Planning Report - Running with Sound: Android Application Simulating Sound Sources at GPS Coordinates Using Smartphone Sensors

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1 Background

The chosen subject, to combine a running application with guiding sounds, is to our knowledge not a very common concept among Android applications. The assumption that it is unexplored makes the subject academically interresting. Computer games make use of sound to enhance the user experience, but with modern smart phone sensors the same could be done in an outdoor environment to create a virtual reality in sound.

There are currently multiple running applications making use of GPS technology in order to measure speed and distance. Some, like "Zombies, run!" even track the speed and simulates monsters approaching (audio) if the user's speed is too slow ("Six to Start", 2014). However, the sound effects are not directional, meaning that the direction the sound is to be heard from is not important for the game's functionality - it acts more like a neat feature.

By combining sound with the running game concept it would be possible to hear something, for example a coin, and by running towards it be able to obtain it when its location is reached. At the same time monsters could be heard from a specific direction and by running in another direction they could be avoided. These features will be a great motivator for people struggling to workout on a regular basis.

Other academical parts that will not be mainly focused on but still could be useful to have in mind is the behaviour science of what makes a game fun and motivating. Therefore the target group of the application is not only people who run regularly, but also people who need motivation to do so.

All of this will be encapsulated in an Android application.

2 Purpose

The general purpose of the project is to make an application that:

1. Registers running activity and presents its statistics.
2. Uses the techniques of sound and sensors in a meaningful way.
3. Makes it enjoyable and motivating for people to exercise.

3 Problem/Assignment

3.1 Main goal

The goal of the assignment is to create a fully functional running game that is fun to use. To do this, the following milestones have been created.

1. First of all the functions of a running app will be implemented. This will include:
    - GPS-positioning of the user.

- The bearing of the user. (The user rotation relative to the compass pointing north)
- GPS-destinations that the user can run towards.
- Statistics after a run.
  - Time - The time you have been out running.
  - Distance - The total distance off your jogging.
  - Speed - Time per kilometer.
  - Altitude - Altitude-changes during the route.
- Running High Scores.
- Best time for given distances.

2. Secondly game functions will be implemented:

   - Sound
     - The sound will be directional, meaning that the sound will appear to come from a specific direction of which the runner is supposed to run towards using panorating[1].
     - The level of the audio will change as the user is approaching or running away from the GPS coordinate set as target.
   - Putting a monster on the map, which will be a moving destination. Games with monsters might be:
     - BETA - With the help of audio-navigation you have to run to a predefined spot on the map.
     - Freerun - You can run anywhere you want without any special goals while monsters are chasing you.
     - Quest - With the help of audio-navigation you have to run to a predefined spot on the map while monsters are chasing you.
     - Under attack - You can run anywhere you want but the amount of monsters that are chasing you are continuously growing and are becoming faster until they catch you.
     - Shooter - A mode more focused on hunting than running. While out running use your cellphone as a weapon and hunt down monsters.

     Each of these modes will require a set of features, some probably easier to implement than others. A table of the required features can be found in Figure 1 on page 5.
   - Game High Scores
     - Most coins taken during a run
     - Most monsters avoided during a run

[1] Balancing the audio level between the left and right ear (Roads, 1996).

		Statistics				Game mode					
	Features \ Modes	Time	Distance	Speed	Altitude	BETA	Freerun	Quest	Under attack	Shooter	Radio orienteering
Hardware	Clock	X	X	X		X	X	X	X	X	X
	GPS		X	X	X	X	X	X	X	X	X
	Orientation sensor					X	X	X	X	X	X
	Accelerometer					X	X	X	X	X	X
Software	Randomly spawn monsters around you						X	X	X	X	
	Randomly generate destination					X		X			X
	3D-Audio					X	X	X	X	X	

Figure 1: Scheme of what features are needed for different modes

3. During the implementation of the game modes, a BETA-version will be released. The BETA will then be evaluated on usability by doing some testing by actual people. The feedback contained from testing the application will be of great value when improving the implemented features.

4. Finally, if there is time, some advanced and further game functions will be implemented:

   - Multiplayer - Run together with a friend in the same game-world with the same monsters and goals.
   - Some game mode including Geocaching[2] or Geocaching coordinates.

