Senior Design Project

SurePa

High-Level Design Report

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1. Introduction

Forgetfulness is a crucial problem when it starts to occur often in daily lives. Forgetting something unnecessary is good for your health and helps you learn and remember new and vital things. However, forgetting things like taking medicines, drinking water, walking, and any other daily routines complicates and adversely affects the lives of those particular people.

Forgetfulness targets elders primarily. Occasional lapses in short-term memory are a normal part of the aging process, such as forgetting which medicine to take and their daily doses. So, many older adults need new ways to remember to take their medications and know which medicine to take.

People with certain diseases, for instance, tumors, blood clots, and thyroid, also suffer from forgetting in their daily lives. While having a disease, daily routines like not forgetting to take medicines, drinking water becomes more critical than usual. In the search for finding a solution to these problems, we came up with SurePa. It is an application for mainly offering solutions to not taking medicine problems resulting from forgetfulness targeting primarily older adults and other people. In addition, different from other applications, SurePa aims to provide their users with some image-recognition-based solutions to their problems. Such solutions aim to ease the life of these patients by providing intuitive ways for remembering and tracking their medication use. SurePa consists of convenient tools for anyone who carries a mobile phone to help its users undergo a smooth recovery process.
In this report, a high-level design of the SurePa application will be provided. This high-level design firstly includes the purpose, design goals, definitions, and overview of the system. Then the current software architecture will be included. Afterward, proposed software architecture, subsystem services, consideration of various factors in engineering design will be discussed. Lastly, teamwork details will be provided in this high-level design report.

1.1. Purpose of the system

SurePa is a mobile application that is free and accessible to everybody who needs to keep track of their medicine schedule. In addition to the other medicine tracking applications, it also invites elderly people to use the application, with its medicine recognition system by using the camera. On the other hand, it gives an opportunity to people who need to care for their elderly relatives to keep track of their elderly relatives' medicine schedules.

The main purpose of this application is to provide a safe environment for elderly people who need to take lots of medicines and have confusion while taking their medicines. In addition to that, it also aims to provide a reassuring environment for caregivers of elderly people to keep track of their elderly people's health conditions.

1.2. Design goals

Reliability: Whether the medicine is taken by the patient should be accurate. Taking medicines multiple times or forgetting to take them could cause serious health problems.

Usability: SurePa appeals to a wide range of audiences and not everyone has to have a good understanding of technology. Therefore, interfaces should be easy and understandable to use.

Accessibility: The program should support the use of everyone such as blind, low vision, photosensitive, limited movement, and a combination of these because all of them can be our users. W3C [1] rules will be considered for accessibility issues and the application will support voiced notifications and will use simple color palettes for sensitive people. SurePa must be suitable for different operating systems and different smartphones because of the variety of phones used by the users. Also, there is the possibility of using different types of phones between patient and caregiver. In order to eliminate this problem, SurePa should work on iOS and Android.

Efficiency: Since SurePa will be used by elders and most of them are using old devices, the efficiency of our application is important. Hence, image processing will be used in the application, cloud computing services must be fast enough to reduce the waiting time.

Scalability: Since our user base is people who take medicines, the project should be scalable to handle lots of users. The server and database should be able to process a a large amount of data and used concurrently.

Security and Privacy: The private information of the user such as contact, health, or medical history will be kept in SurePa. Therefore these data should be encrypted. In addition to that, users should sign terms of use before they join the application.

1.3. Definitions, acronyms, and abbreviations

Caregiver: A type of user whose account is connected with the patient's account.
Medication Schedule: A schedule that shows which pill will be taken and when it will be taken.
Image Recognition: Computer applications that can identify objects from an image or video. It is a context of computer vision.
UI: User Interface

1.4. Overview

SurePa is a mobile application that will help mainly the old patients and their caregivers. The primary purpose of the development of SurePa is to make the medicine use process easy and traceable for people willing to use the application. The application will notify when a patient should take medicine, walk, drink water, etc. It also will help caregivers to keep track of the medicine usage of the related patient. In addition, by using image recognition and machine reading features, the application provides its users with a new and innovative way to get informed about their medicines. This innovation is especially crucial for older people since it is hard to learn new medicines' names, which generally have complicated words to remember.

