Bilkent University Department of Computer Engineering

CS 491- Senior Design Project

Bee+

High Level Design Report

Group Members:

Ahmet Emre Zengin	21400527
Asena Tuğba Şahin	21502354
Hasan Doğan	21402109
Tunç Zerener	21501330

Supervisor: Özgür Ulusoy

Jury Members: İbrahim Körpeoğlu

Uğur Güdükbay

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1. Introduction

In the last half century, the rates of happiness started to decline significantly. According to some scientific researches the rate of happiness globally has declined by 5% in the last 10 years [1]. Depression is a mood disorder that is characterized by continual low mood and unhappiness. Some indications of depression are worthlessness, hopelessness, and pessimism [2].

In today's world, depression has become an important problem and many people have a negative perspective on life. Even though a multi-billion dollar antidepressant industry exists, The World Health Organization(WHO) estimates that depressive and anxiety disorders lead the list of mental illnesses across the globe [3]. It is estimated that globally, depression nearly affects 350 million people [4]. Moreover, according to the Centers for Disease Control and Prevention, 7.6% of people over the age of 12 have depression in any 2-week period [4]. This demonstrates the importance of the issue. Number of people with common mental disorders are globally on the rise[5].

Even though there is a trend of increasing unhappiness among people, this case should not be the final verdict on humanity. Besides antidepressants, there should be other scientifically backed up ways of making people happier. For instance, Happiness Researcher Shawn Achor claims in his blog that "Gratitude, focusing on positive experiences, exercise, meditating, and random acts of kindness are all ways to change the pattern through which your brain views work [6]." Shawn developed what he calls the "21-Day Challenge," which involves the idea of writing down three positive experiences each day for 21 days. By this way, he claims to create a positive feedback habit. Which shows that human thought pattern can be reinforced in a positive way.
Dopamine, serotonin, endorphins and oxytocin are the happiness chemicals. Our happiness can be formulated by these hormones' levels of production in our body [7]. Therefore combining these hormones production ways with 21-day challenge method can improve human thought pattern.

Though there are some well-being applications which have the same aim with our project, they do not keep track of user progress in any way. These applications do not go beyond giving advice about happiness to users. Different from other applications, it will involve daily

positive journaling, happiness hormones tracking, weekly thought pattern progress, interactive user interface and recommendation system through notifications.
In the remaining part of this report, first a description of Bee+ will be provided. Our main constraints are implementation, economic, social, data, language, health and safety. After that, professional and ethical issues will be discussed. Finally, detailed information about the functional and nonfunctional requirements of Bee+ will be included.

1.1. Purpose of the system

Bee+ is a mobile application that will help people to achieve a more positive outlook on their life and overcome depressive thought patterns. This will enable our users to gain a new perspective they will carry throughout their lives instead of just making them happy for the day.

In this mobile application, users will start their journey to happiness by filling a quick test which will determine their current happiness rates. These rates will be calculated by using Natural Language Processing (NLP) in open-end questions and calculating points they gather from multiple choice questions. This test will be done once every week. This will show users and our team, our application's impact on user's happiness rates over time.

After the first test, users will be asked to enter 3 inputs about positive experiences and gratitude about their day or any time they felt happy. An example would be "Today, I helped a kid to find her parents." or even as simple as "I'm grateful that I have a family that cares about me." Human brain labels these recalls of positive experiences as meaningful and this will deepen the imprint of the events.

Hormones are responsible for the biochemical processes. There are four primary hormones that affects happiness which are dopamine, oxytocin, serotonin and endorphin. Happiness hormones balance regulated by food intake and pleasurable activity. Using this knowledge we will encourage our use to consume foods and do activities that increase the production of these hormones. Everyday, our users will be able to select the foods/activities they ate/did from our list of items. According to these items they'll gain points in our application with respect to each hormone. The points which user gains will be determined with respect to a scientific formula we developed by using related those researches. If a hormone's points are under a certain threshold the user will be notified with items to increase that particular hormone.

