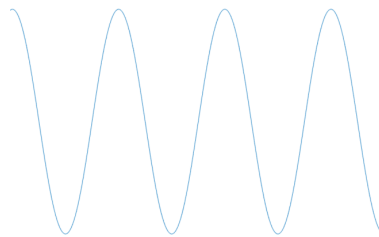


Project Plan

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

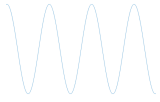
October 14, 2021

Version 1.1



Status

Reviewed	The project group	2021-10-14
Approved	Danyo Danev	2021-10-14



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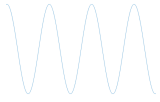
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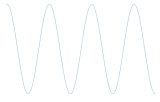
Participants of the group

Name	Role	E-mail
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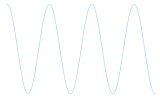
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DOCUMENT HISTORY

Version	Date	Changes made	Sign	Reviewer
1.1	2021-10-14	Updated delivery date for design specification	The project group	RM
1.0	2021-10-10	Sent to customer	The project group	RM
0.3	2021-09-30	Fixed typos and smaller changes.	The project group	Supervisor
0.2	2021-09-29	Fixed typos and reshuffle of content.	The project group	Supervisor
0.1	2021-09-24	First draft.	The project group	Supervisor



1 PROJECT OVERVIEW

The use of channel state information (CSI) to detect human interaction and motion is an interesting concept. We want to explore the possibility to detect different types of motion in an otherwise static environment. By collecting training data in a controlled environment, machine learning (ML) can be used to train an algorithm that can classify different events that take place in the monitored area. This could be, for example, detecting a burglar breaking in or a person falling down.

The goal of the project is to develop a detector that can detect dynamic activities in an indoor environment. For this purpose, the project has been provided with two ADALM Pluto Software-Defined Radio (Pluto SDR) devices [1]. The two devices are shown in Figure 1. The detector functionality is as follows: the detector will first estimate the channel and evaluate the quality of the channel estimate. If the quality of the estimate is not good, it will make another channel estimate and reevaluate. Then it will pass on that information to an algorithm which will do a classification based on the collected information and present the result through a user interface. The algorithm uses ML and is trained in a controlled lab environment, which will be referred to as the training environment. The aim of this document, the Project Plan, is to clarify how the project will be carried out and thereby lay a solid foundation on which the project is built on.

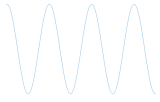


Figure 1: The figure shows the hardware used for the project, two Pluto SDR devices.

1.1 Deliverables

Besides the final product, a number of documents will be produced. Those documents are stated in the Requirement Specification [2]. All the documents will be sent to the customer by e-mail and the date for the delivery is listed next to each deliverable in the list below, presented in chronological order.

- **Requirement Specification:** to be delivered on September 24, 2021;
- **Project Plan:** to be delivered on October 1, 2021;



- **Design Specification:** to be delivered on October 8, 2021;
- **Test Plan:** to be delivered on November 5, 2021;
- **Technical Report:** to be delivered on December 10, 2021;
- **User Manual:** to be delivered on December 10, 2021;
- **Final Product:** to be delivered on December 10, 2021;
- **Website:** to be delivered on December 17, 2021;
- **Poster:** to be delivered on December 17, 2021.

1.2 Limitations

The project and the detector has the following limitations:

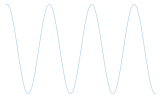
- The project is limited to the hardware provided and will not evaluate performance using other types of hardware;
- The programming languages used for the project are limited to Python and MATLAB. Other programming languages will not be considered;
- The detector is limited to detecting the dynamic events it is trained on.

2 PLAN FOR THE PROJECT PHASES

The project will be partially conducted according to the LIPS project model [3]. The LIPS model divides the project into three different phases: before, during and after. The before phase is dedicated to planning, the during phase is for development, implementation and testing. Finally, the after phase is for evaluation and presentation of the final product.

2.1 Before Phase

The formation of the project group marks the beginning of the project and thereby also the beginning of the before phase. Roles within the group are established and a topic for the project is selected. Then the project group writes a Requirement Specification to specify what the final product should be and which functionality it should have. The document also specifies performance requirements for the system and compulsory documentation to be done during the project. To plan and structure the project work, the project group writes a Project Plan and a Time Plan. The Time Plan includes the work needed for the project, broken down into smaller activities and when to work on these.