2. Current software architecture

There are programs serving similar purposes that are being used for healthcare. Together with the evolution of the healthcare industry, healthcare applications are also advanced and specialized. SurePa will not necessarily provide all functionalities in these applications. Instead, it will give a more specialized, functional, and easy-to-use service targeted at people having diabetes. Just like various industry verticals, applications categorized in healthcare have played a crucial role in the digitalization of the healthcare sector. Several benefits have been linked to such apps, some of which are increased access to medication and reduced (or at least optimized) burden of governments due to health expenditure related to the treatment of minor health conditions. The main motives of SurePa are to provide smooth and clear clinical communication between patients and caregivers, display detailed statistics, and make basic suggestions on the data provided by the patient.
Common Features in Medicine Tracker Applications:

1. Notification on the medicine taking time

Diabetes: M

- Users can record blood sugar levels.
- The application calculates insulin doses for users.
- The application keeps track of food intake, carb, protein, fat taken in a day.
- The application can make graphs of all the data it collects.[2]

mySugr

- Users can record meals they ate.
- Users can connect smart devices like smartwatches.
- The application creates diabetes reports about blood levels.
- The application gives challenges to the customer to motivate them.[3]

Dakik - Uzaktan Hasta Takip Sistemi

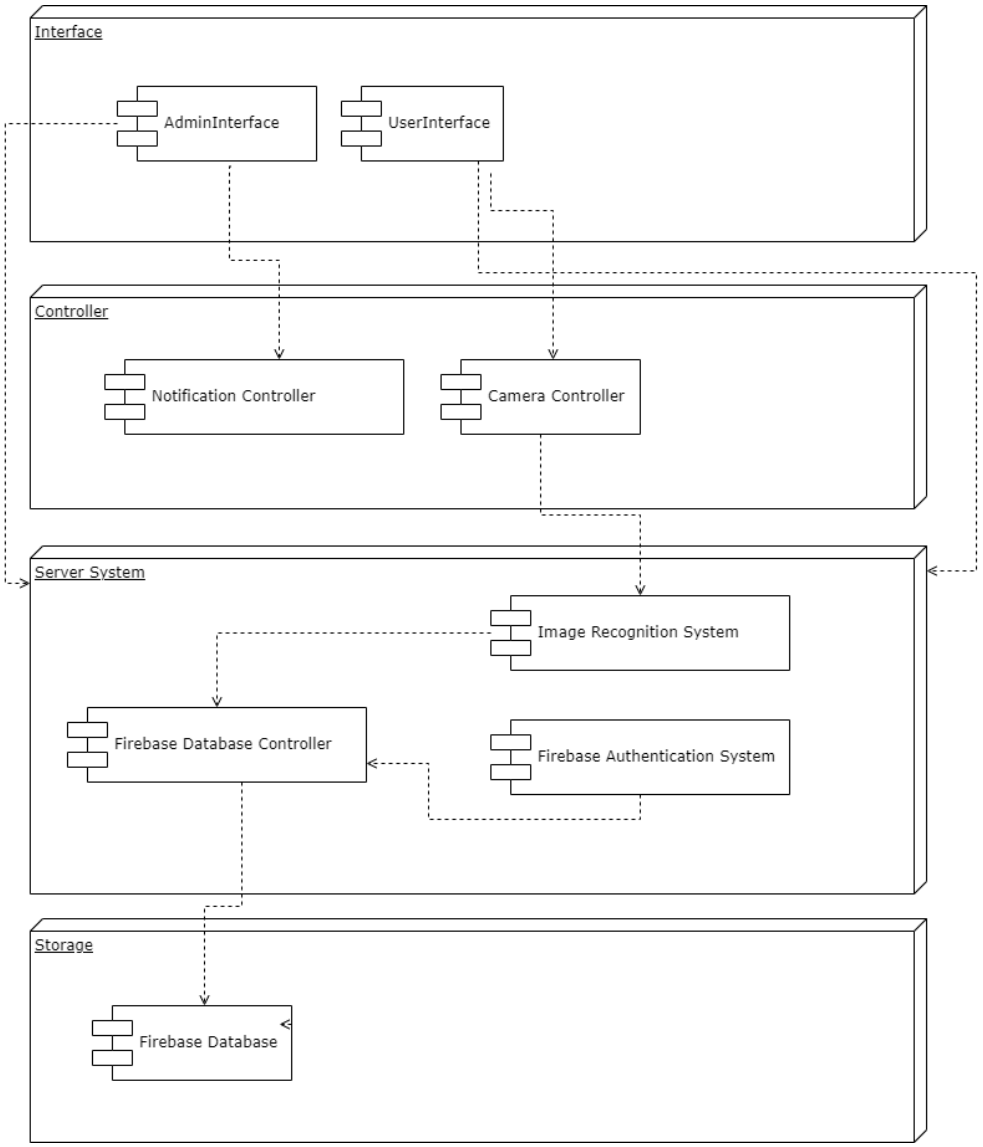
- Doctors can create treatment plans for their patients.
- Doctors and patients can chat via the app.
- Patients can enter the result of tests and medicine taken to the system.
- Doctors can see the data entered by patients.[4]

3. Proposed software architecture

3.1. Overview

SurePa will have 3 main layers. The first layer is a mobile phone application, the second layer is a backend service, and the third layer is data storage. Since we use React Native, there will be one code base for both platforms. For backend server and data storage, we will use Firebase and its components. Cloud Firestore will be used as the main data storage. In order to make connections between mobile applications and Firestore, Firebase will be used. SurePa requires machine learning which means cloud computing is required. Therefore Firebase ML will be used to ease the application development and maintenance.

