MyMusic

Laboratory Work Course in Computer Science

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Index

1. Introduction................................................................................................................................3
   1.1 Motive..................................................................................................................................3
   1.2 Objective ..........................................................................................................................4
   1.3 Methodology......................................................................................................................4
   1.4 Structure of the report........................................................................................................5
2. Requirements................................................................................................................................6
3. Architecture................................................................................................................................7
   3.1 Features..............................................................................................................................8
4. Design.........................................................................................................................................8
   4.1 Personas..............................................................................................................................9
   4.2 Scenarios............................................................................................................................11
   4.3 Mock-ups...........................................................................................................................12
5. Challenges..................................................................................................................................15
6. Testing.........................................................................................................................................16
7. Looking Forward..........................................................................................................................17
8. Appendix......................................................................................................................................19
1. Introduction

In this course, Laboratory work course in computer science, I was asked to develop a project or idea that would help me gain and acquire a better knowledge and understanding of computer science.

As computer science is a very broad topic and there are many things I could research or develop in order to achieve this goal. That is the reason why I decided to develop something more personal in which I’m interested and that I would more gladly invest my time in. Personally I like many things in computer science, one of the things I find more interesting and engaging are computer games, and topics related to the development of such games, but the previous semester I already participated in two courses related to this issue and even implemented a few little games before, and I wanted to learn something new something I hadn’t see or tried earlier.

So I had one idea that I got talking with a friend of mine a few years ago which involves something I also love and enjoy a lot, that is music. The idea was to have a device always ready to play music at home, as is something I and I believe everybody does when they are home, so instead of using your phone or your computer you have this device that can play all your music without much trouble and complication, consuming less resources than a computer always on and without the need of streaming the music you play.

1.1 Motive

As I mentioned before, the motive of this project is not just to learn and develop something that will help widen and broaden my knowledge in the field of computer science but also to work on something I like and enjoy working on, which will I use in my daily life.

A project like this is not just something I have been meaning to start and work on for a few years and I always wanted to do. This project won’t be over after the completion of this course and be left completely unused and forgotten.

I want to keep improving this idea, adding extra features, and polishing it more. I would like to be able to share this software with friends, family and people who like to listen to music in a different way.
1.2 Objective

The objective of this project is to make an Android application that is able to connect to a Raspberry Pi via Bluetooth. This Raspberry Pi would at the same time be connected to a set of speakers and to an external hard disk containing music files. Using this Android application people will be able to connect to the Raspberry and easily play the music they have storage in the hard disk.

To do so the idea is to build a simple and easy to use app that can help people play and manage their music in a different way, that doesn’t require streaming or any kind of internet connection and that is light weighted and allows every kind of phone to use it.

1.3 Methodology

In order to start working in this project there were a lot of new things I need to learn. So to start I should do some research and find tutorials, various pages of documentation, helpful posts in related topics and guides to learn which tools and libraries are of best use for my idea and to help me develop it.

The project can be divided in two big blocks: the mobile app and the Raspberry Pi server. For starters as I didn’t have the Raspberry with me when I began to work on the project so I thought that starting with the app was a better approach.

Also my biggest challenge was to learn how to program in Android so it would consume more time than making the Raspberry server. Besides this having something I could already see and test, like an interface would help me receive direct and positive feedback on my work and encourage me to keep working on in.

Once I already have the app and therefore the interface I was going to use almost defined and done I started working on the Raspberry end. First I needed to know how to read and play an MP3 file, after a lot a searching I found some libraries that were easy to use, and most importantly easy to add to my working environment.

Then I had to learn how to make and handle a Bluetooth connection between the Raspberry and the phone.
Finally I had to wrap up all the software I had that preforms the different functionalities I needed and make a multithreading server that handles the Bluetooth connection and the audio management.

### 1.4 Structure of the report

This report is structured in six sections in which I explain how I have developed this project, the motives that set me to develop it and the process of developing such a project.

First of all I focus on the requirements that I needed to meet for this, what tools, software and hardware that I will need to use.

Secondly in the architecture section I explain different architectural decision I took at the beginning of the development process and also the different features I planned to implement.

After the architecture there is the design section which is equally important, in it I develop several personas, scenarios to give more background to those personas and some mock-ups.

Consecutively I explain the various challenges I faced during the whole development of this project.

Then in the testing sections I give an overview of the different people that tested the latest state of the app and what they reported.

To end this report in the Looking Forward section I will analyse the overall things I learned and gain while developing this project, how do I feel I have worked on it and how could I have improved what I have done.
2. Requirements

The requirements of are more complex and broad that if I were just doing a mobile phone player. First there is the hardware components I needed. In order to develop the project I would need the following hardware components:

- A Raspberry Pi 3 model B.
- A screen so I can connect and work with the Raspberry, to make this connection I will also require an HDMI cable.
- A keyboard and a mouse, so I can configure and work with the Raspberry.
- A SD card so the Raspberry can store its information.
- An external storage unit for the music, a normal USB would serve for the development, but a external Hard Drive would be the closest thing to the original idea of the project.
- A mobile phone.

