's basic personal information such as email and password. Thus, the principle of confidentiality and integrity of personal data is ensured.
- Data management is very important in To-do List and Study Assistant features. In the To-do List feature, the user lists the tasks they aim to do on a daily basis. In the Study Assistant, the user makes a daily work schedule by setting work periods. Thus, it serves as a bridge between the daily work list and working periods. It facilitates seamless integration of information for a more consistent and seamless user experience.
- Data obtained from the Image Processing Subsystem is stored in this subsystem. It serves as a repository for the results of the color scale analysis of the environment in which the user will work and for objects that may cause distraction in the user's work environment.
- At the same time, the relevant sections of the stored data are selected and displayed on the user's profile screen. This provides the user with a more comprehensive overview of the choices the user has made.
- The Data Management Subsystem generally acts as an intermediary that transmits the necessary data to other subsystems of the application. This ensures that the application runs smoothly and securely and provides users with a personalized experience.

5. Glossary

- **Firebase Realtime Database:** This database is a database feature offered by Firebase, and at the same time, the use of this database is very easy with its interface.
- **Firebase**: It is a tool developed by Google that is widely used by developers in mobile applications and web applications and allows developers to easily use many features such as database systems and authentication systems.
- **User-Friendly System:** These types of systems are designed to allow the user to easily access everything they want in the simplest way as if they do not know anything.
- **Third-Party Access:** It refers to access to data by persons other than the direct system administrator or the direct owner of the data.
- **Kotlin:** It is the most used programming language after Java in Android application development, and it can also be used together with Java in the same project while developing Android applications, it is a language that helps us write much cleaner and faster codes.

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