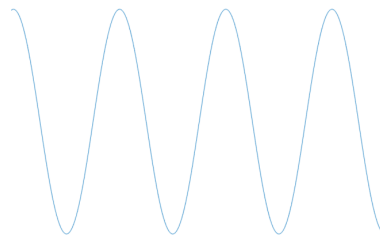# After Study

Robin Mannberg, Martin Andersson, Emma Beskow, Ella Grundin,
Joel Nilsson, Gabriel Suihko and Jianxin Qu
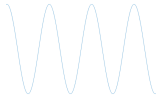
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Version 1.0

Status

Reviewed	The project group	2021-12-16
Approved		

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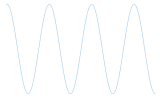   Phone: +46 (0)13-28 19 11
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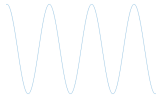   Phone: +46 (0)13-28 13 35
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CONTENTS

DOCUMENT HISTORY

Version	Date	Changes made	Sign	Reviewer
1.0	2021-12-16	First version.	Project group	Project group
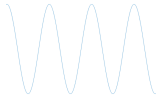
1   EXPENDITURE OF TIME

For the project in the course TSKS23 all group members are expected to put in 240 hours. For a group with seven students, it will be a total of 1680 hours. To structure up the work in the project a time plan was created, in which activities were defined and assigned a time budget. In this section it will be discussed how time was spent in the project and how the time plan worked.

1.1   Division of Labor

During the planning of the project the whole group was working together to decide what the product should be and how it should work. During the project we have worked in smaller groups on the different parts of the project. Some have worked more with the data processing and machine learning models, some more with the hardware and communication part, one of us worked mostly with the GUI and one with the website. Although some people have worked more on specific parts we have also helped each other when needed or when it was hard to find other things to do.

If the time plan has been correctly filled in, the workload has been a bit uneven between the project group members and throughout the study period. However, there can also be some differences in how different group members did the reporting and those who were lagging behind a bit have caught up at the end of the project.

1.2   Expenditure of Time Compared to the Time Plan

The project group have used roughly all the hours planned for the project, in total 1641 hours to this date. The time plan was not followed very closely as it was hard to know on beforehand how long time each part would require. Some parts took longer time than planned and some took less.

One thing that took less time than planned was to implement the machine learning models. To use models from the sklearn package was quite straightforward and it was easy to extend the system to include more models. On the other hand, implementing the BPSK functionality and writing the documents took longer time than planned. Less time than planned was used for collecting data, perhaps we would have got more interesting results if even more time had been spent on it, but other parts of the project that was more urgent was prioritised. Also, we could not collect a lot of data before we knew what data we wanted and how to collect it.

It was decided to implement functionality to continuously classify samples even if this was not highly prioritised in the requirement specification. But since everyone could not work on the same part we had to spread out and work on different things.

2   ANALYSIS OF WORK EFFORTS AND PROBLEMS

2.1   What Happened During the Different Phases?

Before Phase

During the before phase, a number of documents were produced. These were: Requirement Specification, Design Specification, and the Project Plan.
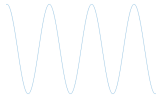
Initially, the documents were supposed to follow the LIPS-model's design, but after the first hand-in, the structure was changed. There were some confusion on how the documents would be written, but after several hand-ins and reading the feedback, it was established how each document should be written.

When it came to writing the Design Specification, this document was merged together with the System Design Sketch, and the first version was more similar to the latter. Here, the group underestimated how much should have been included in the Design Specification, but after receiving the feedback, a special meeting was called and responsibilities for each section was divided out between each group member.

Reading research articles was also done in the before phase, and this material was then used to reference the statements in the Design Specification.

During Phase

The work done in the during phase mainly consisted of implementation of the system. We had some trouble with the hardware which we solved, but if it had been solved earlier we might have had time to do more interesting analysis of the data.

Each week we had a meeting to plan up the work for the upcoming week. It was good to make sure that everyone had something to work on and that everyone were updated on how the project proceeded. At some occasions it was hard to find something for everyone to work with but we tried to solve it by working more together, which also made working more fun!

We also frequently had meetings with our supervisors whenever we needed technical guidance or wanted to give a status report.

After Phase

During the after phase, the group worked with the final documents. We performed very well at the final presentation and have worked with the Technical Report and User Manual already the week before the presentation, and at this point most parts of the project is finished.