The basics of the software I required was easier to find and to acquire. For the mobile phone app I used Android Studio as IDE, which proved to be a really powerful and useful tool, it provided me with all the necessary libraries and functions to make this project.

For the Raspberry it was somewhat more complicated, I installed Raspbian as OS, this OS comes with a lot of IDEs and software already installed, a nice and clean desktop, they are easy to use, but the IDEs that were designed for java, which is the language I decided to use to develop the server side of the project, where too simple and didn’t have many useful features other environments like Eclipse do have to make my work much easier and faster.
3. Architecture

When designing the architecture of this project there where many things to have in mind. As there where many things I needed and wanted to implement and I was a complete stranger in most of them, like developing an Android app, I decided to take what seemed the fastest and simplest approach to the problem.

The architecture of this project is pretty simple, the Raspberry Pi server is always running, it’s lunched when booted, and listening for a client to connect, before it gets locked listening it makes itself discoverable so other devices can spot it and connect to the server.

Once someone connects there are to major thread, one that is managing the music player, it loads the songs, organizes the data extracted from them and plays them, and another one that manages the Bluetooth connection, sends all the information to the client, and receives and takes the correspondent actions after the client performs any activity.

The client on the other hand only has to process all the information and data that the server is sending, which are just a few ArrayLists containing the different objects I defined to manage everything, and after receiving this information.

When the user performs any action that requires an action from the server it sends a simple message via Bluetooth, containing the operation code and the extra information the server might require to handle it.

This client-server architecture seemed like the fastest and simplest way to implement the idea I had. Although having just one possible client at a time doesn’t completely fit the first idea I had, the only thing one has to do to allow someone else to get connected is to close the app and the server will start listening again for another client, and this can be done without interrupting the music player.
3.1 Features

The features I wanted to implement for this project are many, and there are a lot more I would like to implement in the future. As I mentioned before this is not a project I would like to develop just for this course it is a more long term and personal idea. But for starters there are some basic features I would like this project to have:

- Playing, stopping and pausing a concrete song.
- Playing next and previous song.
- Shuffling the songs list and playing the songs in a random order.
- Searching for songs and playing the requested and just found song.
- Displaying the different songs, artists and albums in separate lists.
- Displaying and being able to play all the songs of an artist or an album.
- Showing the information of a songs, name, artist and album.
- Being able to view the artist and the album of a specified song.
- Making playlists and managing them.
- Adding songs to the reproduction queue.

4. Design

When designing this project at first didn’t know really well how to start but then I based myself mostly in some good designs of music apps I had used before, like the ones that already come with your mobile phone preinstalled with the OS, and some I mainly use nowadays like the Spotify mobile phone app. From this apps I tried to take all the concepts and ideas I liked the most and mixed them all together in a suitable way.

After getting some design ideas I decided to design some personas and their correspondent scenarios to help me have a wider view of who and how my app could be used. All this process helped me making some mock-ups that would set the base for the final and programmed versions of the project.
4.1 Personas

In this section of the design I created some personas, to help me with the design process. By creating personas it can be easier to identify and model the different kinds of persons and the profiles that will use the application.

The app is intended to all kind of people, to be able to reach all kinds of people the app will have to be simple and easy enough so everybody can use it. As I tried to reflect in the personas I have made. I would like to believe that people from all over the world could be able to use this app and get a good experience from it that is why all the personas I made personas don’t have a specific location assigned.

These four personas were created using the web Xtensio, which provided an excellent and very helpful tool for this task.

**Carl Carlson**

**Goals**
- Be able to relax at home after going to the university.
- Manage his own music in a easy and adaptable way.

**Frustrations**
- Using apps like Spotify that require you to use Facebook.
- Sharing his personal data and information about him to big companies.

**Bio**
Young and introvert, Carl spent most of his youth listening to music which is his main passion and his field of study at university, not specially technologically savvy but with enough knowledge about how the world and the internet works to be aware about how companies store your data and use.

**Motivation**
- Relaxation
- Amusement
- Growth
- Social

**Preferred Channels**
- Traditional Ads
- Online & Social Media
- Referral
- Guerrilla Efforts & PR
**Evangeline Lilly**

*Goals*
- Be able to easily listen to her own music any time she wants at home, without the need of an internet connection.
- Organize and display her music in a personalized way.

*Frustrations*
- Her internet company doesn't provide her with all the bandwidth she needs for her music streaming apps.
- Not having an easy tool to allow other people to listen to her music in her parties at home.

*Bio*
A young and friendly student, Evangeline has many different kinds of friends and loves listening to music with them every time she can.

