

Smart Barbell: Project Proposal

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1. Project Objectives

1.1 Motivation

Regular exercise is one of the best things one can do for health. In fact, one can experience positive change in their body and outfit by consistently doing an exercise. However, starting to work out takes a lot of determination and doing it in the regular routine is even more challenging. Also, without a considerable amount of effort and time spent, dramatic changes in the body are hard to be witnessed. Consequently, many people procrastinate exercising due to the lack of willpower.

We observed that students in KAIST are no different when it comes to regular exercise. There are many students who wish to work out everyday, but fail to put into action due to tight course schedules and projects. Ourselves, as a student in KAIST, also had experiences failing to exercise in our daily routine. We concluded that there is a definite demand for a service that helps people keep working out.

1.2 Problem Description

We analyzed this problem as the following:

Lack of motivating factor in taking regular exercise to Beginners

Beginners, in this context, includes people who have less than one month of exercise experience, or anyone who is experiencing lack of will power to get regular exercise. We speculated that most people with long exercise experience have found their own motivating factor and thus were able to exercise for a rather long period of time.

1.3 Proposed Solution

Intuitively, a direct solution to this problem is to come up with strong motivating factors which can be easily applicable to beginners. Let us propose the following two motivating factors for it.

1. Music while exercising

Several studies have shown that fast-paced music has the ability to improve a person's exercise performance. Improvement in exercise performance includes

higher endurance, power, productivity, and strength. Music can also have desirable effects on psychological aspects, too. As an example, authors of *Appendix 1* suggested that pleasurable experience of listening to a song can result in an increase in serotonin levels, which can put one in a better mood for workout.

We believe that playing proper music while exercising can make exercising more accessible and satisfactory, by inducing beneficial effects on both physical and psychological domain. We plan to use IoT devices and smart speakers to achieve this goal. Details are in [1.4.2].

2. Rewards after exercising

It is obvious that rewards after some action can help humans to stay motivated and do the specific action. We will analyze the user's exercise status and provide feedback which can give a feel of accomplishment to users. This works as an observable reward that gives moving force to beginners until they actually see the change in body.

1.4 Implementation Details

For the ease of integrating exercise and IoT devices, we've restricted the notion of exercise to the exercise using a barbell. We decided to develop 'Smart Barbell' to give motivating factors to users. Smart Barbell is an IoT device which can be implanted or attached to a barbell to track the movement of the user and adjust the intensity of the exercise based on the tracked data.

Hardware and software objectives are as follows.

1.4.1 Hardware

We will develop a physical device called a Smart Barbell which can be attached to a barbell and track the movement by an acceleration sensor. It includes wireless internet connection to upload real-time data to the cloud. More specifically, the device will contain Arduino-nano for microprocessor, acceleration sensor, and wifi-module of Arduino for connection to the internet (cloud). QR code will be shown on the surface of the device to provide easy connection between the user and Smart Barbell, just like connecting a Kakao bike. Smart speakers connected to the network will be used to play music (if the budget and time is limited, this will be substituted by only software).

1.4.2 Software

There are two kinds of software implemented in this project. One is the software operating IoT devices (noted as device software), and the other is software operating the cloud (noted as cloud software). The device software will perform functions below.

1. Gather the data from sensor
2. Preprocess the data, including noise reduction

We are going to use the AWS server as a cloud. The cloud software consists of Front End and Back End. Front End part will show on the web service, and operate two main functions.

1. Show the statistics of the workout. It will show the individual record and progress of the record with an intuitive graph
2. Play exciting music when the pace of the exercise is decreasing or going under the average record
3. Pair the user and device by scanning QR code

Back End part includes three main functions.

1. Receive the data from the device, and manage it on the cloud database
2. Algorithm that catches motion from sensor value
3. Algorithm that calculates exercise pace and number of repetition

2. Project Process

In short, we are adopting Scrum and Kanban as the software engineering process and for this project.

2.1 Scrum

Nowadays, Scrum is actively used by numerous teams and organizations to manage their projects and interact with stakeholders. The relationship between stakeholders in our project is described in *Appendix 2*. We adopt Scrum as the software engineering process for the project. It is the best approach for two main reasons given as the following.

Scrum is agile. The project should be conducted for about 100 days, an agile software process is required to provide end products in a short period of time. Scrum has a sprint cycle of two to four weeks in general. However, considering the overall deadline of the project, the sprint cycle has been determined to be one week. To this end, the sprint backlog will be kept reasonably light, and the team will organize itself to work fast-paced.