Each activity is assigned a certain amount of hours, in addition to a person in charge of that activity. Finally, a Design Specification is developed, here the project group present how the product will be designed, together with previous work done in the same field. The before phase ends when the Project Plan, Design Specification and the Time Plan are accepted by the customer.

2.2 During Phase

In the during phase, the product and its functionality are developed. This is done by following the Time Plan and its activities, as well as following the Design Specification. Tests will be defined in a Test Plan to ensure that the product meets the requirements defined in the Requirement Specification. Meetings will be held every week to manage resources and ensure that the project is on the right track.

When all requirements with priority 1 in the Requirement Specification are fulfilled, the during phase can be considered completed. However, if the project group finishes the priority 1 requirements ahead of the Time Plan, the remaining time should be used to work with requirements of priority 2 and optionally priority 3.

2.3 After Phase

In the after phase, the finished product is delivered to the customer together with the User Manual and Technical Report for it. The product should be presented on a website, a poster and at an oral presentation for the customer. The Technical Report is written to describe the technical details of the product and to enable continued development. The User Manual is an easy-to-understand document that will tell the user how to use the product. In order to evaluate the work within the project, an Afterstudy will be written by all the group members. When the aforementioned presentations and documents in this phase have been finished, the project is considered completed.

3 ORGANISATION PLAN

A model over the projects organisation can be found in Figure 2. The project group is seen as an entity where the internal communication happens as the projects goes on. The Project Manager is responsible for the communication between the project group and the customer. The project is also assigned two supervisors. The project group will communicate with the supervisors continuously throughout the project when the need arises.

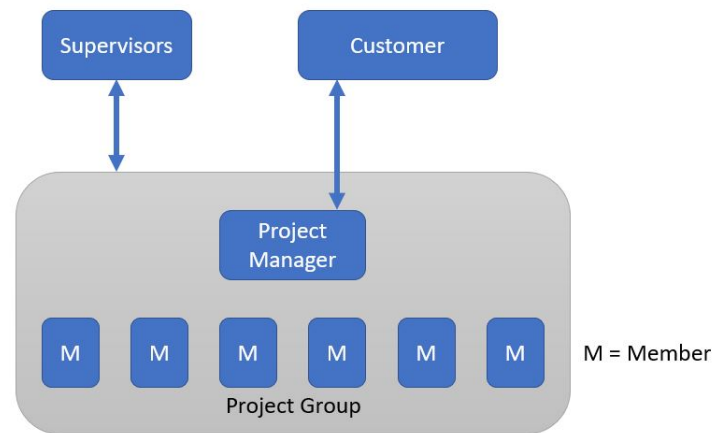
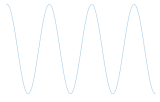


Figure 2: The project organisation and channels of communication.

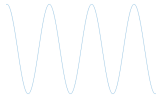
3.1 Letter of Agreement

To help set the guidelines for how the project group should work and how to interact with each other, a Letter of Agreement has been written and agreed upon by the whole project group. It can be found in Appendix B.

3.2 Definition of Responsibilities

To organise the project work, each and every project member is assigned a specific role that is responsible for a certain part of the project. The roles and who is assigned to what is shown in the list below:

- **Project Manager: Robin Mannberg**
The Project Manager is the link between the customer and the project group and is the person responsible for that the work is done according to the Project Plan.
- **Test Manager: Martin Andersson**
The Test Manager is the person that plans the product testing and ensures that the plan is followed.
- **Document Manager: Emma Beskow**
The Document Manager is the person responsible to bring out useful templates for all documents and that documents and code are version managed properly.
- **Hardware Manager: Ella Grundin**
The Hardware Manager is the person responsible for that the product's hardware meets the requirements set in the Requirement Specification.



- **Chief of Design: Joel Nilsson**
The Chief of Design is the overall expert on the product.
- **Graphics Manager: Gabriel Suihko**
The Graphic Manager is the person responsible for the Graphical User Interface (GUI) and the poster presentation.
- **Software Manager: Jianxin Qu**
The Software Manager is the person responsible for the software and algorithms.

