



HOCHSCHULE
RAVENSBURG-WEINGARTEN
UNIVERSITY
OF APPLIED SCIENCES

Course Applied Computer Science
School of Electrical engineering and Computer Science

Appendix

Experimental Results

submitted by:

Martin Samuel Lanz

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1. Reviewer: Prof. Dr. Markus Schneider
2. Reviewer: M.Sc. Daniel Hofer

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1 Experimental Results

This appendix contains experimental results for all models trained. The appendix is referred to in the main paper, in Section 5, which is describing the Experimental Results.

The number of bagfiles are increased exponentially, for most models, as $a_{n+1} = a_n * 2$, where a_n is set to 10 as a starting value. The environments provide different varieties and density of obstacles. Images of the environments are displayed in each subsection. The results contain each pipeline’s stage parameters, a graph displaying the validation versus the training loss, another graph that displays the Area Under the Curve results, and a summary for the current batch.

The parameters and graphs are extracted and created automatically from the pipeline. The summary contains manual tests, as described in Section 4.4.3 in the main paper. The pipeline runs are bundled in batches, where every batch has models trained in the same environment.

1.1 Batch 1

These are the test results for the first training batch. It consists of 8 different models, with the number of images increased from 600 to 19200. Fig. 1 displays the environment used for this batch.

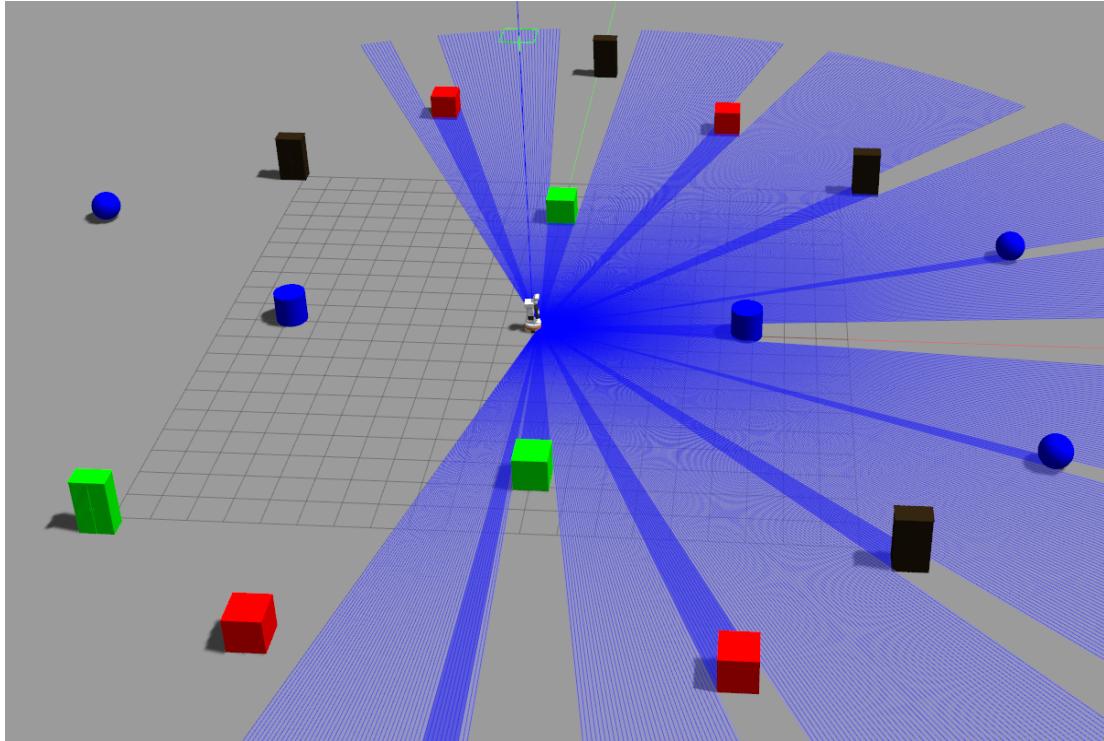


Fig. 1 Environment used for Batch 1.

The following subsections will list the parameters and graphs used for each model created by the pipeline. As defined in Section 4.4.3 in the main paper, the manual test results are summarized in Section 1.1.9.