3.2 Plan B - Radio orienteering

If the initial idea of a using panoration of audio to indicate the direction of the sound is not accurate enough to make it possible for the user to find a sound source, the already written code will be used to make an application to emulate radio orienteering[3].

Instead of real controls and receivers, this application will rely on generated GPS coordinartes and audio. By turning around with the phone in hand, the audio level will change depending on if there's a control in the direction of which the phone is pointing. To clarify: no panoration will be involved - just the volume of the audio changing as the user is rotating (depending on direction to source).

The GPS part of a radio orienteering application would work similar to how it'd work in our initial application idea. The most drastic change would be the audio not being panned, but instead relying completely on the level of the sound always being in the centre - making it an easier task to get working well. That would eliminate the problems occurring when trying to make a sound appearing from a certain direction.

[2] An outdoor "Treasure hunt" using GPS ("Groundspeak, Inc.", 2014). http://www.geocaching.com/

[3] A sport where the competitors have to find hidden controls by listening to a signal caught up by a receiver carried by each contestant ("Radio-orientering Sverige", 2014).

4 Limitations

The device sensors will limit how accurately the user orientation can be measured, thereby limiting the user experience.

When starting writing this report, possibilities to enhance the experience with 3D positional audio was still being researched by members of the group. There's an API called OpenSL ES that claims to make it easy to position audio binaurally (as well as processing it in other ways) ("Khronos Group", 2014). However, as for 2012, no actual Android device seemed to support that specific feature (Ratabouil, 2012). Neither did any of the project groups own phones. It turned out a device had to implement a profile provided by OpenSL ES in order to make use of all its functions.

Instead, if the sound is supposed to be heard from behind the user, it will instead appear from one of the ears and gradually move towards the center as the user is rotating towards the source. A voice or sound informing the user that he/she is heading towards the wrong direction might be a good alternative if the former turns out to be difficult.

When developing the application the assumption that people might listen to music when running will be considered. Ideally the user should be able to listen to music while using the application. Alternatively the experience could perhaps be made fun enough for the user not wanting to listen to music while using the application.

5 Method

Initially, information will be gathered on how to use the Android APIs in the most efficient way for this kind of application. This will include how to use activities, sensors and maps. Since the application is developed to be run entirely on Android platforms, this part of the research will be of huge importance for the outcome.

Alongside the coding-aspects mentioned above, information will be gathered on how specific areas (GPS, audio, etc.) work and how they're implemented using Java for Android. Most of the information will probably come from e-books, as well as Android's developer pages on the Internet.

When information is gathered the structure of the app will bef decided. Here UML-models will be drawn to make the structure clear. After the modelling decisions are made sketches will be drawn to decide how the GUI might look.

Then the coding process will start. The parts to be coded will be the ones mentioned in Section 3. Alongside with the coding, testing will be made to make sure that everything is working as expected. When possible, the tests will be made as test cases. It will also be important to test with real values - such as going out and running and see how the application works.

An evaluation will be performed when the first BETA-version is finished. This will be done by letting a test group use our app and evaluate it by conducting an interview.

5.1 Development

The Scrum method will be used when developing the application - a flexible Agile software development framework where the team works more as a unit opposed to a traditional and sequential approach. The division of labor will be done in cycles (sprints). Each job occasion will begin with a scrum meeting - a short meeting where the group talks about what's going on, what's about to happen as well as possible problems.

To handle the coding part of the development, Git will be used, which is a version handling system that makes it easy to collaborate with others in coding projects. It makes it possible for each team member to work in the same classes and merge them when needed. Each specific part of the application (audio, gps etc.) will be implemented in individual branches.

When it comes to the testing part of the development, both the virtual phone available in the Android developing environment will be used, as well as our own phones.

5.2 Literature studies

The literature studies will involve how the human ear perceives sound, and how it's possible to imitate sounds coming from specific directions using stereo headphones (Roads, 1996).

Literature about Android and how to best develop the app will also be studied. This is necessary to make the app enjoyable for the user and flexible enough to work on different kinds of phones. According to the Android API Guide - Fragments (2014a), fragments can decompose the functionality of an app into smaller parts (fragments) that can be reusable and, depending on the screen size, show up in different quantities at a time.