4 DOCUMENT PLAN

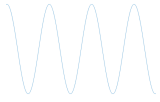
Within the project there are several documents that will be produced. The documents should be based on the LIPS project model [3] and follow the IEEE reference system [4]. All documents are listed in Table 1.

Table 1: A compilation of the documents to be produced during the project.

Document	Purpose	Target Group	Format
Project Plan	Describe the project and its different phases.	Customer	PDF
Requirement Specification	Specify what will be included in the finished product.	Customer	PDF
Design Specification	Give an detailed description of the product and its design.	Customer	PDF
Test Plan	Specify the tests that will be carried out to make sure that the requirements are fulfilled.	Customer	PDF
Meeting Protocols	Show when and which decisions that has been made during the project.	Project group	PDF
Technical Report	Thoroughly explain how the product works and how to operate it.	Customer	PDF
User Manual	In a straight-forward way explain how to use the product.	Customer	PDF
Afterstudy	Compile the whole group's experiences from the project.	Customer	PDF

5 DEVELOPMENT METHOD

For the development to be conducted smoothly there are a few points that should be taken into account, these things are brought up in the list below.



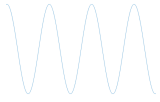
- **Follow the Plan**
The status of the project will be talked through on each weekly meeting, and a plan for the coming week will be created. The project members are supposed to follow this plan and finish the tasks assigned to them.
- **Unofficial office hours**
An Excel-sheet will be used to find time slots where most or all of the group members are available for project work. The group will then decide upon unofficial office hours for the project work. These slots will begin with a stand-up meeting to see how everyone is doing on their assignments. If necessary, specific times for short stand-up meetings will be decided.
- **Ask for Help**
Everyone should try to accomplish their own responsibilities. If discovered that a task will be more time consuming or troublesome than expected it is important to ask for help as soon as possible. It is important so it does not cause to much of a delay for the whole project.
- **Code Comments**
To simplify continued development everyone should keep their code well commented at all times. This will also be of great value when other persons have to gain understating for other persons code.
- **Git**
Git will be used for all code in the project. Branches should be used so it is possible to work with different features in parallel. Only well tested and working code will be on the master branch. To ensure this, the master branch should always be merged into the development branches and not the opposite. Once ensured that the merged code is functioning, it can be merged back to master.

6 REPORT PLAN

A weekly report will be sent to the customer every Monday to keep the customer updated on how the project proceeds. This includes a copy of the Time Plan and a Status Report. The Time Plan shows how many hours each project member has worked on the project and with which activities. All members are responsible for adding their own time before Monday morning. If some activities turn out to be more or less time consuming than expected, the Time Plan will be revised. The Status Report is a compilation of ongoing, finished, and pending activities in the project. If there are any problems or opportunities regarding the project, these are also described in the report.

7 MEETING PLAN

The project group plan to have at least one project meeting each week to go though the status of the project. The meetings will lay the foundation to the weekly report as we go through completed, ongoing and upcoming activities. Any problems, both of a technical, social or planning nature, are also raised at these meetings. If additional meetings are required the group will decide the time for these during a meeting or through Microsoft Teams.



8 RESOURCE PLAN

The project has a number of resources of different nature available, these are:

- **Personnel:** The project group consists of seven individuals. Each member has other courses in parallel to the project, so none of them can be expected to be available at all times or on short notice.
- **Material:** The project group has access to two Pluto-SDR [1] devices and multiple antennas.
- **Supervision:** The project group has a supervisor and an expert consultant available.
- **Premises:** The project group has access to room 3D:502 at Linköping University including the stationary computers located in the room.

9 TOLLGATES

The project is partially following the LIPS model and in this model, a number of tollgates is defined. The ones applicable to our project is listed in Table 2.

Table 2: The tollgates that should be passed during the project.

Number	Description	Date
0	Project group formed and topic selected.	2021-09-06
1	Approval of the Requirement Specification.	2021-10-01
2	Approval of the Project Plan.	2021-10-01
3	Approval of the Design Specification.	2021-10-15
3b	Approval of the Test Plan.	2021-11-05
5	Approval of the functionality of the product, decision to deliver.	2021-12-10
6	Approval of the delivery, decision to dissolve the project group.	2021-12-17

10 ACTIVITIES

The required tasks in the project have been broken down into smaller activities. This was done to help ease with the project's work flow. The activities are shown in the Table 3. The table contains information about the activity, the expected time required to work with it and possible dependencies to other activities. An activity with one or several dependencies can not be started or sometimes completed, without first completing aforementioned dependencies.

