



Bilkent University

Senior Design Project

Project short-name: GymFeat - AI Training Coach

Project Specifications Report

Talha Burak uhadar, Mustafa aęrı Gngr, Aye Ezgi Yavuz, Gonca Yılmaz

Supervisor: Halil Altay Gvenir

Jury Members: Can Alkan, iędem Gndz Demir

Progress Report

Oct 12, 2020

This report is submitted to the Department of Computer Engineering of Bilkent University in partial fulfillment of the requirements of the Senior Design Project course CS491/2.

	2
1. Introduction	2
1.1. Description	3
1.2 Constraints	4
1.2.1 Development Constraints	4
1.2.2 Economical Constraints	5
1.2.3 Social Constraints	5
1.3 Professional and Ethical Issues	5
1.3.1 Professional Issues	5
1.3.2 Ethical Issues	6
2. Requirements	6
2.1. Functional Requirements	6
2.1.1. Personalized Fitness Program	6
2.1.2. Google Calendar Synchronization and Progress Log	6
2.1.3. Synchronous Training with AI Fitness Trainer	7
2.1.4. Additional User Interaction with the AI Fitness Trainer	7
2.2. Non-Functional Requirements	8
2.2.1. Usability	8
2.2.2. Reliability	8
2.2.3. Accessibility	9
2.2.4. Portability and Compatibility	9
2.2.5. Performance	9
2.2.6. Security	9
2.2.7. Maintainability	10
2.2.8. Legal and Regulatory Requirements	10
3. References	11

1. Introduction

Given the importance of healthy life, sports itself play a prominent role to develop a healthy body. Not only it helps people to develop the muscle mass, but it also improves the health of one's mind [1]. According to the researches about how sport affects the health of mind, it is shown that doing exercises “positively impacts the level of serotonin, a chemical that helps regulate mental health”, reduces the level of stress, improves mood, and distracts people from negative thoughts [2, 3]. In addition to these impacts of sport on mind, it also boosts the immune system [4]. Therefore, we should always prioritize doing exercises in our lives.

In normal circumstances, some people would prefer to go to the gym, and some people would prefer to do exercises at home and there used to be a trade-off between them. However, since the beginning of the pandemic, people are seeking new means to stay active inside the house, because many parts of our lives remain restricted. At this moment “maintaining an exercise routine at home can seem more like a ‘should’ than a ‘want to’” says Shannon Collins, an Integrative Manual Physical Therapist [4]. We, as a team, would like to encourage people to be more active at home.

Nevertheless, when people work out at home without the guidance of an expert, there is a risk of getting injured. Imagine yourself, trying to preserve your healthy body and mind, and while doing so, getting injured. Our project idea started out with the question, how we can prevent people suffering from exercise-related injuries, i.e. sprains, muscle strains, tendinitis, and so on. According to an article from Harvard Health Publishing, people should choose their workout carefully, learn the proper technique in order to prevent injuries and drink water to stay hydrated [5]. Hence, we would like to address these issues and provide a mobile application, which will prepare a training program for you, check your body movement to make sure that you are applying each movement correctly, and remind you of drinking water during the training.

In this report, we will give a brief description of the project, along with the developmental constraints, the economical constraints and the social constraints. After that we will discuss the professional and the ethical issues regarding the project. Last of all, we will introduce the functional and the non-functional requirements from many different aspects.

1.1. Description

GymFeat is a training application for anyone who wants to work out alone without hiring a training coach. The main goals of this application are to encourage people doing exercises at home, to enhance the quality of training at home, and to prevent people from getting injured. In order to facilitate a work-out of high quality, we are offering a personalized training program, along with an AI-Trainer, which will compare your body lines with the ideal ones, and will tell you how you can enhance the quality of the movement.

This application is innovative, in the sense that it brings a free training coach with one-click, and assesses your movements, helping you improve them. There is already one existing workout app that provides movement tracking [6], however it lacks giving people personalized programs unlike other training apps in the commercial market [7, 8]. Our mobile application offers both, while also keeping track of the overall progress.

Our AI-Trainer will apply advanced models such as neural networks [9] to give feedback of each movement to the user in real-time, and it will count the number of each movement, as it happens with a real trainer. For this reason, we will apply the techniques from sub-domains of Computer Vision, that are Image Processing and Deep Learning [10, 11]. As a result, this project will demonstrate how some practical problems can be addressed with such technologies.

With this project, we are aiming to have a broad audience. Therefore, our application will be executable both for iOS and Android. Because our idea is to encourage everyone to do more exercises at home and, hence, everyone, who has a phone, will be able to download and execute our application.

1.2 Constraints

In this section, we will discuss the development constraints, the economical constraints, and the social constraints.