Besides all the above features, this application will provide some information related to the self care such as meditation, better sleep, sport activities, water intake and daily routines. Users can utilize from this application with or without registering. They will be accessing the same functions except Facebook friend list and leaderboard.

1.2. Design goals

In this section, the design goals of Bee+ will be presented and the rationale behind the goals will be explained.

1.2.1. Usability

- Since Bee+ has the customer range from all ages and various groups of people, the application should have a user-friendly interface for all of these potential user types.

- The application should include an explicit user manual that demonstrates how to use Bee+.

1.2.2. Reliability

- The application needs to be stable and avoid any interruptions/crashes.
- Tests performed in the past to measure positiveness will be accessible by user.
- Reasons for suggestions to users will be explained in a detailed way.

1.2.3. Security

- The application needs to secure user information from any possible threats.

1.2.4. Performance

- Load time of the application should be low.
- The database should be optimized so that users can quickly and easily look for the information they can access.

1.2.5. Extensibility

- Making updates and adding new features is necessary for an application to satisfy the demands of users. For that reason in Bee+, we will consider the comments of users to improve and modify the system.
- In order to be able to improve and modify Bee+, the datasets will be extendable.

1.2.6. Portability

- Any device with android operating system will be able to run Bee+.

1.3. Definitions, acronyms, and abbreviations

DOSE: Dopamine oxytocin serotonin and endorphins. Quartet of chemicals that are responsible for human happiness[8].
WHO: The World Health Organization.
MySQL: Open-source relational database management system.
NLP: Natural Language Processing
UI: User Interface
IDE: Integrated development environment
Health and Wellness Applications: Health and wellness applications are mobile application programs that offer health-related services on smartphones, tablet PCs and other communication devices[9].

1.4. Overview

Bee+ is a mobile application that will help people to achieve a more positive outlook on their life and overcome depressive thought patterns. The main purpose of the system is to enable our users to gain a new perspective they will carry throughout their lives instead of just making them happy for the day. In order to achieve this our team has came up with the idea of combining happiness hormones effectiveness with positive feedback habit. Bee+ aims to reinforce human thought pattern in a positive way to create a better happiness hormones production in our user with repeated productive cycles.

Our users who want to increase their happiness levels will only have to download our application and all the useful information, productive activities, healthy hormone production aimed food lists, and daily/weekly tasks for positive feedback loop will all be given to the user by Bee+ application.

Users will complete quick daily tasks which will include writing down three daily positive experiences for that day, last week and any positive experience from any time they want to write about. This will increase the positive feedback habit as explained in our introduction. They will also be able to reach the information of happiness hormone increasing activities and food lists. Checking the items from the lists they've done for the day will increase their hormones points which will be stored in our application. Users will be able to view positive changes they've created on their body and symbolize it as an achievement on their way to a better outlook in life.

Users will also complete weekly tests starting from the day they've downloaded Bee+ which will be used to determine their increase in overall happiness levels and outlook in life. The test used for this purpose is very important in our case, therefore professionals in the field of health psychology will be consulted to create the most significantly decisive test to determine our user's situation and maximize our chances to help him/her. The results of these tests will be calculated by using the specific questions through calculating answers given to them, and open ended questions which will be analyzed through Natural Language Processing.

Users will be able to view their progress through weekly tests they've completed, daily tasks they have done, and hormone points they've got in our application. Bee+ aims to give users the sense of improvement through showing them their accomplishments and celebrating their success.

We will make sure to send daily notifications to our users in order to attract them to our application and give small recommendations about useful information they can make use of throughout their day. The continuity of our users is important for us and it will be made sure that our users won't have the chance to forget about us and their happiness.

2. Current software architecture

There are many wellness applications on the market, however none of them are as comprehensive and functional as Bee+. Most lack the integrity and can't go beyond becoming a health dictionary that doesn't motivate or guide users to accomplish desired results. The applications that are well-rounded don't include happiness hormones tracking. Instead, these applications just give general recommendations. The general complaint about comprehensive apps from ratings is that they require way too much in-app purchases to progress and don't let users continue without giving astronomical money which scares them away from the application.