Alongside the audio and Android studies, the sensors considering position and orientation need to be studied. While GPS is the most natural way to measure the position (Sood, 2012), there are various ways to measure the user orientation.

The orientation while in motion could be decided through the GPS bearing ("Android Developers", 2014b), which is calculated as the direction the phone is travelling in. Although, while standing still and only rotating on the spot, we might be able to use the magnetic field sensor (compass) and accelerometer to provide an orientation of the phone itself (Sood, 2012). This however has problems since the orientation of the phone relative to the actual user is not always known (it depends on how the user is holding the phone).

Probably, as some initial testing shows, some combination of both is preferable.

6 Timetable

In order to create a preliminary time plan of the important phases of the project a Gantt chart was used. It is to be found in Figure 2 on page 8.

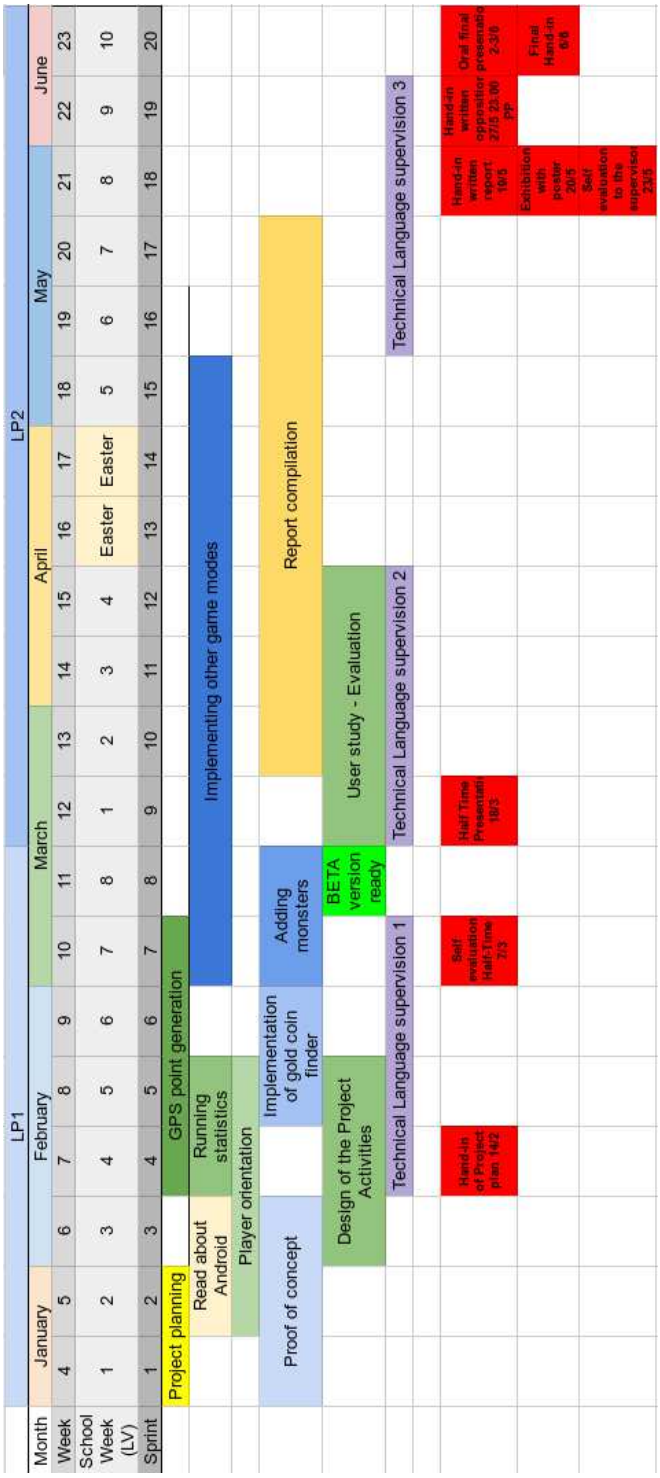

Figure 2: Preliminary Time Plan for the project

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