**Motivation**
- Relaxation
- Amusement
- Growth
- Social

**Preferred Channels**
- Traditional Ads
- Online & Social Media
- Referral
- Guerilla Efforts & PR

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**Anna Toddler**

*Goals*
- Relax and enjoy listening to podcasts after arriving after a long day at work.
- Reducing her ecological footprint using less cloud services.

*Frustrations*
- Using too many streaming services.
- Not having a good place to store and play his podcasts about jazz in an accessible and easy way as soon as she gets back home.

*Bio*
University teacher, Anna is a computer science teacher who loves listening and learning things about jazz.

**Motivation**
- Relaxation
- Amusement
- Growth
- Social

**Preferred Channels**
- Traditional Ads
- Online & Social Media
- Referral
- Guerilla Efforts & PR
4.2 Scenarios

After developing the personas of the project, we need to elaborate the correspondent scenarios to give more background and explain with more detail what would bring these personas to use this app.

Now here are some scenarios that allow us to complete and give a more detailed view of the different personas:

- Carl is a young musicology student. He is quite introvert and always had some troubles making friends. He has many anxiety issues and doesn’t handle really well being with a lot people in class. So as soon as he gets back home where he lives alone, he likes to put music as loud as he can to relax and forget about all the troubles he has. He is not a fan of social media and big internet companies like google that storage and use all your data. He is not especially paranoid about it, but he simply prefers other tools instead of the most mainstream ones.
Evangeline is a political science student with many different and diverse friends. She is really friendly and enjoys every kind of party. But the ones she likes the most are flat parties, just chilling and having fun with friends at home. She likes all kinds of music and loves sharing it with her friends as often as she can. When she is with her friends at her place she wants them to be able to look through her music and play whatever they want in an easy way.

Anna is a music lover. She has a broad and rich taste in music. When she was younger she used to buy tons of CDs and she has a huge collection of them. She likes to listen to podcasts that she previously downloaded, she likes to short them from different genres and themes. That’s why something like MyMusic is perfect for someone like Ann, she can have all her different music and podcasts in the same place, without the need of moving them in and out to her phone or computer all the time because she doesn’t have space anymore. She can organize them in any way she wants in a simple manner, without the need of her computer.

Adam is a gardener that is passionate about music. He likes to listen to music at home and most of all he loves to share it with his family and the people he knows. He wants his kids to have a musical background, to learn and enjoy music as much as he does. That’s why something like MyMusic, can help him share all that music, and as is easy to use his kids can use as well the simple app and learn more things from themselves.

4.3 Mock-ups

In this section I will show some mock-ups I tried to draw in order to help me during the development process of the app, in them I represent on only the state and look that I would like the final version of the app to have but also the different features of the project and how they interact with each other.

This process was really helpful to help me change and modify the ideas I had at the beginning of the process of design, before I started to implement anything I made some colleagues and friends test this paper version of the app, so they could give some feedback on things I hadn’t realise I had to improve or change.

After this process I had a clearer and precise idea of what I wanted to make, what was important and what not, and what was missing.
Here there are some mock-ups of the app:
5. Challenges

In this section I will mention and explain the different challenges I had to overcome during the process of development of this project in order to give a more detailed vision of how making and setting up this project was.

Sometimes when developing software not being able to see the results of hours of work can be frustrating and make the task you are working on more tedious and less appealing, resulting in a less productive and time efficient work.

Fortunately as I started working directly in the interface I was able to see myself progress more and more every day. But as I had never worked with Android before, and though is Java based and I have a good knowledge of it, I had to learn everything from scratch. With some many important and different concepts, objects, methods and features the Android libraries where a bit too extent and complex to start working fast on something. I started by following some tutorials, but has many of them where quite outdated I probably, as I found out with some features I implemented, used methods and techniques that were almost deprecated or not as efficient as the ones added in the last releases. But learning all the state of the art knowledge about Android was never the main point of developing this project, so I didn’t consider too much learning everything in the latest and better way.

When starting with the Raspberry I had some problems as all the software I found that was needed to burn the .iso image of the OS in the micro SD of the Rapsberry didn’t work. And as I had never worked with one it took me a while to know what was failing and what not.

Then the IDEs that were preinstalled with the Raspbian OS where far too simple and didn’t have the best support for adding external libraries in an easy way. That’s why I opted for using Eclipse, as even if it is a more heavy and resource consuming IDE I had already worked with it several times, and is a tool I really know how to use.

Finding the right documentation and guides for some of the libraries I was using, like the one I use for playing the music, was complicated as they were quite old and not many people had had recent problems with them.
6. Testing

As any software project for developing an app is mandatory to have different sets of people test it. The app has to be tested various times, since the begging with the mock-ups, which give us a general overview of what and how things should be done to appeal and help the app be successful, to the end and last versions when one might think that everything is fine and working perfectly, but nothing like a stranger touching all the buttons to finds the most weird bugs and mistakes.