1.2.1 Development Constraints

- Since the application will be for mobile platforms, Flutter will be used as a UI tool due to its portability for both IOS and Android systems [12]. Another reason to use Flutter is that it is able to work with Python scripts which will come in handy while integrating the image processing part of the project.

- Consequently, Dart will be used as a UI development language [12].
- For the backend development of the application, Python will be used.
- Firebase will be used for keeping the backups and user information.
- Zoom will be used for team meetings.
- Git and GitHub will be used as version control tools. Additionally, Github offers a tool to track issues to enable project management.
- Object Oriented Programming paradigm will be used throughout the project.

1.2.2 Economical Constraints

- Libraries and tools that are planned to be used in the project are generally open source and free to use.
- To be able to publish the application, IOS Appstore requires a 99\$ annual fee for a developer account and Google Play Store requires 25\$ one time fee [13].
- The scale of the product will determine if the Firebase services will require additional money [14]. However for the initial product this doesn't seem to be a concern.

1.2.3 Social Constraints

- The exercises that are offered in the application will be according to the suggestions of a professional coach to best serve the users' needs as well as to not cause them harm.
- The main user group of this app is aimed to be young adults/adults since the exercise programmes will be prepared based on that group's capabilities. Thus, not all aspects of the application will be suitable for usage of children.
- The application will require an internet connection for the backup and registration functionalities. However, it will be possible to bypass these steps and still use the application with local data.

1.3 Professional and Ethical Issues

1.3.1 Professional Issues

- Keeping the piracy issues in the sector in mind, the source code of the project will be kept private.

- To be able to keep up with the tight schedule, our team will meet at least twice a week. Later, based on the project schedule, the meetings will transform into weekly Scrum meetings [15].
- The decisions regarding this project will be made democratically within the team.
- Team members will all have separate roles per divide and conquer development strategy [16]. The roles of the group members are as follows:
 - Gonca Yılmaz, Mustafa Çağrı Güngör: Machine Learning Engineer
 - Ayşe Ezgi Yavuz: Mobile Developer
 - Talha Burak Çuhadar: Backend Developer

1.3.2 Ethical Issues

- In this project, we will apply General Data Protection Regulation (GDPR) and the Code of Ethics [17, 18, 19].

2. Requirements

2.1. Functional Requirements

In this section, the functional requirements of our system will be explained.

2.1.1. Personalized Fitness Program

- To be able to use online backup functionality the user will have to sign up and create an account. Otherwise, the user will create his profile, there can be several profiles in the same application.
- After creating a profile, the user will enter personal information such as weight, height, and his aim, i.e., getting fit, getting muscular, losing weight etc.
- According to the information given by the user, a personalized fitness program will be proposed by the application.
- The fitness programs that are suggested by the app will be pre-prepared programs with the help of professional fitness trainers.
- The user can adjust the proposed program by editing the order of the movements, or by changing the training-rest days that were suggested by the app.

2.1.2. Google Calendar Synchronization and Progress Log

- The personalized fitness program will include a weekly fitness schedule with both active and rest days, including the movements to be done given the active days.
- According to the desired time periods set by the user, the app will have the option to export the schedule to the Google Calendar
- A progress log within the app will keep information about which movements were made successfully daily so that users can track their progress and how much they follow their schedule.
- The suggested schedule will be editable so that users can add, remove or change active and rest days to get a schedule better suited to their life.

2.1.3. Synchronous Training with AI Fitness Trainer

- Before starting the training, the mobile phone of the user will be set leaning against the wall in a stable position. The application will guide the user to align the phone properly.
- The frontal camera of the mobile phone will observe the user so that the AI trainer can interact with the user by giving directions and warnings with voice.
- At the beginning of the training, the AI trainer will show how the movement should be made correctly, then the user will be able to observe himself while doing the movement to learn the correct way of making the move.
- While the user is doing each movement, the AI trainer will be tracking 16 points on the user's body to analyze how the user applies the move.
- If the user is not applying the movement correctly, the AI trainer will intervene to highlight how the movement should be adjusted to do it properly.
- The AI trainer counts the repetitions of the movements, and once the count reaches the predetermined set limit, training is set to be completed and the AI trainer scores your movement.

2.1.4. Additional User Interaction with the AI Fitness Trainer

- The application will send regular notifications to the user such as banners to enjoy the rest days, and reminders to keep him/her from missing a training.

