PHYSIGO

Maciej DROBNIK[1], Marcin JABORSKI[1], Rémi JARDRET[2], Léo SALE[3], David SOKOL ZELAZKO[4], Supervisor Rafał KOTAS, PhD

[1]Lodz University of Technology, International Faculty of Engineering, Lodz, POLAND
[2]Erasmus ESAIP, Angers, FRANCE
[3]Erasmus Centrale, Lille, FRANCE
[4]Erasmus Universidad Europea, Madrid, SPAIN

Supervisor: Rafał Kotas, PhD (e-mail: rafal.kotas@p.lodz.pl).

ABSTRACT This project was made with the cooperation of five students, two from the Lodz University of Technology, ESAIP Angers, Centrale Lille, and Universidad Europea Madrid. Our task was to find and solve one problem from the given topics. We chose the subject of the ageing society.
The problem that has been chosen after deep research and interviews is the lack of physical activities in the group of aged people, as well as loneliness. This lack of exercises can cause some diseases for instance stroke or heart failures.
Our solution to the problem was to make a mobile application that will encourage elderly to exercise and socialize with others. In our application, the users will be able to walk around their city through challenges which are exercises and walking. They could add friends and share their challenges to them. The exercises have different levels of difficulty so everyone can use the game.

KEYWORDS elderly, exercising, firebase, flutter, gamification, image recognition, loneliness, mobile app, people, retired, walking

I. INTRODUCTION

A. BACKGROUND INFORMATION

As the topic of ageing society is quite broad, we needed to split it into smaller categories to have one person focused on just it. We defined five main categories of problems: social, economic, physical, cognitive, and emotional.
Regarding social problems, we concluded that there is a huge problem of loneliness of elderly, it mainly concerns single women between age 50-65 with small social network [1], but 30% to 50% of all elderly experience some level of loneliness. Also socializing with others can help reduce risk of depression [2]. Situation during the pandemic got even worse [3] because the elderly needed to stay even more in their homes. Next, we found the report about diseases which are the most common causes of death [4]. What was important was the fact that by exercising people can increase resistance to some diseases [5].

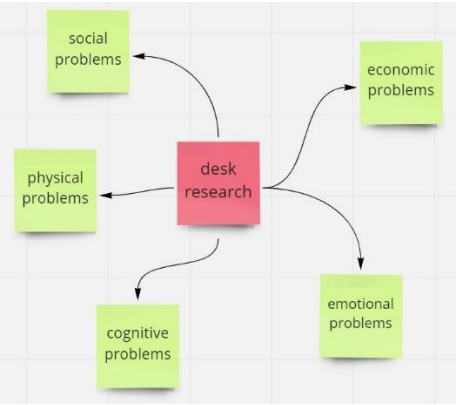


Figure 1 Different categories of problems of elderly

B. PROBLEM FINDING

After deep research we found around thirty different problems. At this stage we wanted to have as many of them as possible and the next step was to filter them and choose one to focus on. To accomplish this task, we made an affinity map, where on x-axis we put ease of implementation of solution. This one was chosen because we are just a team of five students with limited time, so we needed to pick one problem that would be possible to solve for us. On the y-axis we put how impactful the solution would be for our target user, so we could choose an important problem.

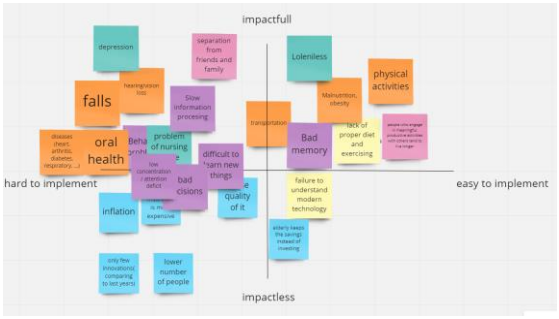


Figure 2 Affinity map with all found problems

The best problem to solve for us was in the top right quarter, and all of them are somehow connected with the idea of physical activities and/or loneliness. That is why we choose this as the problem to solve.

