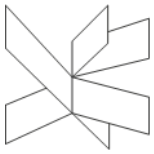

Android Remote Controller for Mixed Reality Head-Mounted Displays

Using Bluetooth Low Energy

Process Report

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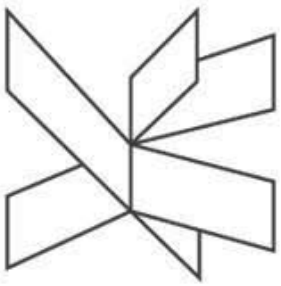
SYSTEMATIC



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ICT Engineering

7th semester

12. 12. 2018

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1 Introduction

This process report reflects on the group work our team had performed over the past few months, starting from the inception of the idea, and finishing with the delivery of the product to the stakeholder.

To ensure, that work efficiency is maintained on a high level we have decided to use agile SCRUM framework and Unified Process. This way it was easier for us to keep track of the workload and the development process.

Weekly meetings with the supervisor took place in this project, where we have received relevant feedback about our progress and advice on how to advance further.

We have also participated in meetings with the company associated with our project, Systematic, in order to gain further insight about the problem domain and the current implementation of the system. In the beginning of the project an interview took place with a domain expert and stakeholders, from which the team has managed to adjust its approach to the problem.

The following sections shall describe the different aspects of the overall process.

2 Group Description

Our team consists of three ICT Engineering students with Cross Media specialization at VIA University College in Horsens.

Bence Sólyom

I'm from the capital city of Hungary, Budapest. I've had an interest in computers and IT for a long time now. In high school I've already gained some knowledge in programming (mostly C++), and that made me realize that this is what I want to work in the future. After finishing my high school studies I have decided to go to university in Denmark, since I believe, that, while it can be challenging at times, studying in a different country can provide lots of valuable experiences.

A friend requested the ICT Engineering course at VIA University College in Horsens, so that's what I've chosen. During this course I have participated in several mandatory semester projects, innovation week projects and a hackathon as well. Through these projects I've learned about the importance of decent teamwork, efficient ways of brainstorming and how to document the work we do properly.

Bogdan-Laurentiu Ene

My roots are from the shore of the Black Sea, more precisely Constanta, Romania. My passion for technology and computers started at a very young age. Yet, my journey into the world of technological development only started in high school, choosing to go for a mathematical and informatics specialization, not knowing anything about computer programming.

After gaining some base knowledge learning C++, I've decided to continue pursuing studying this branch further. So, after graduating high-school, I had the opportunity to go abroad to continue my studies. Denmark was the first option and I've landed to VIA

University College in Horsens, which it has been my home for the last three and a half years.
Studying here, I've gained a lot of in deep knowledge on how to design and develop systems, with a great focus on Android Applications and Augmented/Virtual reality experiences. But, the most important part is the multi cultural environment that I was part of and how this improved my communication and team working skills.

Mario Burgov
I am 22 year old passionate student born in Plovdiv, Bulgaria. My love for computers and technologies overall has arose from the fact that I've been constantly spending my time with them since the age of 7.
My more mature technological development started when I joined the Mathematics High School in my home town where mathematics and informatics were of a great interest to many people. As the other 2 guys in my group, I've also first started coding in C++ which at that point developed my interest in programming even more.
After the high school studies the difficult choice of choosing my next step in life came in the face of university. I wanted to go abroad and I ended up here at VIA University College in Horsens, Denmark.
Finally, having studied here for three and a half years, I can say that I have gained a lot of knowledge on how to develop systems in different languages as well as improved my communication skills and how to properly work in a team orientation.

3 Project Initiation

The composition of the group went fairly quickly. We are good friends and we have known each other for quite some time now, since we were classmates in most of the university subjects. Moreover, we've all had our internships at Systematic, the company we were working with during this project, therefore it seemed like a good idea for the three of us to form a bachelor project team and propose a project idea to Systematic.

The idea to work in the area of mixed realities (MR) was proposed to a team member of our's, Bence Sólyom, by an employee at Systematic. He pointed out that the current controls of MR headsets are cumbersome, therefore an alternative solution is required. Since we all share an interest in the topic of MR, and another team member, Mario Burgov had already worked on Systematic's MR project in question during his internship, we have taken the idea into consideration.