- **Track Your Happiness**: It aims to measure the cause of users' happiness during certain events.
- **Reflectly**: It is a personal journal and diary that lets users write their feelings and track the happiness levels(users entered out of 10) over time. It gives motivational quotes and challenges about the day.
- **Nefes**: It aims to teach its users meditation through notes and voice recordings and give recommendations on depression and stress.
- **Sanvello Stress & Anxiety Help**: It is a daily mood tracking application that offers voice records on relaxation. It challenges users and keep track of their health habits.
- **Happify**: It aims to give games and activities that can help reduce stress, overcome negative thoughts and build greater resilience by providing tools to improve emotional well-being.
- **Psychology Tracking**: Keeps track of the daily mood of users throughout the time.

3. Proposed software architecture

3.1. Overview

The system should be designed in a smooth and proper manner to achieve the design goals. The whole system has an immense complexity, and to solve this, the program can be broken down into smaller parts, grouping similar functionalities together and collecting the groups that have more connections in one package. Bee+ sticks to these design goals and adds priority to the decomposition of the subsystem. Although Bee+ aims to decouple the specified subsystems and attempts to collect the classes which are relatively coherent with

each other. Decomposition offers some flexibility and modularity, allowing multiple teams to work concurrently and maximize the process of implementation. As each subsystem provides an interface to others, error corrections will also be made easier and each team's dependency on others will be reduced. During implementation, it will reduce contact between teams. In addition, other subsystems will not be influenced by this shift in a well-defined subsystem hierarchy when a change is made. As a consequence, these beneficial features of the decomposition of the subsystem are understood and used. The subsystems, their relationships and functionalities will be clarified in the latter sections. The hardware to software mapping will be discussed in section 3.3, describing which software is running on which hardware.

3.2. Subsystem decomposition

Since Bee+ is an Android application, its main functionalities are divided into two parts, the functionalities related to user interface and the functionalities related to data preservation and manipulation. Client / Server architecture will be used as a decomposition of the core subsystem in order to provide this separation. In this case, client requests services of server, while server hosts the data and makes calculations using the data and provides those services to Client. The key connection to the database will be set up on the server side. The subsystems are View Layer, Controller Layer, Authentication Layer and Data Layer. The presentation layer should be included on the client side. The presentation layer is Bee+'s highest level. The main function of this layer is to provide an interface between the user and the application, which translates and propagates user’s requests to the server side for request processing. Also, the data provided from the server side will be visualized in this layer. In addition, the presentation layer will be partitioned to two subsystems, View subsystem will hold classes of high coupling with view-level objects. Controller subsystem may contain the controller classes that are responsible for controlling the view-level objects when there has been a significant change in the database. The server-side will be divided to two layers: Authentication and Data layer. Data layer is responsible for the databases.