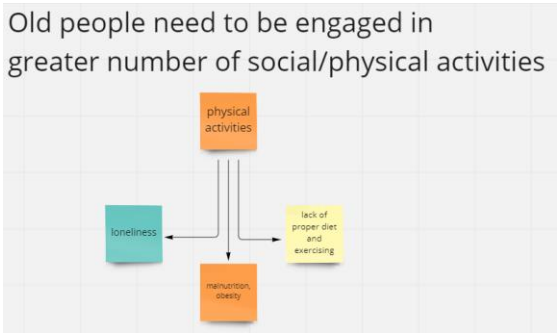


Figure 3 Final problem definition

II. IDEA FINDING

A. STATE OF THE ART

During our first research, we found some existing solutions that already answered the problem that we found. We discovered some social media, which can reduce the loneliness of the elderly [6]. We found a lot of applications that provides a lot of exercises with program and diet. The problems about those applications are that they do not aim enough the population we chose, and they did not encourage people to stay [7] [8].

B. INNOVATIVE IDEAS

During the process of finding a solution, we wanted to make the elderly move, go outside, see other people. Furthermore, the main goal was to make them stay on the application. The idea that we had was to make a game because we know that it could be a good solution for the engagement.

Now that we know that we wanted to do a game, what will be the goal of it? Some exercises had to be there, we wanted to make the people walk around their city and it must be fun. In this way, we thought about some challenges that users could send to the other and a kind of ranking. Another aspect about previous applications is that users cannot know if they did the movement in a proper way. We could use the camera as a personal coach to avoid this problem. The next step was to think about the support, would it be a web page, a mobile application, or some connected objects?

C. MAIN IDEA SELECTION AND JUSTIFICATION

The team chose to do a mobile application because we think that it is the best solution for doing a game. We have come to this solution because we did some interviews of aged people, and near everyone has a smartphone. Moreover, to go outside, it is better to take a phone. Thus, we did a game that contains a system of challenges, walking through those challenges is awarded. We also selected the camera to validate the movement. We selected the idea of ranking because it would bring the gamification that we wanted to add. We also selected the system of friend to keep a social activity for the elderly.

III. SOLUTION IMPLEMENTATION

A. Friends

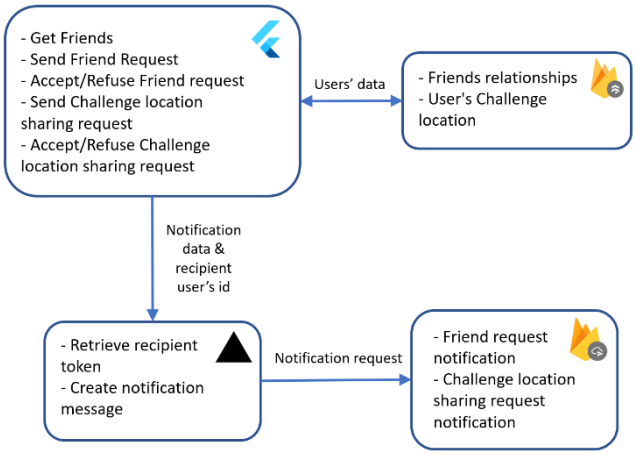


Figure 4: Technical overview of the friends feature

In Physigo, the user has the possibility to add friends. The purpose of adding a friend is to be able to share your weekly challenge location with them. Thanks to that, you can do your weekly challenges with your friends, at the same place.

The mobile application takes care of displaying the relative information of the feature (list of friends, friend requests, …). To display this information, the application contacts the database. Push notification is used when the user accepts a request, to increase engagement. But to send a notification to a specific user, their device token used to target the correct device must be kept private. For that, a Backend for Frontend is used, implemented with a serverless function. An overview of the interaction of the different systems for this feature is shown in Figure 4.

B. Navigation

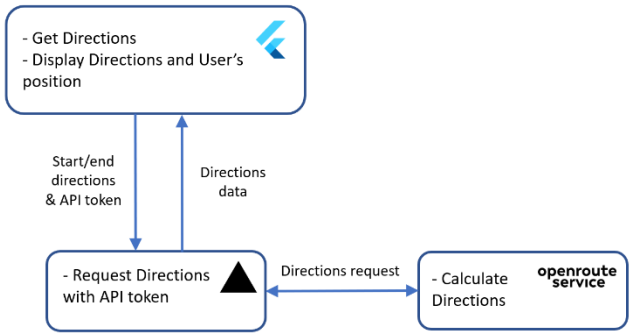


Figure 5: Technical overview of the navigation feature

Figure 6: Showcase of the navigation feature

From the current user's position, we request the directions to OpenRouteService with the challenge location as the destination, via a serverless function to keep our API token private. With these directions come data to draw the current path on a map. Thanks to that, we can indicate to the user the path done (shown as green in Figure 6)

and the path they need to follow (shown as red in Figure 6). As we know the path the user should follow, we can also update the path with a new request when the user is too far from the line. That way, we do not need to keep an open connection with the directions service or spam the service with requests. An overview of the interaction of the different systems for this feature is shown in Figure 5.