Scrum can manage risks well. Since the software being developed needs to control the IoT hardwares which are unfamiliar with developers, project schedules may be delayed due to unexpected difficulties in the modeling, developing and testing tasks. This poses a critical risk throughout the project, and can even lead to failure when the deadline is short as described above. Scrum can handle the risk in several aspects.

- Frequent meetings will allow the team members to communicate issues as soon as they occur.
- In sprint planning, the team can forecast which difficulties will arise and establish strategies in advance. Potential risks can be also noted in the product backlog.
- While sprint review, issues and risks appeared in the previous sprint make it possible to predict the difficulties that will occur in the future sprint.

2.2 Comparison with XP

There also exists a reason why eXtreme Programming is not adopted. XP requires the team to communicate as much as possible. Feedback through frequent face-to-face meetings is recommended to perform tasks and enhance product quality in XP. Pair programming also takes place often in XP. Considering the job and personal schedule of team members, frequent face-to-face meetings may have to be replaced by online or non-real-time communications, indicating Scrum is better suited for the project.

However the process adopted and some aspects of XP share some aspects flexibly in that 1 week sprint for fast-paced development and some technical practices such as test driven development or continuous integration may be applied.

2.3 Kanban

Kanban is adopted with Scrum in order to prioritize the product backlog, and visualizing progress and future works.

3. Project Plan

3.1 Project Management

Throughout the semester, we will have 2 meetings per week. One at 8pm, Tuesdays in the Group Study Room of the library, and another during the weekend. We will usually do most of the discussions at the Tuesdays meetings. On the weekend meetings, we will have time to check the progress of each person's work and provide feedback for each other. (For the Scrum, we will have a 1-week-sprint and since we won't be able to have daily scrums, we will do the small meetings on the weekends.)

For the product development process, we will use the Scrum method as we explained in [2.1], using Jira and Github to manage each sprint and code. Until then, during the requirements engineering process, we will use our Notion page to manage our meetings and requirements.

3.2 Requirements Engineering Schedule

For the midterm, we will be conducting a requirements engineering process and writing a SRS document. In order to follow the evolutionary process we will first gather requirements by document analysis on former projects and by brainstorming within our team. Then, we will be able to generate storyboards and scenarios. With these, we will interview people who workout regularly to elicit requirements. Then will repeat the elicitation - specification - validation several times until the second week of April. Then, we would write our SRS document and prepare the presentation. The specific schedule for the requirements engineering is as follows.

- Requirements Gathering + Elicitation (~3/29) : Prioritize gathered requirements

- Requirements Specification & Validation 1 (~4/1) : Specification and validation of functional requirements
- Requirements Specification & Validation 2 (~4/5) : Reflecting the previous validation results, specify and validate the requirements again.
- Finish our SRS (~4/12)
- Make the presentation video and prepare for the presentation (~4/17)

3.3 Software Development Schedule

For the final, we will be developing our software and writing a SDS document. As explained previously, we will use the Scrum method with Jira and Github. From this stage each member will have a distinct role and responsibility as explained in 2.R&R. Until the last week of April, we will build our system architecture and design. Then, until May 17th, we will finish our implementation of the basic structure and function. Then until the first week of June, we will implement the specific functions and interface. Then, we will prepare our presentation for the rest of the time.

3.4 R&Rs

Our team consists of 4 people. For the scrum, we have a product owner and a scrum master to manage the overall process. For the development, we will form an egoless team and each will be a leader of a specific task based on our previous development experiences. Besides the development process, each of the members have a role.

3.4.1 Development Related R&Rs

Arduino Hardware - Assemble : 김창희, Arduino Software - Sensor, Cloud Connection : 김정민

Web Front End - User Interfaces : 김민성, Web Back End - Cloud, Database, Data Process : 석주영

3.4.2 Project Related R&Rs

Scrum Product Owner, Video editing : 김창희

Scrum Master, Presentation, Notion page management : 김정민

Document organization, Group study room reservation : 석주영

Document organization : 김민성

4. Appendix

1. Altenmüller, E., & Schlaug, G. (2012). Music, brain, and health: exploring biological foundations of music's health effects. *Music, health, and wellbeing*, 12-24.
2. Stakeholders Relationship Diagram