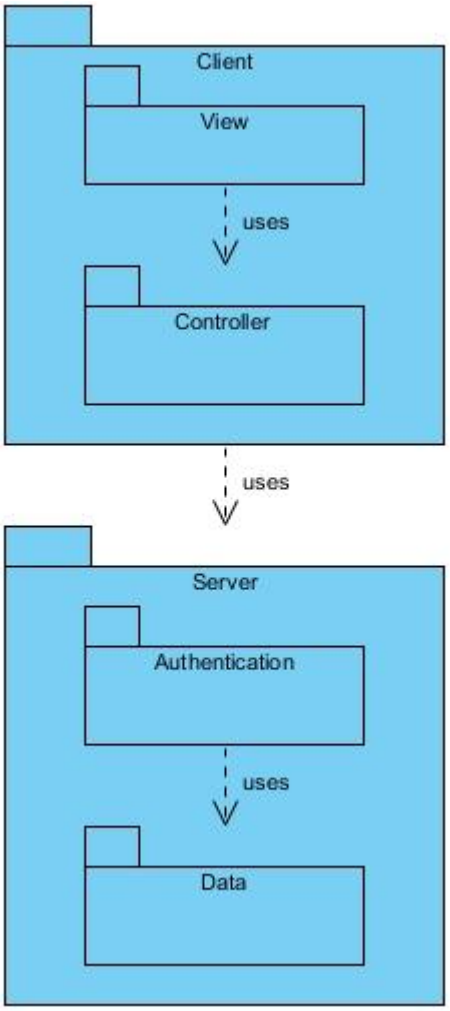

Figure 1. Subsystem Decomposition

3.3. Hardware/software mapping

Bee+ is an application that will run on Android devices. The authentication and database will run on a Firebase server. The client will access the server with a HTTP connection and the server will connect to the database. The Android application will run on Java and will send appropriate request to the authentication using HTTP as well. If the authentication needs to access the database to respond to requests sent by the client side, necessary information will be retrieved through a TCP connection. The database lives in the cloud and is a NoSQL type database.