C. Exercise Validation

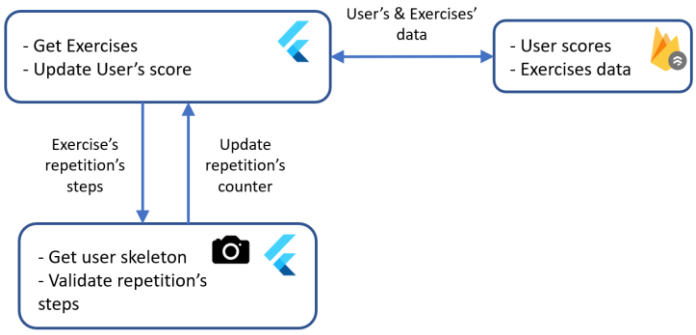


Figure 7: Technical overview of the exercise validation feature

To earn points, a user can do an exercise from previously prepared list of exercises adjusted for elderly. An exercise is composed of a specific number of sets, and a set is composed of repetitions. Each repetition brings points based on the difficulty of the exercise. The most important part of this feature is to validate that the repetition is done correctly, as we do not want our users to cheat or to do the exercise incorrectly. For this purpose, we are using the device camera, and a pretrained IA to retrieve the user's joints from the video. With these joints, we can determine the position of the user and define 4 different states.

The state *notInPlace* indicates to the user that they need to place themselves correctly in front of the camera for all the necessary joints to be visible. This is used to prevent counting repetitions when the user is not visible.

The state *ready* indicates to the user that they are correctly in place and can start doing the exercise. This is a necessary step before being able to count repetitions.

The states *start* and *end* are used to count the repetition. A repetition is represented by a start position and an end position. This way, a repetition is validated when a user has gone through a cycle *start-end* while still being considered in place.

An overview of the interaction of the different systems for this feature is shown in Figure 7.

D. Challenges

To keep the users engaged and have them returning to our app to doing exercises we implemented challenges. There are two types of them: daily and weekly. Daily challenges are reset every day at 6am and consists of 3 random exercises. These are the same for all users to have equal playing field. One of the exercises is worth double the amounts of points to further motivate elderly to do them. In doing so, logging to our app even for just few minutes is worth the effort. Weekly challenges are similar, but with addition of location of the challenge. Once a week (reset on Monday 6am) user must go to a specified location to do the exercises there. This location is based on user home location (set on account create) and is unique to each user. To help with social aspect of our app users can share location with each other and do the exercises together.

To implement challenges, used five parts working together. For locations of weekly challenges, we have a one-time use python script that fetches and puts in firebase all places from overpass API that can be interesting to visit by users. We chose places like arts centres, forests, parks, artworks, or tourist attractions, and there are around 15000 of them scattered in whole Poland.

We also have a serverless function in vercel that generates exercises for daily and weekly challenges. To automate this process, we run a cron job that automatically calls this function when needed. Exercises are kept in separate document in firebase, so it allows to keep history of them. In this way we can make ranking from the past.

Generating location of weekly challenge for each week is done on client side, if at least seven days have passed since last challenge counting from Monday. This way all users have synchronized weekly challenge, and there will not be a situation in which for different users, location updated on different days.

Lastly to notify users about new challenges we have a push notification service setup on firebase. It sends notifications on 11am for weekly and 2pm for daily. We chose this hour, because at 6am the elderly would be probably sleeping, and at this chosen hour we have a higher chance that they would have free time.

Figure 8 Technical overview of challenges feature

D. Accessibility

Our target group is the people around the age of 60-65. According to W3C (Word Wide Web Consortium), the standards from WAI (Web Accessibility Initiative) address the accessibility needs of older users [9]. In our case, it includes font size, colour contrast, and navigation.

Considering the font size, we added by default a big font size and Flutter scales this font size automatically with the current user's settings. It means that if the user is using a bigger font size setting on their phone, it will scale the application's font size correspondingly.

The colour contrast is calculated based on the foreground colour (the text's colour) and the background colour. For instance, before adapting our UI, the button shown in Figure 9 did not have a correct contrast ratio, according to WCAG, as shown in Figure 10.