It is important also to test during the process of development, as more functions and features are added more mistakes can be made and more problems may arise. As the project I’m trying to develop is not hermetic and completely closed to one unique idea and feature it is good to test it often to see what things can be going wrong and can be improved before too many things have been already implemented and it takes too much time and resources to change it.

I tested only with young people, colleagues and friends, with so much time and knowing mostly just young people here on my Erasmus I couldn’t try on persons from other age ranges, or with absolutely no idea of the project or the kind of technologies it uses to see with more details things and mistakes I might have made when designing it.

As the state of the app is pretty raw most of the tests and reviews I got where pretty positive, they found the app simple and easy to use, nothing important to point out, just some minor bugs reported, which were fixed right away, and there were some minor complaints about some features like the add to queue or making playlist that I didn’t have the time to implement.
7. Looking forward

Here I explain all the things I think I learnt during this process of development of the project, also how I considered I did things and how I could have improved them and to end how I think this project is going to keep going when I keep working on it as a personal project.

First of all I learnt a lot of things by starting this project, I did not only learn how to develop and Android app, and most of the general and some more specific features that they can have, which can be really useful if in a future I want to develop any other thing in Android. I also learnt good practices to follow while developing an app and where to find important documentation and information about how to develop apps.

Secondly I also learnt how a Raspberry Pi works, how to install and set it up. This was something always I wanted to learn as I find Raspberries a really nice and useful tools that can serve many proposes in this world where things can be automated more and more and in which if you have a minimum knowledge of computer science and programming concepts learning how to do really interesting and cool projects is pretty easy.

I had done some servers before, but they were mainly, in client-server architectures that did process all the petitions sequentially, and didn’t have other or at least not so many background thread. So I also learnt a lot about multithreading, how they communicate and how to manage them. I refreshed as well many other programming concepts I had seen previously in my career but I had somewhat forgotten.

When I started working in this project I thought it was going to be easier and less time consuming. It had been quite a long time since I tried to develop a project this big and it caught me a little bit off ward. I started working on it early but not as hard and continuosly I should have. The last past weeks where quite stressing and had to work for many hours a day trying to keep up with the death line.

Working in a project like this alone is not an easy task, as there is no one to share the workload with. That made something’s easier, like design decision making but when you don’t have anyone supervising you or working alongside you it is easy to lose track of time, the death lines.
I could have avoided most of this issues if I had done a deeper reflection and analysis of all I had to do in the first place, instead of making one thing after the other without really thinking in the big picture.

Some of these time problems resulted on being unable to finish some features I wanted to make in the first place, like adding to the queue and making and managing playlist. But even if I couldn’t develop them for the end of this course, as mentioned several times before this project is something in which I want to keep working so I will definitely get them done. The general visual aspect of the app is quite simple and ugly, I would to change that in the future as well, and adding nicer and better colours to the buttons, stylizing them and making everything look prettier, making animations for screen transitions and so on. But as it wasn’t the main point of this project is something I will change long from now.

Some other features I thought about adding are: being able to share the actual music files with your friends, your playlists and selections of songs via Bluetooth, making the server capable of holding several connections at the same time, being able to search for a song in YouTube and downloading it into your database, being able to modify the metadata of a song, adding the pictures of the different albums. Some of these are the ideas I would like to keep working in the future. I would and should as well make this project an open source project, so other people and friends can help me with my code and participate in this project.

To sum up making this project was a really nice and insightful experience, I learnt a lot a new things, it has widen my knowledge in some areas of computer science I always wanted to get to know and explore. Developing a personal idea was a good and different experience, there is nothing better than working in something you like and you are invested in, it makes everything easier and better.
8. Appendix

In this section there are attached different links to the various sources and documents that I used during the development of this project so far, so that if others were to create a similar application they could have an idea of what are the different things and knowledge they might need to achieve it.

Tutorials I used:

- Creating a Music Player in Android:

- Creating a chat app via Bluetooth in Android:
  http://www.dev exchanges.info/2016/10/simple-bluetooth-chat-application-in.html

- Creating a Bluetooth scanner:

External libraries:

- Java javazoom music player:
  http://www.javazoom.net/javalayer/docs/docs1.0/overview-summary.html

- Java bluecove, for Bluetooth server:
  http://www.bluecove.org/bluecove/apidocs/index.html
Java documentation needed:

- Threads:
  
  https://docs.oracle.com/javase/7/docs/api/java/lang/Thread.html

- SwingWorkers:
  
  https://docs.oracle.com/javase/7/docs/api/javax/swing/SwingWorker.html

- Input and output stream:
  
  https://docs.oracle.com/javase/7/docs/api/java/io/InputStream.html
  
  https://docs.oracle.com/javase/7/docs/api/java/io/OutputStream.html