Furthermore, the team took part in a bachelor project preparation course in the previous semester which greatly assisted the process of coming up with ideas. After a comprehensive brainstorming session we have formulated our project idea, and after further supervision from our contact person from Systematic we have finalized it into a proposal that would suit the company's interests. This process served as the foundation of the project description.

4 Project Description

"Mixed Reality (MR) is used as an independent concept or to classify the spectrum of reality technologies, as referenced in the reality-virtuality continuum.
As an independent concept, mixed reality combines the best of both virtual reality and augmented reality. When used to classify the larger scope of reality technologies, it

refers to the coverage of all possible variations and compositions of real and virtual objects."

Systematic, a large Danish software development company with 4 departments, has a new project in the Defence department. The project involves the usage of SitaWare through a MR head-mounted display (HMD).

"The SitaWare Suite is a fully integrated range of top-to-bottom C4I and Battle Management Systems that give you shared situational awareness on all levels of command together with powerful Command & Control tools."

Since SitaWare is related to complex operational environments and battle management systems, the existing controls of HMDs, is not sufficient, and an improvement is required.

The goal is to come up with an alternative to the existing controls of an MR head-mounted display, providing new ways to interact with MR. The idea is to develop an Android application prototype that would mimic the current controls and extend them with additional functionalities.

The decision to work in the area of human interactions with MR was made due to the fact that the user experience of MR devices is rather limited by the current general controls, and that the team has relevant experience and knowledge in the subject field.

5 Project Execution

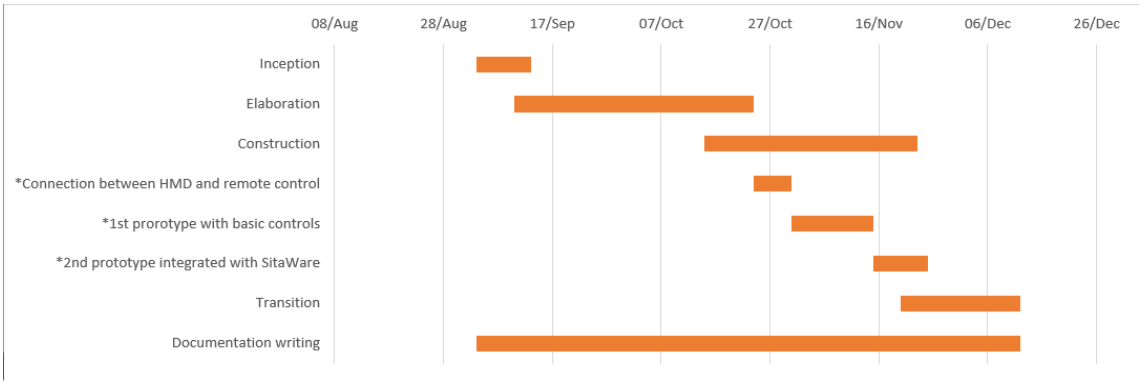
We have decided to apply agile development in our work process with some small changes:

- Since the team only consisted of 3 members and we have worked in the same room, at the same table, daily stand ups would occur only if necessary (e.g. a team member had made big progress)
- We have decided to skip sprint retrospectives for the same reason

The role of Scrum Master was given to Bogdan, while Bence was the Product Owner. At the same time the scrum team was composed by all 3 of us.

After taking the available time into consideration, the team has decided to assign 4 hours per story point. Using this information, the team proceeded to make estimations for the individual backlog items.

Another planning tool we used for project scheduling was Unified Process, where we have agreed upon the allocated time intervals for the different project phases (Inception, Elaboration, Construction, Transition). By doing that, we have came up with the following Gantt Chart that helped us keeping track of deadlines.



The execution of the project kicked off on the 3rd of September 2018 with a meeting with the supervisor, in which some questions were raised regarding the project description, all of which were resolved until the following meeting.

Interview

An interview with the stakeholder and a domain expert was scheduled in order to come up with the final project requirements. The interview took place at Systematic's headquarters in Aarhus, together with the Innovation Manager of the Defence Department, one of the Project Managers (who qualified as a domain expert as he had military experiences) and the System Engineer that helped developing the current SitaWare HMD implementation. During the interview, the team received a lot of useful information from the stakeholder and the domain expert, due to their previous experience in the army. This was the closest we could have been to get some feedback from an end-user. The meeting proved to be a success, since we left with a lot of knowledge on what the stakeholder expected from the outcome of the project. The next phase was ready to begin: putting all the notes and knowledge gathered into the requirements that will guide us throughout the project.