Figure 9: Button with not enough contrast

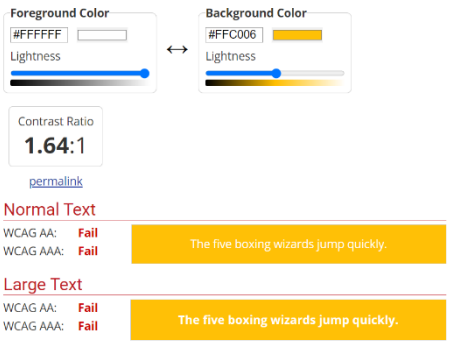


Figure 10: Low contrast ratio

Here are the result afters adapting the colours:

Figure 11: Button with good contrast

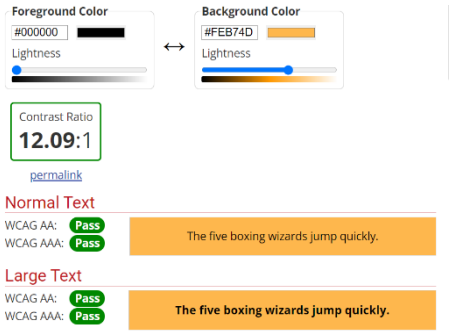


Figure 12: High contrast ration

Two main things were considered to improve navigation: the user can easily identify where they are on the application, and the user can navigate through the application with a screen reader.

As we already specified the name of the current page on each page, we just changed how the bottom navigation bar shows the current page. The improvement is displayed on Figure 13.

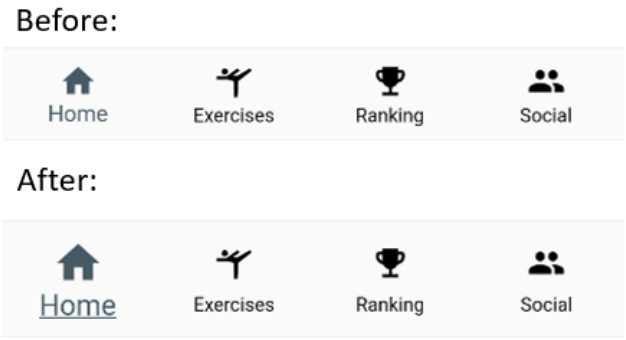


Figure 13: Bottom navigation improvement

The text of the current page is now underlined, and both the text and the icon of the current page are bigger.

Flutter by default handles the interaction with a screen reader so we had little to change to make our application completely usable via screen reader. The only change was to add a back button on pages where the bottom navigation bar was not displayed, as shown in Figure 14.

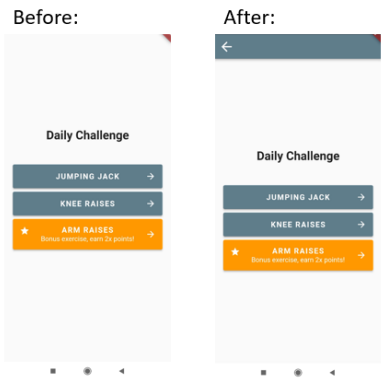


Figure 14: Addition of a back button

E. Check Walking

In our application, when you are doing a weekly challenge, you must walk to the place that has been chosen by the application. Doing exercises give you some points. But another way to earn points is to simply walk. The application will automatically know which activities you are doing. It means that if you are walking, running, or not moving, it will recognize. Thus, if you are running or walking when the application is running, you will gain points.

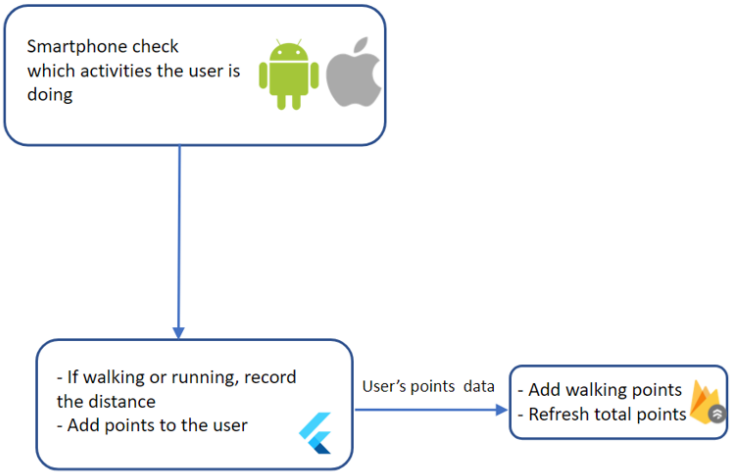


Figure 15: How the feature check walking works

When the application is launched, we ask to the smartphone with the flutter plugin "activity recognition" which activity the user is doing. When it tells us that the user is walking or running, flutter wait that the user stop, and it measures the distance that has been covered.