- There will be an award/badge system, i.e., if the user follows the fitness program for a full week, they will be rewarded with the “Perfect Week” badge. This aims to make the application enjoyable for the users and keep them motivated and engaged.
- The AI trainer will determine the rest period between sets, and will remind the user to drink water between the movements and to engage in active recovery because according to the studies, practicing active recovery between sets helps clearing the lactate in the body faster than engaging in passive recovery, i.e. sitting [20]. Our application will give directions to the user in order to stay active during the rest period, by walking, or doing dynamic stretches, hence, the body will stay warm and it will keep the muscle and the tendon pliability [21].
- Users can skip the introduction of the movement at the beginning of the set and deactivate the warnings if he feels he is performing the movement properly.
- The rest period between sets can be shortened or extended according to the desire of users.
- The AI trainer will also do emotion recognition based on the user's face during training. If it detects that users are having too much trouble, it asks the user to finish the set, or it lightens the set depending on the emotion recognition result.

2.2. Non-Functional Requirements

In this section, the non-functional requirements of our system will be explained.

2.2.1. Usability

- The user should be able to use the application without logging in, or to keep logged in, to ease usability.
- There should be at most two pages before starting the training, and those pages should be the enrolment page and the initial setup page to generate a special training program.
- After the program is created, the user should be able to start training with only one click. To see the progress log, he should click at most two buttons.
- The user should be able to learn the use of UI with a tutorial video of at most thirty seconds.
- The user should be able to memorize the UI, in average, after fifth usage of the application.

- The user should be able to observe the fitness program along with the other activities within the same calendar, and to start training by clicking on the calendar event.

2.2.2. Reliability

- The professional fitness trainers should be consulted to design healthy and reliable fitness programs.
- Real-time movement analysis should be done in high precision, hence, the users should be able to count on the application that they are performing the movement correctly, if it does not show any warning about the enhancement of the movement.

2.2.3. Accessibility

- The system should be downloadable for free.
- It should be downloadable from the official website of the project for both iOS and Android, from Google Play Store, or from App Store.

2.2.4. Portability and Compatibility

- Flutter is used as a UI tool. Hence, we have the according requirements [22]. The system should run in
 - Android Jelly Bean, v16, 4.1.x or newer
 - iOS 8 or newer.
 - As mobile hardware: iOS devices (iPhone 4S or newer) and ARM Android devices.

2.2.5. Performance

- Screen loading and response times from the server side shouldn't take more than one second.
- The AI trainer will analyze the movements in real-time to give instant feedback.

- Creation of personalized fitness program, and Google Calendar Synchronization should not take longer than three seconds.

2.2.6. Security

- The user has the option to use the application without any internet connection and with having stored their progress logs in their local. Additionally, the user is also able to register and use the application from multiple mobile devices, therefore, the information about the user will also be stored in a database. Therefore, the system should provide a secure environment in order to keep the data about the user safe. The data that will be stored in the database are the progress log, e-mail, username, and password. This data should not be shared by anyone and should be kept according to General Data Protection (GDPR) [19].

2.2.7. Maintainability

- The network will have a modular structure, so modules should not be strongly bounded and they should not be affected by changes in other modules.
- In addition to the automated checks about the new code changes, there will be a specified code standard. Each pull request will be checked by the reviewer to increase the maintainability of the code in future changes.

2.2.8. Legal and Regulatory Requirements

- Each user will need to accept the terms and privacy policies, to be able to use the application.

3. References

- [1] “What Is the Importance of Sports in Our Life?,” *Impoff*, 2020. [Online]. Available: <https://impoff.com/importance-of-sports/>. [Accessed: 12- Oct- 2020].
- [2] “Sports and Mental Health | Newport Academy,” *Newport Academy*, 2020. [Online]. Available: <https://www.newportacademy.com/resources/mental-health/sports-and-mental-health/>. [Accessed: 12- Oct- 2020].
- [3] “Top 6 benefits of sports and physical activity on mental health – Sport Energy,” *Sportenergy.club*, 2020. [Online]. Available: <https://sportenergy.club/2020/02/21/top-6-benefits-of-sports-and-physical-activity-on-mental-health/>. [Accessed: 12- Oct- 2020].
- [4] M. Weber, “Exercise During Coronavirus: Tips for Staying Active - HelpGuide.org,” *Helpguide.org*, 2020. [Online]. Available: <https://www.helpguide.org/articles/healthy-living/exercise-during-coronavirus.htm>. [Accessed: 12- Oct- 2020].
- [5] H. Publishing, “10 tips to prevent injuries when you exercise - Harvard Health,” *Harvard Health*, 2020. [Online]. Available: <https://www.health.harvard.edu/pain/10-tips-to-prevent-injuries-when-you-exercise>. [Accessed: 12- Oct- 2020].
- [6] “Engadget is now a part of Verizon Media,” *Engadget.com*, 2020. [Online]. Available: https://www.engadget.com/2019-03-21-kaia-personal-trainer-app-iphone-ipad-camera-fitness.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAFEhpVIghX612lHa9E-KTd-Hn8y3gSv6UnHBOWfcT9DvoAC6YQw5HrEYWMI9iWwycAF76rOFYfR4vhMiYqJiVfDJZDejpsxKXecIDn-14oFEtkhou0xqYOAvg6WIwBbmejrIfSun9yvuKO-ese0cS0IndNf6oM0McnZm3eO0qG77. [Accessed: 12- Oct- 2020].
- [7] “Best Fitness and Exercise Apps of 2020,” *Healthline*, 2020. [Online]. Available: <https://www.healthline.com/health/fitness-exercise/top-iphone-android-apps>. [Accessed: 12- Oct- 2020].