The following section will go into detail with the overview of SCRUM sprints.

Sprint 1

Task	Work estimation	Work done	Achieved?
Establishing the connection between the HMD and the AA	8	8	Done
Documentation Writing	36	36	Done
Total	44	44	

During the first sprint, the main focus was on documentation writing and one of the top priority tasks which would become the backbone of the project: the connection between the HMD and the AA

Sprint 2

Task	Work estimation	Work done	Achieved?
Implement gesture recognition	12	12	Done
Documentation Writing	6	6	Done
Implement map panning	8	8	Done
Implement zoom controls	16	11	Under implementation
Implement map rotation	8	8	Done
Total	50	45	

During this sprint we continued with the some of the 2nd priority tasks. Even if not all of them got done, we were still on track since the quota for the week regarding number of working hours was achieved.

Sprint 3

Task	Work estimation	Work done	Achieved?
Documentation Writing	11	11	Done
Implement Settings Activity	6	6	Done
Implement zoom controls	7	7	Done
Total	24	24	

The task that was not achieved last week was completed this week. Unfortunately, due to unforeseen circumstances, the work time for this sprint was lower than expected, which put us behind.

Sprint 4

Task	Work estimation	Work done	Achieved?
Documentation Writing	6	6	Done
Implement architecture	10	20	Done
Implement Map scaling	12	8	Done
Implement keyboard Input	12	12	Done
Total	40	46	

During this sprint, we continued implementing features while at the same time writing parts of the documentation.

Sprint 5

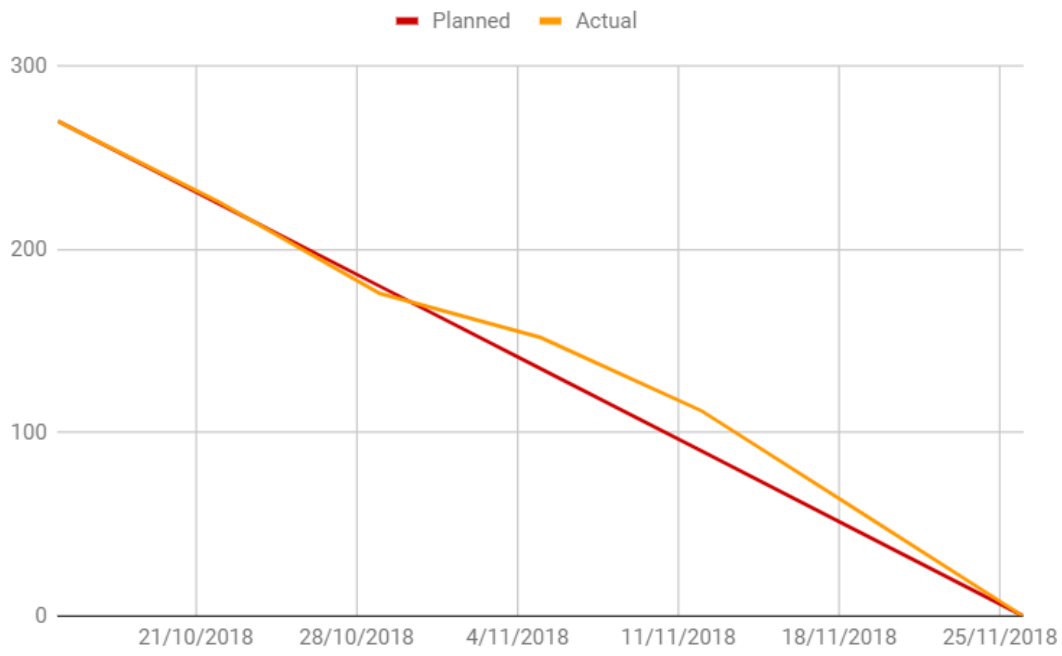
Task	Work estimation	Work done	Achieved?
Documentation Writing	6	16	Done
Implement gaze selection	12	8	Under implementation
Implementation on the actual system	32	11	Done
Implement Settings Activity	6	6	Done
	56	41	

3 of the 4 tasks proposed for this sprint were completed, the last one being still being under implementation at the end of the sprint. During this sprint, we also achieved to implement almost all features on the actual Systematic implementation. We managed to achieve this in less than half of the original estimated time.