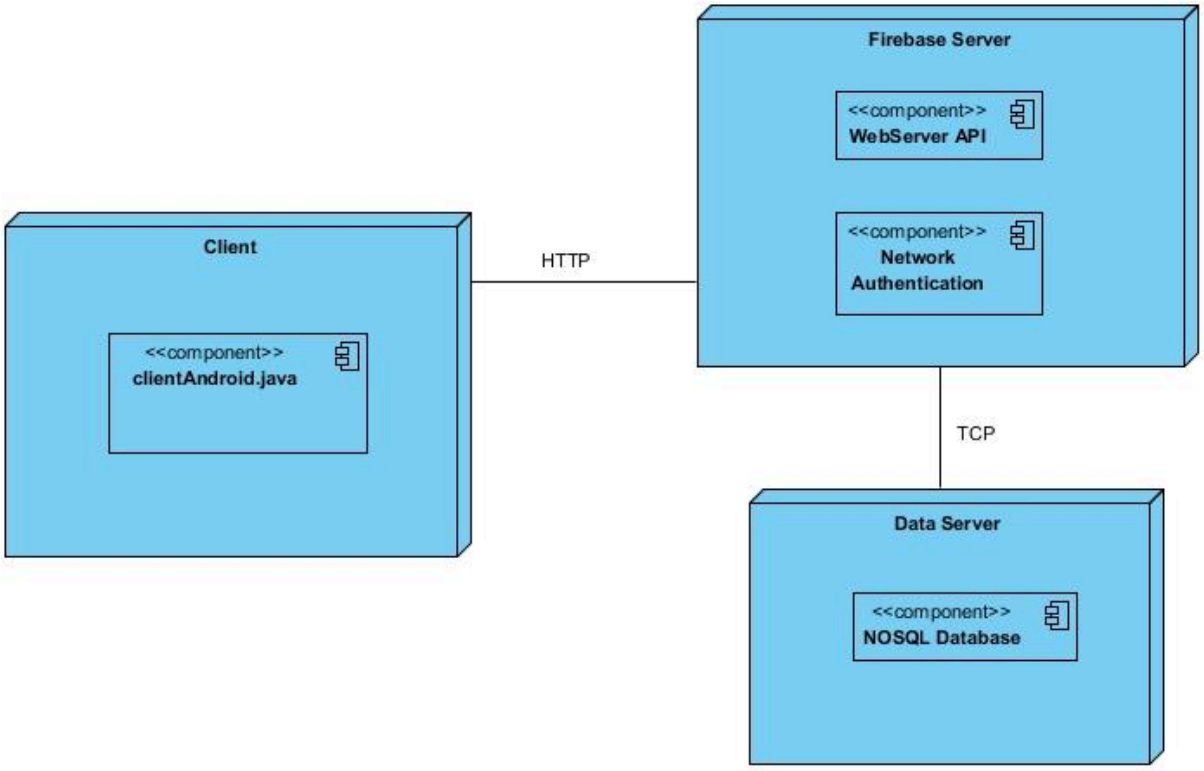

Figure 2. Hardware Software Mapping

3.4. Persistent data management

Bee+ will hold user information, name, mail, and answers of tests etc. The Firebase Realtime Database lets build rich, collaborative applications by allowing secure access to the database directly from client-side code. When integrated with Firebase Authentication, developers can define who has access to what data, and how they can access it. The Realtime Database is a NoSQL database and as such has different optimizations and functionality compared to a relational database. We respect the privacy of the user; hence, we have selected a database that can be conveniently used for an Android environment while providing security and privacy. Data on programs and configurations, however, will be stored in external storage. Relational databases are selected because our system requires simultaneous access. In order to avoid race conditions on the servers, updates on the client side will be reflected to the database immediately. Non relational database (NoSQL) will be used to store persistent data. In terms of the volume of a server, databases do not have an upper bound that makes them a good choice.

3.5. Access control and security

Users are required to have an account to have access to functionality of Bee+. They will be registering to the system by providing unique email addresses and information or connecting their available social media accounts. The importance for access control and data security in Bee+ increases with gathered information through daily and weekly tests about users. Therefore, our application should ensure data security and access control. Bee+ will encrypt the user passwords using Bcrypt password hashing algorithm. The passwords will be hashed and the system will compare entered passwords with stored password before authenticating the user.

If the user is accessing the application through a social media account their permission will be required to use their personal data in order to create the account. The social media accounts will also be used to link their friends' profiles in the application. Personal data of the users can only be moderated by them. Users will not be given access to modify any data on their friends' profiles.

3.6. Global software control

Bee+ is a client-server application and the system has an event-driven software control. When user tries to login the hashed password and email will be matched on the server. If the login information is matched, the server will give permission to enter the system. If users wants to make changes in their account such as changing their profile information, password, entries etc., the system will update the account of the user.

The data collected from the user through daily/weekly tests will be sent to and stored in the system. Necessary content shared by the user will be presented by the system if requested. Hormone points will be calculated by the system daily and the gathered points through user activity will be shown to the user which will also be accessible by user's friends list.

3.7. Boundary conditions

3.7.1. Initialization

Bee+ is an Android application. Therefore, our users must first download the application from Google Play Store and install it to an Android device. Then the user must open the

application and register to the system by using their email. Once registered, users can sign in using the credentials they've registered and start using the application.

3.7.2. Termination

The user can log out from the system by either using the "Sign Out" button which can be found at the settings page or terminating the application through Android's task manager. If the user logged out using "Sign Out" button, next time they open the application they must sign in to their account again.

3.7.3. Failure

Internet connection is not mandatory for application usage but in order to display up to date information and synchronize user entry and information, change profile settings, the user must be connected to the internet. The system will fail to provide these services without internet connection.

4. Subsystem services

This section of the report aims to outline the components of each subsystem and explain the services offered by each subsystem.

4.1. Client

The system that interacts with user by using two subsystems that are View and Controller is Client. View of login, signup, main pages and the tests are managed by client subsystem by handling the connection between controller, which interacts with server and gets the data asked by view subsystem, and view subsystems. Client will be implemented with MVC (Model View Controller) pattern.