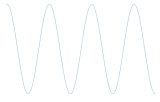
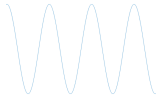


Table 3: Activities for the project, including expected time requirement and dependencies

No	Activity	Description	Dependencies	Time
1	Weekly Meetings	Internal meeting with the project group.	-	196
2	Requirement Specification	Write the Requirement Specification.	-	45
3	Time Plan	Write the Time Plan.	2	15
4	Project Plan	Write the Project Plan.	2	22
5	Design Specification	Write the Design Specification.	2	48
6	Research and read articles	Find and read articles relevant to the project.	-	140
7	Status Reports	Write weekly Status Reports and send to the customer.	-	8
8	Hardware Setup	Setting up the hardware and the required module-packages.	-	45
9	Hardware Communications	Write the functions for the hardware communication and setting the hardware parameters.	8	80
10	Channel Estimate	Write the channel estimation function.	8,9	60
11	BPSK Evaluation	Write the BPSK evaluation function.	8,9,10	40
12	Save the Raw Data	Write a save-function for the collected data.	-	20
13	Data Processing	Implementation of the data preprocessing and feature extraction.	12	80
14	K-means clustering	Implementation of the k-means clustering algorithm.	13	28
15	Support Vector Machine	Implementation of the Support Vector Machine algorithm.	13	28
16	Hidden Markov-model	Implementation of the Hidden Markov-model algorithm.	13	28
17	Decision tree	Implementation of an additional ML-algorithm.	13	42
18	Processed Save function	Implement a save function for the processed data, the trained models and the classifications.	14,15,16,17,24	30
19	Evaluation function	Create the evaluation function that compares the resulting classifications from each model.	12	40
20	Plots and graphs	Create a visualisation function to show the plots and graphs.	18,19	40
21	Test Plan	Write the Test Plan.	-	14
22	Data collection	Collect and create data for training and testing.	8,9,10,11,12	120
23	Testing	Perform the system testing specified in the Test Plan.	22	40
24	GUI - Interface	Write the code for the GUI-skeleton.	-	30

cont. on next page



<i>cont. from previous page</i>				
No	Activity	Description	Dependencies	Time
25	GUI - Functionality	Write the functions for the GUI to enable communication with the other subsystems.	18,24	60
26	Create Website	Create the skeleton for the projects website.	-	40
27	Website material	Create the material for the website.	26	20
28	Poster	Create the project poster for the presentation.	-	10
29	Presentation	Prepare for and create the presentation.	-	49
30	User Manual	Write the User Manual.	1-27	28
31	Technical Report	Write the Technical Report.	1-27	60
32	Afterstudy	Write the Afterstudy.	1-31	21
33	Buffer	Buffertime for when activities takes longer time than expected.	-	153

11 TIME PLAN

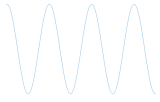
The project group has created a Time Plan where the activities to be done in the project are listed. The Time Plan also states when they should be executed and who is responsible for them. This Time Plan is our base plan but the document is a dynamic document and will be updated during the project if needed. The Time Plan is attached in appendix [A](#).

12 QUALITY PLAN

A quality plan is developed to ensure that the final product has a high standard. This includes having a good relation with the customer to show the status of the project and to have a continuous communication with the supervisors and heeding their advice.

12.1 Review Plan

To ensure that all the documents produced keeps the quality level, everyone in the project group must review each document. This is also done so that everyone is aware of each document's content. Regarding the code for the software, it is enough if two people review it.



12.2 Test Plan

To ensure that the final product meets the requirement set in the Requirement Specification, a Test Plan will be produced. The Test Plan contains information about how the final product will be tested to ensure high quality and performance. The Test Plan contains, but not limited to, different test cases for the classification algorithms. These test cases varies in size and smaller tests are done continuously throughout the project, and with a larger test at the end of the project. The Test Manager is responsible for the test plan and that it is followed.