3.2. Subsystem decomposition



3.3. Hardware/software mapping

SurePa is a mobile application that will be applicable both on iOS and Android. The application will use the smartphones' cameras for the purpose of recognizing medicine boxes. To recognize medicines, the program will store the data of all medicines that will be needed. Patients' medicine schedule, amount of remaining medicines, health records will be stored in the Firebase Database. The application will use the application's current machines' local time for notification times and keeping track of the medicines' current situations.

3.4. Persistent data management

Persistent and accurate data is essential as the SurePa provides reporting features. In addition, the application can be a part of treatment, wrong data can cause misled or wrong treatment plans which can harm patient health. Therefore patient data is persistently kept in Cloud Firestore. Cloud Firestore is a cloud-hosted, no-SQL data storage for mobile devices[5]. Firestore provides data synchronization which means when the database is updated in the database it will update the data in any collected devices. As a result, the users will see the same data at any time. In addition to that Firestore offers security methods for securing the data which will be used for keeping the data safe ın the case of cyberattacks.

3.5. Access control and security

SurePa will have mainly two different users: patient and caregiver which means the access permissions of these users should be separated. Caregivers should be able to see all data about their patients but patients should not see all the data in order to avoid confusion since our target users are elders for patients. The user interface and the features are also different according to user type. These screens should also be separated. Patients should not be accessing their caregivers' UI's and using the functionalities in there. Similarly, caregivers should not access their patient's UI's. This means no caregiver should act as a patient and no patient should act as a caregiver. The administrator cannot access sensitive information about the users. Passwords and sensitive information will be hashed.

Caregivers can have multiple patients, which they can view, but they cannot access the data of other caregivers' patients. As SurePa keeps sensitive information about health, access control will be carefully handled by the application.

In addition to that SurePa will follow the guidelines General Data Privacy Regulation(GDPR) [6]. This means the user data will be encrypted before storing it and the user will be informed about the data being processed. Even the administrators will not have direct access to users' data. In addition to these, users will be kept the right to be forgotten.

3.6. Global software control

SurePa has both time-driven and event-driven events. Therefore it follows both time-driven and event-driven principles. In an event-driven system, user actions shape the program's

behaviors without the user input system staying stationary. For instance, patients' input of taking medicines will trigger other events in the system. On the other hand, the reminders will be triggered by time. Therefore, they are time-driven. Until the time triggers an event the system will stay stable and will continue to wait for a time signal.

3.7. Boundary conditions

From the user's perspective, SurePa will have 3 boundary conditions. The first one is an initialization, the second one is termination and the last one is a failure.

3.7.1. Initialization

Both types of users(caregiver and patient) should have the SurePa app on their mobile phones. In the sign-in process, they should agree with the terms of use. Both phones should have access to the internet because there will be data flow from the patient to the caregiver.

3.7.2. Termination

When the user closes the SurePa app, it doesn't listen or collect any type of data. The only function that works in the background is reminders. There are two cases where applications send notifications. The first one when it is pill time it sends a notification to the patient. Second is when a patient forgets to take pills, the application sends notifications to caregivers to warn them.

3.7.3. Failure

When an unexpected crash occurs only the current operations of the customers will be suspended. SurePa has a storage unit that keeps the data. Therefore, when the app is restarted no data will be lost. However, in a crash scenario, the application might not be able to send notifications or collect data. Therefore, The application can not be sure about whether the pill is taken or not.

4. Subsystem services

This part of the report will explain the main component and subsystem of the SurePa.

4.1. Interface

4.1.1. Admin Interface

The admin interface allows the admins of the application to control users' permissions.

4.1.2. User Interface

There are two types of users and their interfaces are different from each other. The first user type is the patient. Patients' UI is for taking information about medicines that they are using at that current time, showing the current situations of the medicines. It also enables users to open their cameras for recognizing the medicine boxes.
The second user type is a caregiver and their UI depends on keeping track of their related patients' situations. They are able to see if the patient took the needed medicines or they are able to see the reports for the patients. These reports include all past information about the patient such as usage of the medicines, test results if they are uploaded, etc.

4.2. Controller

4.2.1. Notification Controller

The notification controller subsystem handles user requests and actions by managing notifications. It is responsible for sending and receiving notifications from users. Each user receives different notifications corresponding to their roles and inputs. Patients receive filtered notifications about their health. Also, it collects the notifications of the patients and sends them to the patient's caregiver in a different format.