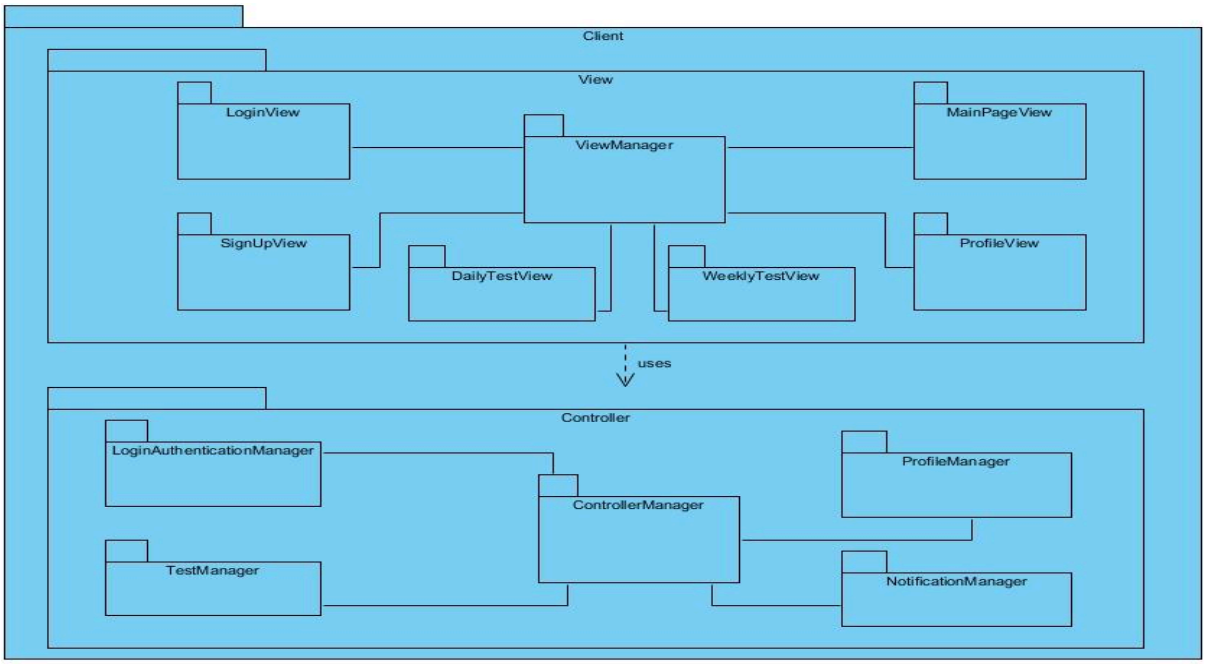

Figure 3. Client Subsystem

4.1.1. View Subsystem

The main functionality of View Subsystem is demonstration of the components and features to the user. Namely, visualization, it can be said. Login, signup, main, profile and test pages are viewed by this subsystem. To demonstrate what user asks for, view subsystem requests the necessary data from controller subsystem. After having the data, the results are shown to the end user.

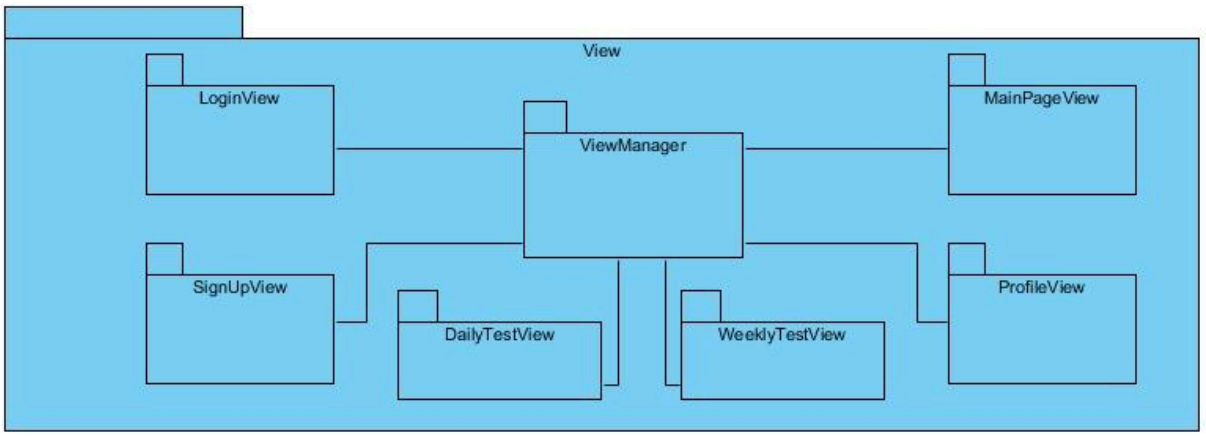

Figure 4: View Subsystem

4.1.2. Controller Subsystem

Controller subsystem manages the data transmission between the client and server. Gets the necessary data that is requested by View Controller subsystem and does the transmission. The controller subsystem divides the work to LoginAuthentication, Test, Notification and Profile managers. Each of these managers handle the controls that they are assigned to.