13 RISK ANALYSIS

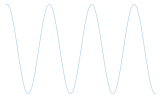
There are several unwanted situations that can occur during the project. One potential risk is hardware malfunction, to avoid this the hardware must be operated correctly and handled with great care. Another risk is unfair workload within the group. To minimize this risk, everyone will report all hours they have worked with the project in the Time Plan. That makes it is clear how many hours each project member has put in. In case of an uneven workload, it will be discussed at a project meeting and a plan for solving it should be created. If the problem continues and someone does not contribute enough to the project, it should be brought up to the customer so that a solution can be found in consultation with him. Lastly, there is also the risk of someone falling ill and therefore missing meetings and the opportunity to work with the project for some time. If this occurs, the other members should make sure to update the person who have been away so that it is easier to continue with the project when well again.

14 PRIORITIES

In case of delays regarding the deliveries, it is of high importance to maintain a good dialogue with the customer. It should be done by informing the customer as early as possible that there will be delays so that it is possible to renegotiate requirements if needed. In addition, it is important to keep an open dialogue within the group if any problems or delays arise so that the group as a whole have the opportunity to find a solution. In case of delays it is important to prioritise the activities that other activities are dependent on, so that other group members can continue their work.

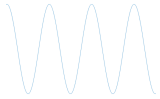
15 PROJECT CLOSING

The project is done when the final activities have been finished. Foremost the finished product together with the documentation for it will be handed to the customer. Around the same time the website and poster should be finished. Finally, the Afterstudy is written to reflect upon the project, once it is completed the project is formally done. Hopefully there will be no restrictions regarding restaurants at the time and if so the project group will have a more informal closing in the shape of a hangout somewhere to enjoy that the effort put in gained results.



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- [1] *ADALM-PLUTO for End Users*. Wilmington, MA, USA: Analog Devices, 2021, Accessed: Sep. 17, 2021. [Online]. Available: <https://wiki.analog.com/university/tools/pluto/users>
- [2] M. Andersson, E. Beskow, E. Grundin, R. Mannberg, J. Nilsson, G. Suihko, and J. Qu, “Detection of static and dynamic indoor environments: Requirement specification, 2021.”
- [3] T. Svensson and C. Krysanter, *Projektmodellen LIPS*, 1st ed. Stockholm, Sweden: Liber AB, 2011.
- [4] *IEEE Reference Guide*. Piscataway, NJ, USA: IEEE Periodicals, 2018, Accessed on: Sep. 17, 2021. [Online]. Available: <https://ieeauthorcenter.ieee.org/wp-content/uploads/IEEE-Reference-Guide.pdf>



B LETTER OF AGREEMENT

Author:

Group 1

Date:

Letter of Agreement

The purpose of this document is to set guidelines and outline the conditions of cooperation within the group for the duration of the project course.

- (1) Every group member is expected to attend the weekly meeting and every meeting with the orderer. If the group member cannot attend a meeting the group member will inform the project manager about their absence in advance.
- (2) The workload within the group will be distributed equally among the project members, so that each member's worked hours are roughly the same amount (240 hours).
- (3) Every project member is assigned a primary and a secondary role. Every project must be well prepared and informed to answers question regarding their primary responsibilities.
- (4) Each member respect the internal and external deadlines set by the project group and the orderer respectively.
- (5) It is important to give feedback, both positive and negative, but when doing so it is done in a constructive manner.
- (6) The ambition of each project member is to make the final product as good as possible.
- (7) On a normal week¹, no project member is expected to work or answer questions regarding the project outside the normal work schedule 8:00 - 17:00 (weekdays).
- (8) Every deliverable document must be approved by the document manager before submitting.
- (9) The project manager will upload the weekly meeting protocol at least a day in advance.
- (10)The project members agree to start the project with a kick-off and celebrate after handing in the final report.

Signed,

Signature	Name in plain text	Role
	Ella Grundin	Hardware Manager
	Jianxin Qu	Software Manager
	Martin Andersson	Test Manager
	Joel Nilsson	Chief of Design
	Emma Beskow	Document Manager
	Gabriel Suike	GUI
	Robin Mannberg	Project Manager

¹ Exceptions can be made around deadlines, tollgates and milestones.