2.2 Collaboration in the Group (responsibilities, decisions, communication etc.)

The group divided up responsibility areas early on and initially stuck with those. As the project went on, these responsibilities was not followed and it changed into being responsible for a certain activity or part of the project instead. Some who were responsible for one area worked more on an other and vice versa. The initial idea for each project member to have a main role and a secondary role was good, but in the execution of the project, it was not followed to the letter. This was not completely bad, it gave the members opportunity to work with different areas and for some roles (Test manager, Document Manager, and Project Manager) kept their responsibilities since these was clearly defined.

In between the weekly meetings, the main form of communications and information sharing within the group has been through Microsoft Teams. Also a group e-mail (tsks23group1@gmail.com) was created and used to CC all relevant emails to and from the supervisors. The e-mail was then forwarded to each group member. The project group decided to have a standing weekly meeting every Monday at 8:15-10:00 throughout the course of the project. When it was close to deadlines or if it was deemed necessary, extra meeting was scheduled. Also there was some smaller meetings scheduled with the supervisors when their input was needed. Overall, this structured worked very well. The Planning
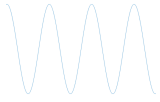
of the project was done early one and a time plan was created, however, the initial time plan was sound but a bit over-optimistic on certain activities. After handing in the first three documents (Requirement Specification, Project Plan, and Design Specification), the group was more experienced with dividing up the report in-between each other and who writes what. This really helped when writing the Technical Report.

When it came to design choices, whenever an issue or a suggestion arose, this was generally suggestion by those who had worked on it and presented to the whole group for discussion on what the suggested action would be. This was to include everyone into the decision making, but also so that if any group member would be asked the question why a decision was made, they would be able to answer it.

2.3 The Project Model Lips – Use, Comments

The project was supposed to follow the LIPS model, and initially it was. After discussing with the supervisors, the idea was formed that the project would follow a different structure and disregard the LIPS model. In hindsight, this was a mistake. The LIPS model had certain tollgates and checkpoints as a project continues throughout its different phases, but in this project, there was a clear lack of predefined tollgates and it caused some stress and uncertainty to the project members with the lack of feedback and opportunity to show how far the project has gone or if the project as in phase with the expectations. A mid-point or three-quarters tollgate would have been good to have, this would enable each group to both show what they have done, but also gain valuable feedback from the customer/examiner.

That being said, the project did follow the LIPS model to a certain degree. There was weekly meetings with the project group, time reporting was done according to the LIPS model, and the initial phase was also following the LIPS model. The group took its own initiative to contact the supervisors to "feel the waters" so to speak, and check if they thought we were either behind or in phase.

When it came to the document structure in LIPS, the project did an alternative version of these and picked out the most important parts, and merged the other to form a more interesting and appealing structure to the reader. Only the Project Plan document did follow the LIPS model and included most parts.

All in all, not having to follow the LIPS model to the letter was very much appreciated and the suggested way to write each document was initially a little uncertain, but in the end it produced a more appealing report. The main criticism to be taken from this, is the lack of set tollgates. Our suggestion would be to implement a mid-point tollgate in November.

2.4 Collaboration with the Customer/Examiner

We feel that the collaboration with the customer/examiner has worked well from time to time, but also we feel that the other group got information from the examiner, and we heard about this from them. For example about when the Pluto devices were delivered to the room, we weren't aware of this and heard about this about a week after when the group mentioned that they had already started with working on them.

At other times, the response was very fast and if we needed something, we got the resource or help within a reasonable time. One thing that would be have been helpful, was when we handed in the documents to receive a reply stating if the document was approved or not. In the case of the Requirement Specification we got some feedback, but with the Project Plan and Design Specification we sent an email a few weeks after to ask if it was approved.
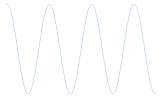
2.5   Collaboration with the Supervisor

The collaboration with the supervisors have been very good. They have been available at almost any time for a meeting, or for us to drop by at their office. They have been helpful in discussions on technical problems.

2.6   Technical Problems and Successes

2.6.1   *Sending and receiving signals with the Pluto devices using Python*

The project group strove to write all code in Python, and was successful in a sense. The script in MATLAB that was provided to the group required some time to understand and was not translated to Python until the late stage of the project. One of the reasons for this was that the Python interface to The Pluto devices was different from the MATLAB interface (e.g., the use of multiprocessing in Python to send and receive on different devices, and that the received signal was complex integer).

