

December 16, 2022

Requirement specification: Delivery version

TSKS23 Group 1: WaveCounter

December 16, 2022

Version 1.0

Status

Reviewed	PM	2022-12-08
Approved	Danyo Danev	

Requirement specification: Delivery version

1 SYSTEM REQUIREMENTS

This document aims to report to the customer on the project achievements regarding system requirements. This is a part of the delivery process to the customer, as specified in the project plan.

1.1 Requirement Definitions

The requirements will be described in the form of tables exemplified below. In the first column, the number of requirements can be found. In the second column, the version of the requirement can be found. The version of a requirement can either be of type "Base " or "Renegotiated". A brief description of the requirement is contained in the third column, and the priority of the requirement is in the fourth column. Requirements of priority 1 must be fulfilled, and requirements with priority 2 may be fulfilled. Requirements with priority 3 are only to be worked with if the economy of the project allows it after all other requirements have been fulfilled.

Requirement	Version	Description	Priority
1	Base	Description of requirement	1/2/3

1.2 Overall product requirements

Requirement	Version	Description	Priority
2	Base	System can detect in what direction an object passes through it with an accuracy of 75%, given the information that something passes through the door.	1
3	Base	System can detect if something passes through it with an accuracy of 75%	2
4	Base	System can detect with what speed an object passes through it with an error margin of +/- 1 m/s	3

Comment: Overall model results are shown by live tests and on gathered data. The group has not had the time to explore the possibility of speed estimation.

1.3 Hardware Subsystem (HS)

The hardware subsystem consists of the Pluto SDR devices and a host computer. This subsystem is responsible for data collection and data storage, so that data can be easily accessible for the software system.

Requirement	Version	Description	Priority
5	Base	System consists of a transmitter and more than one receiver, where the transmitter can send to the receivers	4
	Revised	System consists of a transmitter and one or more receivers, where the transmitter can send to the receiver(s)	1
6	Base	The transmitter can be controlled by the software subsystem	4
	Revised	The transmitter can be controlled by the UI	1
7	Base	The receivers can be read by the software subsystem	4
	Revised	The receivers can be read by the UI	1
8	Base	The physical placement of the transmitter and receivers can be changed dynamically	3

Comment: The revised prio 1 requirements are met. The approved revisions basically clarify the original meaning of the group. The 8th requirement should be met by the product, but note that the results should be less good. Did we think of testing this live during the presentation in Systemet?

1.4 Software Subsystem (WS)

The software subsystem consists of code for training the machine learning algorithms as well as code for the final classification algorithms the project is going to use. The data will be divided into training, validation, and test data. The accuracy of classification will be defined as the number of correct classifications divided by the total number of classifications.

Requirement	Version	Description	Priority
9	Base	Software subsystem has a running mode	1
	Revised	Hardware subsystem has a running mode	1
10	Base	Software subsystem has a calibration mode	4
	Revised	Hardware subsystem has a calibration mode	1
11	Base	Software subsystem can switch between its two modes	4
	Revised	Hardware subsystem can switch between its two modes	1
12	Base	Software subsystem can read data collected and stored by the hardware subsystem	1
13	Base	Software subsystem can control the hardware subsystem	4
	Revised	UI can control the hardware subsystem	1
14	Base	Software subsystem can use an ML-classification algorithm to classify the movement direction of an object passing between the sensor	1
15	Base	Software subsystem can use an ML-classification algorithm to classify if there is an object between the sensors	2
16	Base	Software subsystem can classify if an object has passed through it using no more than 3 seconds of data	3

Comment: All the prio 1 requirements are met. The approved revisions reflect a move from one subsystem to another. In requirement 15 (prio 2), we choose variance as the basis for "triggering" rather than an ML-model. This is to reduce the cost of calculations. Doing it as an ML-model would not have been a problem, though. In requirement 16 (prio 3), this is a matter of interpretation. It could be considered met, or not.

1.5 User Interface (UI)

The user interface is of use to simplify the handling of the system. This subsystem will be used to control both the hardware subsystem and the software subsystem by changing parameters used by the classification algorithms and by starting and stopping data collection. A user should also be able to calibrate the system using this interface. The UI is also a tool for the user to easily interpret the result to see in which direction the moving object passed through the door.

NOTE: There is a gap in the numbering of requirements (16-19). This is not a loss of requirements, only an Overleaf-faux pas made by the PM in revisions. For clarity, here we use the numbering from the approved revised version.

Requirement	Version	Description	Priority
21	Base	The user can select between calibration and running mode	4
	Remove	<i>Comment: This will be done automatically, not a relevant requirement.</i>	
22	Base	The user can select the model type to train in the UI	4
	Revised	The user can select the model type to train in the UI	2
23	Base	The user can select model file used for evaluation	1
24	Base	The user can select which gathered data to use when evaluating a model	1
25	Base	The user can gather and label data in the UI	1
26	Base	The user can train a model using automatic hyperparameter optimization	4
	Revised	The user can train a model using automatic hyperparameter optimization	3
27	Base	The UI displays relevant model metrics after training	4
	Revised	The UI displays relevant model metrics after training	2
28	Base	The UI displays relevant model metrics after evaluation	1
29	Base	The user can select hyperparameters and start model training in the UI	2
30	Base	The UI displays relevant model metrics during model training and evaluation	2
31	Base	The UI displays relevant metrics about a model on selection	2
	Revised	The UI displays relevant metrics about a model on selection	1
32	Base	The UI saves a log of predictions over time	2
33	Base	The user can select to run models on live-gathered data in the UI	2

Comment: All the prio 1 requirements are met, and most of the prio 2. The approved revisions reflect a switched focus toward a product that's easy to use. For instance, this meant removing the need to manually calibrate the equipment by doing it automatically on start. Also less focus on training and complicated parameters in the UI. The product should have good algorithms and ML models from the start. In requirement 30 (prio 2), the UI displays

relevant metrics for evaluation but not training, this is a natural consequence of not including training of new models in the UI.

2 LIVE TEST STATS

Live tests were performed in "Skrubben" for the different models. The requirement specification states that the model should detect the direction with an accuracy of 75 percent.

For passages where the system should trigger, the requirement specification states that the model should detect this with an accuracy of 75 percent. Note that improvements of the trigger has been made between tests and demonstration.

1DCNN - test 1	IN	OUT
IN	19	4
OUT	1	26
Result	90%	
Missed passages	6 (~ 11%)	

1DCNN - test 2	IN	OUT
IN	21	2
OUT	3	24
Result	90%	
Missed passages	6 (~ 11%)	

1DCNN_100	IN	OUT
IN	15	9
OUT	2	25
Result	78%	
Missed passages	2 (4%)	

2DCNN_50	IN	OUT
IN	23	1
OUT	13	13
Result	72%	
Missed passages	0 (n/a)	

Automated tests have also been made on data collected during the project. These show good results overall, in line with the evaluation metrics presented in the UI.