When the application knows the distance, it will calculate the points of the user. The user needs to walk at least 10 meters to earn points. Now that the application knows the points that has been won by the user, it will update the score into Firebase to add those points for the current user. He will earn walking points and the total points will be updated.

F. Ranking

In Physigo users have the possibility to compare with other users. There are three rankings for other periods of time (daily, weekly, and monthly). Currently logged in user can check his score and compare it to players with highest scores.

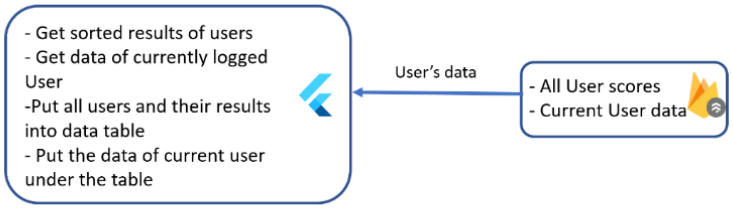


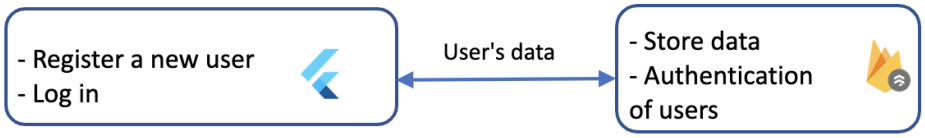
Figure 16: Technical overview of the ranking feature

There were two tools used to create this feature (firebase and flutter). Firebase is a database, and it is responsible for storing all users and their results. When we need the result of players flutter is sending the request to take these scores from database. Next it is sorting all result from the highest to the lowest. When all results are sorted flutter is presenting whole data as the tables in the application.

G. Sign Up & Log In

In our application, our users have the possibility to create an account with their email address and add their information, such as their address and contact details. When you start the application for the first time, you will see on the screen the option to log in and register. If the user already has an account, the user should log in normally, but if not, the user should create an account.

This is how this functionality works with all the tools:



As we can see the scheme is quite simple, we observe two tools: flutter and firebase. From flutter all the information provided by the user is collected and we will ask firebase for the information to authenticate the user or to be able to store the user's information depending on whether it is an existing user or is registering.

IV. WAYS OF VERIFICATION

After the prototype was ready, we have shown Physigo to our target users. We got following feedback:

Anna 59
The app is nice, it has big font and buttons, so it is easy to read. About the exercises, these are easier done with somebody else, because it is sometimes difficult to put my phone somewhere stable. Challenges are great, but besides them I do not know what else I can do. Weekly challenge is a great idea, I can do this when I go shopping and I know where to go thanks to the navigation. Ranking is ok but I do not know who these people are.

Lech 63
Big font is a great plus. I cannot walk for these distances as you said 2-3 km, but I can do normal exercises. It is fun seeing myself on the screen and doing them. I do not understand the idea of points, but still, I like doing the exercises. Having friends is good, but if I do not do the weekly challenges there is no point in it for me.

Barbara 72
I think the idea is good and the app seems to be well created. I like the exercises and wide range of them, but I think that some of them may be tough to do for me. There also some exercises that may be added. For example, bending over.

V. CONCLUSIONS AND PERSPECTIVES

We strongly believe that our app can make an impact. The elderly can have a way of exercising and socializing in an easy way. However, from the feedback we got we found some weaknesses that we can still work on. A way of making new friends would be a valuable feature, and not just working out with our old friends. Also, we can work on stronger interactions between users in addition to sharing location of challenge.

APPENDIX

GitLab repository: https://gitsr.dmcs.pl/iwa-13/PhysiGo
Navigation: https://youtube.com/shorts/751ALd2YWiA?feature=share
Ranking: https://youtu.be/au2y14Hxm1g
Friends: https://youtube.com/shorts/u4UzpxWTWFo?feature=share
Login/Signup: https://youtube.com/shorts/pOJIRwWVmCk?feature=share

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