- [8] “The 7 best free workout & fitness apps for tracking & planning,” *The Sports Edit*, 2020. [Online]. Available: <https://thesportsedit.com/blogs/news/sweat-7-of-the-best-free-workout-apps-for-tracking-and-planning>. [Accessed: 12- Oct- 2020].
- [9] M. A. Nielsen, “Neural Networks and Deep Learning,” *Neural networks and deep learning*, 01-Jan-1970. [Online]. Available: <http://neuralnetworksanddeeplearning.com/chap1.html>. [Accessed: 12-Oct-2020].
- [10] Infrd, “Image Processing With Deep Learning- A Quick Start Guide,” *Medium*, 25-Aug-2019. [Online]. Available: <https://becominghuman.ai/image-processing-with-deep-learning-a-quick-start-guide-38e166340200>. [Accessed: 12-Oct-2020].
- [11] R. Kwok, “Deep learning powers a motion-tracking revolution,” *Nature News*, 30-Sep-2019. [Online]. Available: <https://www.nature.com/articles/d41586-019-02942-5>. [Accessed: 12-Oct-2020].
- [12] “Why Flutter Has Become the Best Choice To Develop a Startup Mobile App in 2020?,” *Medium*, 2020. [Online]. Available: <https://medium.com/flutter-community/why-flutter-has-become-the-best-choice-to-develop-a-startup-mobile-app-in-2020-5785ea153b13#:~:text=Flutter%20is%20the%20complete%20UI,learn%20and%20understand%20this%20language>. [Accessed: 12-Oct- 2020].
- [13] “The Hidden Costs of Developing A Mobile App You Should Be Aware of,” *Dumb Little Man*, 2020. [Online]. Available: <https://www.dumblittleman.com/how-much-does-it-cost-to-create-an-app/#:~:text=Apple%20App%20Store,as%20an%20individual%20or%20organization>. [Accessed: 12-Oct- 2020].
- [14] “Firebase Pricing,” *Firebase*, 2020. [Online]. Available: <https://firebase.google.com/pricing>. [Accessed: 12- Oct- 2020].
- [15] “Scrum - what it is, how it works, and why it's awesome,” *Atlassian*, 2020. [Online]. Available: <https://www.atlassian.com/agile/scrum>. [Accessed: 12- Oct- 2020].

- [16] “Approaches to software development,” *OpenLearn*, 2020. [Online]. Available: <https://www.open.edu/openlearn/science-maths-technology/approaches-software-development/content-section-1.5>. [Accessed: 12- Oct- 2020].
- [17] “Code of Ethics | National Society of Professional Engineers,” *Nspe.org*, 2020. [Online]. Available: <https://www.nspe.org/resources/ethics/code-ethics>. [Accessed: 12- Oct- 2020].
- [18] “How Codes of Ethics Work,” *Investopedia*, 2020. [Online]. Available: <https://www.investopedia.com/terms/c/code-of-ethics.asp#:~:text=A%20code%20of%20ethics%20is,business%20honestly%20and%20with%20integrity.&text=A%20code%20of%20ethics%20also,an%20employee%20code%20of%20conduct>. [Accessed: 12- Oct- 2020].
- [19] “Official Legal Text,” *General Data Protection Regulation (GDPR)*, 2019. [Online]. Available: <https://gdpr-info.eu/>. [Accessed: 12-Oct-2020].
- [20] S. Smith and Stephanie Smith Stephanie Smith is Fitbit’s Fitness editor. A New York City native and University of Missouri grad, “6 Things You Can Do Between Strength Training Sets to Get Better Results,” *Fitbit Blog*, 02-Feb-2018. [Online]. Available: <https://blog.fitbit.com/make-the-most-of-your-rest-period/>. [Accessed: 12-Oct-2020].
- [21] S. Smith, “Resting During Workouts -- Actual Rest or Active Rest?,” *Military.com*. [Online]. Available: <https://www.military.com/military-fitness/resting-during-workouts-actual-rest-or-active-rest>. [Accessed: 12-Oct-2020].
- [22] "FAQ," *Flutter*. [Online]. Available: <https://flutter.dev/docs/resources/faq>. [Accessed: 12-Oct-2020].