4.2.2. Camera Controller

The camera controller subsystem handles the real-time flow of the user's camera scan. It sends the scanned frame from the user's cameras to the server.

4.3. Server System

4.3.1. Firebase Database Controller

Firebase database controller is responsible for writing data to Firestore and retrşaveing data from Firestore when asked.

4.3.2. Image Recognition System

The image recognition system allows users to recognize their medicines and understand which one they should take at the right time.

4.3.3. Firebase Authentication System

It provides backend services to authenticate users to the application. Firebase Authentication supports authentication using passwords.

4.4. Storage

4.4.1. Firestore Database

Firestore is a persistent data store unit of SurePa. It keeps the data secure and consistent. It communicates with the Firebase database controller to write new data to the database and retrieve data. As Firestore is no-SQL data storage we won't have any tables. Instead we will have collections and documents. Collections have documents and documents have data in them. The document will be in the form of JSON[7].

5. Consideration of Various Factors in Engineering Design

Public Health: Improving the medication process of the patients is the motivation of our project, which focuses on strengthening the communication between the patient and caregivers and providing patients with helpful features, easing keeping track of their medicines' doses and schedules. Therefore, it is expected to enhance public health.

Public Safety: Taking into consideration the ongoing pandemic, it is essential to stay isolated and keep a distance from others. Since SurePa is targeted at establishing contact between the patients and caregivers about the medication process of the patient, it is projected to have a positive effect on public safety.

Public Welfare: SurePa aims to provide a medical service for the elderly worldwide without requiring any payment. Since SurePa will be free to use and accessible, it is expected to have a positive contribution to public welfare.

Technological Factors: Management of rapid technological development for sustainable development is an important issue to be considered in the implementation of SurePa. In order not to have SurePa obsolete in a few years, the development of new technologies should be tracked, and such technologies should be easily applicable to SurePa. For this purpose, SurePa should be implemented considering the maintainability issues.

Cultural Factors: Concerns and practices regarding privacy issues differ from culture to culture. For example, the European Union implements strict regulations about data protection, whereas Turkey does not enforce that authoritarian rule about privacy. Therefore,

in the implementation of SurePa, the privacy boundaries of different cultures should be respected.

Social Factors: The potential users of SurePa are the elderly, which could have different deficiencies. So, SurePa is expected to provide both visual and auditory directives to meet the needs of its users having different deficiencies.

Global Factors: SurePa aims to provide a medical service to be used by people worldwide. For this purpose, considering that potential application users should have enough English proficiency to use such an application, SurePa will support both English and Turkish languages.

Table 1: Factors that can affect analysis and design

	Effect level	Effect
Public Health	10	The motivation of our Project
Public Safety	10	The motivation of our Project
Public Welfare	5	Accessibility and Purchasing Power
Technological Factors	10	Maintainability of the system Design and Implementation
Cultural Factors	4	Privacy and Data Protection
Social Factors	7	Availability of Visual and Auditory Directives
Global Factors	5	English Language Support

6. Teamwork Details

6.1. Contributing and functioning effectively on the team

The SurePa development team uses Zoom and Github for collaboration and proper teamwork. Every member believes that time management is also very important since there are strict deadlines. So, tasks are divided equally and according to the knowledge base of the members to not have a time delay. Zoom is in use for meetings in which discussions about application features, collaboration on the current work are held. Every member joins the Zoom meetings and is actively contributing. Since every member has different experiences, we use this variety of experiences to contribute to the project in different ways.

6.2. Helping creating a collaborative and inclusive environment

As it is mentioned in the previous part Zoom and Github are used to make teamwork an easier process. Zoom meetings give us a chance to make collaborative and inclusive works. In some meetings we do not just talk about features or what are we going to do, we also divide works into parts and make them collaboratively in Zoom by using Breakout Room feature. This allows us to work virtually in the same environment and help each other if any of the subgroups are not able to do any tasks. So, this process allows us to contribute to every task either by doing it or solving the problems of the tasks. We know that it is not just important to do a task but also it is also important to review a task. Thus, when a subgroup does a task another subgroup of us goes over the done issue and gives feedback. This working principle allows every member to contribute to every task even if s/he did not work on the task.

6.3. Taking lead role and sharing leadership on the team

At the beginning of the project process, we noticed that every one of us has a different knowledge base and past experiences. We wanted to take advantage of this situation and everybody took a lead role according to his/her skills and experiences. The SurePa project is divided into logical subtasks and every member took a lead role in which task s/he felt good about. That allows us to not lose too much time on a task and learn things from every group member.

7. References

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