



UNITA - Ultrasonic Network for IoT Applications

Zwischenbericht | Call 13 | Stipendium ID 3277

Lizenz: CC-BY-SA

Inhalt

1	Introduction.....	3
2	Status.....	3
2.1	Milestone 1 - Research on literature and hardware.....	3
2.2	Milestone 2 - Specification of ultrasonic beacon	3
2.3	Milestone 3 - Website	4
2.4	Milestone 4 - Software development beacon and use case (in Progress).....	4
2.5	Milestone 5 - Software development server (in Progress).....	4
2.6	Milestone 6 - Mobile app and testing (in Progress)	5
2.7	Milestone 7 - Proof-of-concept evaluation (in Progress).....	5
2.8	Milestone 8 - Thesis writing (in Progress).....	5
3	Summary of planning updates	5

1 Introduction

My thesis UNITA is on a good way. Though there were some changes in the planning and some problems appeared, which were converted into challenges to tackle, many parts of the milestones are finished or in progress.

2 Status

2.1 Milestone 1 - Research on literature and hardware

The main part of the research was finding a first list of scientific papers and books about ultrasonic communication. This includes different aspects of ultrasound like using it as a side channel, privacy aspects and security of this communication method, and usage of ultrasound in IoT. Moreover, this research also included the search for existing ultrasonic technologies. Beside the ultrasonic part of the research, finding a suitable single-board-computer or microcontroller was important.

For the research, I used the platforms IEEE and ACM to find scientific papers. Before that, I searched more general with Google Scholar. During this research, I found several existing technologies, which already use ultrasound. Also, many scientific papers about ultrasonic communication in general are already published. In terms of hardware, there is huge selection of different devices for building a beacon.

The outcome of the research were two lists, one with many scientific papers about the topic ultrasound and one with the specifications of several single-board-computer and microcontroller.

There were no notable problems or special achievements and the research was in time.

2.2 Milestone 2 - Specification of ultrasonic beacon

The specification of the ultrasonic beacon was split in defining three parts: the base structure of the beacon software, called Unita SDK, and the layer to build on; the environment of the beacon with the app, the server and its communication methods; and the hardware for the physical beacon.

To define the beacon, I scribbled the main functionality of the beacon and tried to define all functions, which the ultrasonic beacon should have. The ultrasonic part is based on a separate layer. This layer is the SoniTalk SDK, which I have chosen as it is fully open source and completely written in Java. The environment was easily set up, because a server is needed for communication with the beacons and the internet. For use case testing and the proof-of-concept I added a smartphone application to the environment. Then two more communication methods were added, which are only there for the server communication. The beacons communicate bi-directional with Websockets and the test app uses REST, which only works in one direction, as the server never needs to ask the app something.

On the hardware side, I looked through my list and compared the specifications, which the definition of the beacon implied. The main one was that it should be possible to run an Android operating system on it, as the lowest layer SoniTalk is built for Android. I decided then on using a Raspberry Pi 3, as it can run Android as an operating system and has on-board Wi-Fi. For the audio

part I searched for best practices with Raspberry Pi 3 and many of the existing ones were using an USB audio interface.

The outcome of this milestone was a specification and a structure for the ultrasonic beacon. All the devices and connection methods were defined as well as the hardware itself.

The biggest problems appeared on finding a suitable audio interface, as it did not work via the GPIO header of the Raspberry Pi in combination with Android and some USB audio interface did not work at all.

This problem also delayed this milestone a bit.

2.3 Milestone 3 - Website

The main task was to build a website to present my master thesis and the blog posts which are also on the Netidee website. Beside I also designed a logo and an icon for it.

For creating the website, I used Wordpress as the CMS and searched for a one pager theme for it. Then I entered all the content.

The result was a website, where no big problems or achievements happened and there were no differences in the planning.

2.4 Milestone 4 - Software development beacon and use case (in Progress)

The first task for Milestone 4 was the creation of several use cases. Then I defined a class diagram for the Unita SDK layer. For the application on top of the SDK a main use case was defined. And the biggest part was the implementation of the SDK itself and the chosen application.

First, I researched for possible use cases for the Unita SDK and scribbled diagrams with features and explanation. Based on that I took the general parts of the use cases, which every application would need in the end, and created a class diagram as the base for the software. For the application I took one of my previously defined use cases and elaborated that in detail. This is the main use case for my thesis. After that the implementation of the SDK and the application started. The SDK had several parts which are the sending and receiving part with ultrasound in combination with the extension for SoniTalk, which consists of sending multipacket messages; the local and remote database, whereas the remote is considered as the websocket connection to the server; the UnitaMessage with its header; and the user/message subtypes.

The outcome were several use cases, a class diagram for the SDK based on the use cases, a main use case and parts of the implementation of the SDK and application as it is still in progress.

The most important success was the extension of the open source SDK SoniTalk. The biggest problem was to keep the layers atomic and not mixing them up.

This milestone was delayed because of unexpected number of projects and exams in the end of the winter semester 18/19 and summer semester 19.

2.5 Milestone 5 - Software development server (in Progress)

The main tasks for the server development were the definition of the software itself and its communication interfaces (REST and Websockets) and the implementation of that.

The server interface for communication was defined based on the SDK (Websockets) and the test app (REST). The server itself is a Node.js application with Express.js as support. Then the

integration of the database was done and queries to get the data were applied. The database used is the NoSQL database MongoDB. Another part was creating a simple map view to show all beacons. The server application is still in progress.

The biggest success so far was the working communication interface, whereas the biggest challenge was finding suitable libraries.

This milestone was delayed because of unexpected number of projects and exams in the end of the winter semester 18/19 and summer semester 19.

2.6 Milestone 6 - Mobile app and testing (in Progress)

The main tasks are the implementation of a mobile test app and the testing in combination with the beacon.

The REST interface is in progress as well as using the SDK for receiving and sending. This part is in progress.

This milestone was delayed because of unexpected number of projects and exams in the end of the winter semester 18/19 and summer semester 19.

2.7 Milestone 7 - Proof-of-concept evaluation (in Progress)

The proof-of-concept consists of testing the selected microphones and loudspeakers and evaluate their capability for higher frequencies.

For testing the loudspeakers, I used a well working microphone which is plugged to a notebook. I played a frequency sweep on the beacon and the plugged loudspeakers. This was then recorded for every loudspeaker three times with 100% and three times with 70% of volume. The evaluation of those recordings is in progress.

The outcomes so far were recordings of different microphones and loudspeakers.

The biggest problem was to find amplifier for the microphones and loudspeakers to work with the Raspberry Pi.

2.8 Milestone 8 - Thesis writing (in Progress)

The tasks thesis and documentation writing are still in progress.

3 Summary of planning updates

The biggest changes in the planning were in the milestone four and six because of unexpected number of projects and exams in the end of the winter semester 18/19 and summer semester 19. Those mainly effected the implementation of the SDK, server and the testing phase. Though there was this delay of the time period or expansion of the period of time, the end goal for finishing my thesis is still the same. Another big point was adding an extra milestone for the server, as it was previously included in the milestone four (Implementation of SDK). Beside that the milestone seven, proof-of-concept evaluation, got extended by one month and the milestone two got also extended by two months.