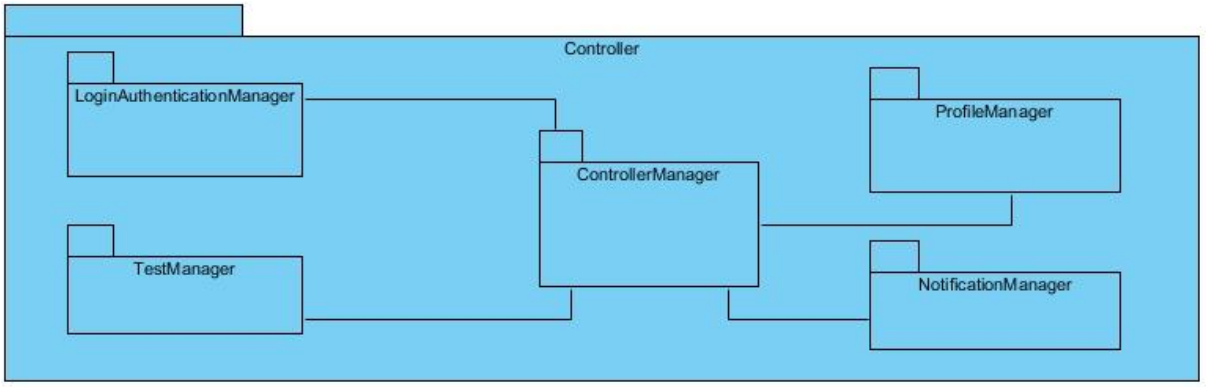

Figure 5: Controller Subsystem

4.2. Server

Server Subsystem includes two minor subsystems: Authentication and Data. This system manages the data that is needed to be changed and improved accordingly with the requests made by end users and transmitted through client subsystem.