There was an additional problem in Python that corrupted the received signal so that the sent BPSK symbols could not be recovered, and cause of the problem has not been isolated to any of the components (parts of code or hardware). The fact that the script was translated can still be considered a success. If more resources had been put into figuring out this problem earlier, perhaps it would have been possible to send and receive OFDM signals for data collection.
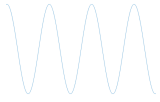
2.6.2   *Feature extraction pipeline*

The feature extraction pipeline that was implemented was a great success considering its functionality and flexibility. It is possible to customize the pipeline, add more features, and use the generated meta files to understand each data set given that one is familiar with how the system works. We spent a lot of time on the pipeline in the initial phase of the software subsystem development, and it was worth it since it was the basis for the machine learning models.

2.6.3   *Collecting and storing the data*

To train the models and investigate suitable hardware parameters, data was collected with the Pluto devices. This was challenging from several perspectives. Collecting data was a time consuming task, and the group had to make sure that variables such as device positions, parameters and activities were well defined in order for the data to be usable. It was observed that in the collected data there was an offset in the amplitude that could not be isolated to the environment or to the hardware devices, which increased the difficulty of the analysis. Storing the data in a convenient way was also a problem. The other group used a database which seemed at a glance like a good idea. Our solution to have it on git or Teams was a bit clunky.

3   FULFILLMENT OF THE GOAL

Here we discuss the fulfilment of the requirement specification. Other than that we describe the relationship between the study situation and our project in the corona pandemic period.

3.1   Summary of Achievements

All the base requirements are fulfilled in this project, additionally we had fulfilled some of the lower priority but not all of them because of lack of time and some technical problems when it is comes to the hardware part. We can detect a dynamic or static environments with hundred percent accuracy. A GUI interface can be used to control the system that we build and also anyone can see what we did in this project throw an website that present our work in a professional way.

3.2   How the Delivery Worked Out

Most of the documentation are finished and delivered but not at the time of this writing. We also delivered a final presentation. However our group and the other group got different information about how long the presentation should be. Our group heard "at least 30 minutes, maybe an hour" while the other got 30 minutes as instructions, it would be good to give the same information to both groups.

3.3   How the Study Situation Influenced the Project

The pandemic affect the project a bit because sudden sickness in the group means we need to use the online alternative to connect with the sick person which can make the understanding for that person harder than usual.

Some of the group members have different level of knowledge when it comes to signal theory and machine learning models. The pre-study period we had to do some reading about the relevant topics helped us to organize the project structure, the theoretical background of each part of the project work, and also provide us a bigger picture of how to start with the project.
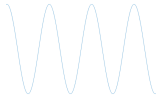
Everyone have had different schedules and been taking different amount of credits during the different parts of the semester. This made planning meetings that everyone can attend hard sometimes, and also some people might have had it more stressful than others in periods.

4   SUMMARY

Looking back it feels quite nice to see what we have achieved. We have together overcome many challenges and at the end our product can do what it was supposed to - detect static and dynamic environments.

4.1   The Three Most Important Experiences

1. It is always a developing experience to work in a team to a common goal. This course has been an opportunity to do so. This include experience in project planning and continuous detail planning of what is needed to be done.

2. During the project a lot of documents have been written. Thanks to that and our supervisors we have developed our academic writing and learnt a bunch of pitfalls not to repeat.

3. Finally the project gave us practical experience of the importance of data in machine learning. We faced the

difficulty of developing a system for collection of data in parallel with a system that should use the data. Evaluating the quality of data has been a challenge as there are many possible sources of impact to the result.

4.2 Good Advice to Those Undertaking a Similar Project

- Carefully think about the requirements. Make sure that they are easy to test and that fulfilling them adds value to the final product.

- Make sure to use the competence from the supervisors, do not hesitate to ask them for help and advice!

- Make sure that everyone knows what they are expected to perform, and make use of the collected competence within the group.

- Think trough how communication between subsystems is done in the best way. How the interface should work will affect both subsystems and thus probably at least two persons.

- Use Git and make sure that all project members are (or are made) familiar with it. Also, make sure to work with branches in a good way.

- Using Teams for digital meetings, written communication, meeting protocols and informal documents can be a good choice. It has been convenient to collect everything at the same place.

- Make use of the weekly meetings to update everyone in the group on whats going on in the project.

- Utilize the resources given, working together in the project room makes it easier for the project members to collaborate.

- Throughout the project, a large amount of data will be stored, think through early and carefully how to store it.