Sprint 6

Task	Work estimation	Work done	Achieved?
Implement gaze selection	4	4	Done
Implement responsiveness	20	16	Done
Implement automated tests	12	12	Done
Save last state of the app	12	12	Done
Prevent standby mode	8	1	Done
Total	56	45	

During the last sprint we managed to complete the very last tasks from the backlog.



In the end, the final burndown chart can be observed underneath.

6 Personal Reflections

Bence Sólyom

We have worked very efficiently and in a well-organized manner during the project. The work on the project was going almost fully according to plan. The cohesion between the team members was great, no fights or disputes, pleasant atmosphere and very good overall teamwork.

Our team has also managed to overcome most of the challenges that came up during the different phases of the project. The quality of the final product met all expectations, we have managed to put together a highly functional application with great practical significance. Despite the fact, that this has been the biggest project so far with lots of tasks to do we have managed to finish everything in due time without any major setbacks.

All in all, this has been an incredibly productive project, which gave me even more experiences about project group work.

Bogdan-Laurentiu Ene

Looking back at the project, I personally feel we have achieved a lot. From analysing the problem and requirements, designing a solution for those, implementing the idea and to testing the final product, the team felt like a well-oiled machine. The team chemistry only improved during the development of the project.

Even though at first our solution felt like something next to impossible to achieve, like something out of a Sci-Fi movie, we managed to deliver a product that we are proud of. The solution might look simple from a development point of view, but it gets the work done. It fixed the troublesome controls the user previously encountered, and it delivered a really good experience together with Systematic's AR implementation of SitaWare.

The knowledge gained during this project will definitely prove useful in the future, especially since we worked with a technology that we never used before (bluetooth low energy).
Overall, I feel the team achieved a lot and everything went according to plan. Yet, there is always space for improvements.

Mario Burgov

Turning back the clock, the project seemed hard on paper and it felt tough to pull through. But as time went by, it started to feel much easier and smoother since the teamwork and team environment was really great. There were no fights, next to no disputes and if there were any, we handled them in a great manner and solved them as quickly as possible.

In the end, the product that was made fulfilled all of the needed requirements and the needs of Systematic as it alleviated the pain from trying to use the built in HoloLens controls.

This project was the biggest and hardest one so far since it was rather innovative and unconventional and I for one can say that I have gained a lot of knowledge out of it and that will definitely be of great use in my future.

To sum up, the work done in our group was very pleasant and the end result was satisfying which makes up for a nice project period overall.

7 Supervision

The supervision during the project was all that we could have asked for. By having both our project and process reports in google docs and sharing them with our supervisor, Kasper made all of our lives easier, making it possible for him to keep an eye on our documentation and allowing him to give precise feedback fairly quickly.

Kasper always helped us by sending links with useful information about the problems that we currently had and keeping us on the right track at all times, letting us know when there was a problem with any part of the documentation.

The weekly meetings we had helped us understand the mistakes we've made previously. Having a 30-minute talk every Monday always proved to be more efficient than a 4-hour chain e-mail.

Overall, the whole supervision process was of great help to our group and really aided us in the moments where we did not know how to proceed.

8 Conclusions

In conclusion, looking back at the project from the perspective of the actual process of it, we can strongly affirm that having SCRUM and UP as planning tools helped us staying on the right track. The team working experience gained from the semester projects from the previous semesters also helped us working in a highly efficient and cohesive manner.

The team had managed to design and deliver a final product on time, that met the stakeholder's requirements. The prototype of the system was highly functional and turned out to be a great improvement over the currently existing controls for Microsoft HoloLens.

Throughout the project each of us in the team had gained quite a lot of valuable experiences regarding teamwork in general, brainstorming, handling of challenges, documentation of our work and management of the whole process in a well-organized way.

All in all, the positive results of the project, the more than adequate supervision conducted by our supervisor and the pleasant atmosphere of the work environment provided by the team made this final push before the graduation a really enjoyable experience.

9 Appendices

- Appendix A – Gantt chart
- Appendix B – SCRUM