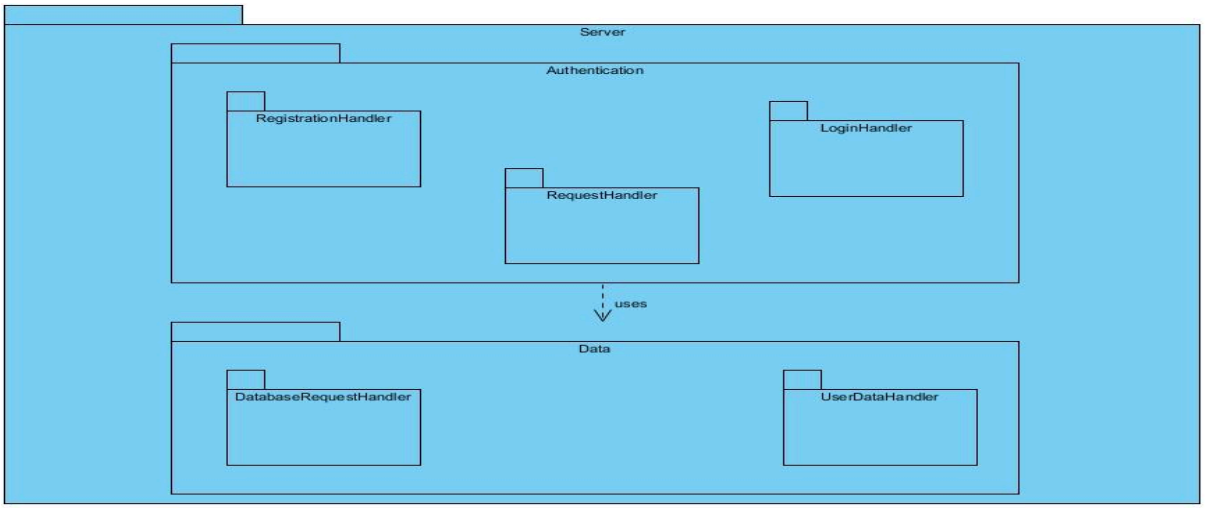

Figure 6: Server Subsystem

4.2.1. Authentication Subsystem

Authentication Subsystem consists of Registration Handler, Request Handler and Login Handler, each manages the necessary authentications for relevant requests.

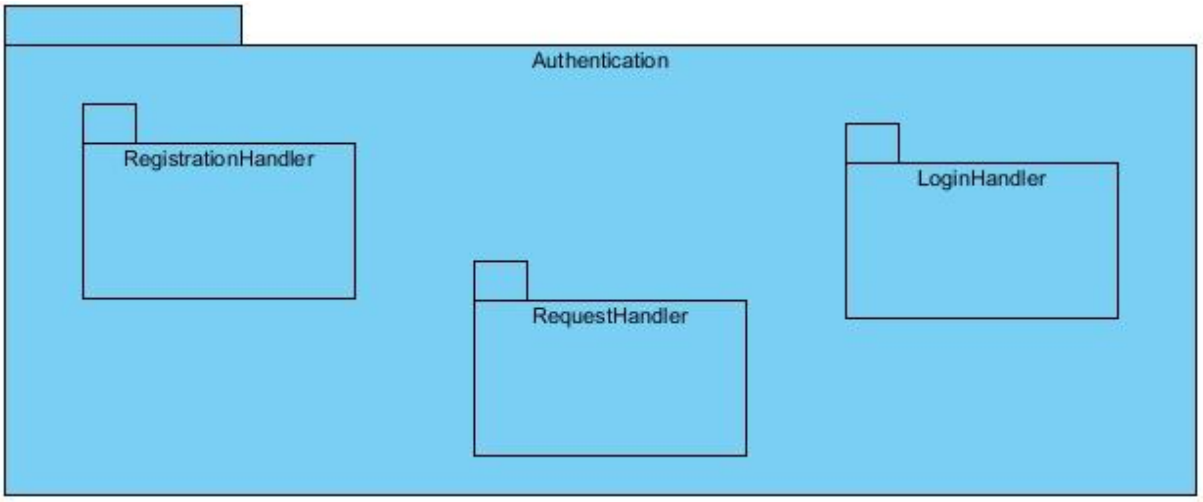

Figure 7: Authentication Subsystem

4.2.2. Data Subsystem

Data subsystem includes Database Request Handler and User Data Handler, both regulates the necessary data changes and improvements accordingly with the requested action that requires data fetch or change.

Figure 8 : Data Subsystem

5. New Knowledge Acquired and Learning Strategies Used

In our Senior Design Project our team wanted to prepare a project that will challenge ourselves by requiring us to acquire new knowledge, and enable us to use new tools and technologies. After all, this will be the final and most challenging project we'll create in our university life.

Therefore, our project includes many technological tools such as GitHub, Google Firebase, Android Studio, a new subfield Natural Language Processing and requires us to use our knowledge on our prior courses such as Algorithms and Programming, Database Systems, Object-Oriented Software Engineering and etc.. These Bilkent courses have also taught us to do proper research on finding new sources and develop self-learning skills. Therefore we're doing research, studying resources and taking courses about these subjects in Udemy.

Bee+ project also requires us to have a basic knowledge of human psychology due to being a wellness application. Also, in order to create the weekly tests we'll present to our users, and to make inferences from the user inputs we need to seek professional advice from psychology experts. Therefore we're currently consulting with a psychologist in this very construction phase. Other than the sources mentioned above we're trying to make use of every reliable source on the internet in order to create a successful, beneficial application.

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