1.1.1 Model 1

Data acquisition

- recorded bagfiles: 10
- recorded images: 600
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.5
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_1.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_1.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

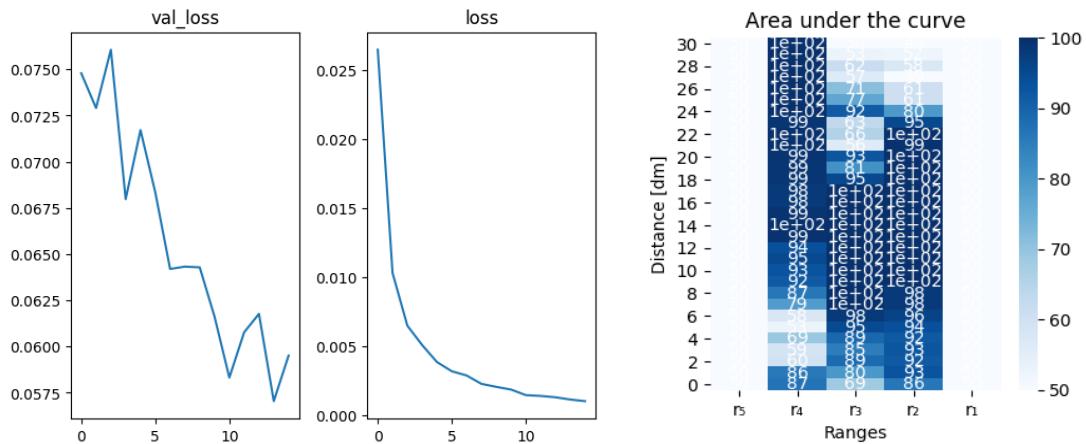


Fig. 2 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver operating characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.1.2 Model 2

Data acquisition

- recorded bagfiles: 20
- recorded images: 1200
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.5
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_2.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_2.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

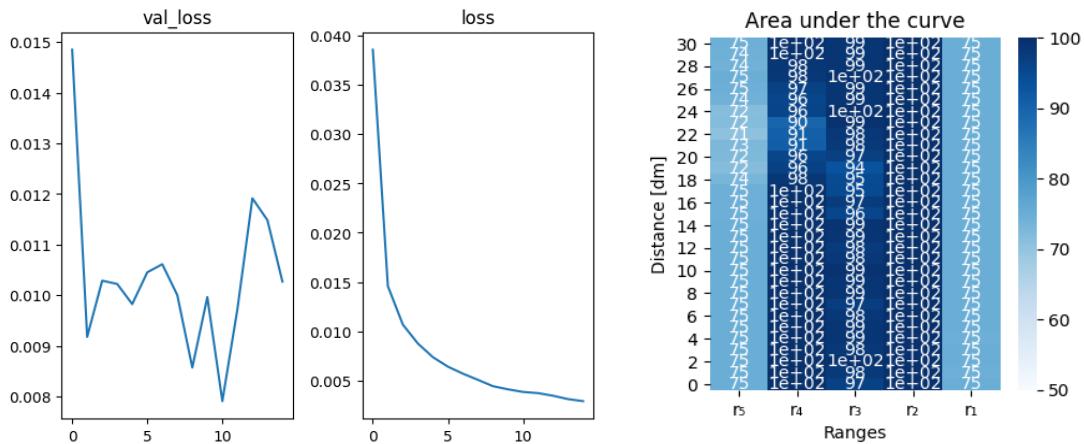


Fig. 3 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.1.3 Model 3

Data acquisition

- recorded bagfiles: 40
- recorded images: 2400
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.5
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_3.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_3.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

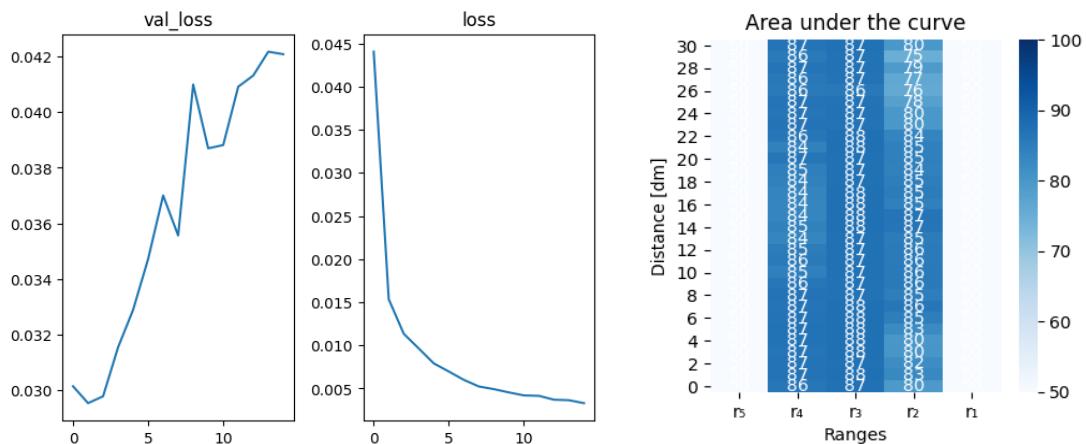


Fig. 4 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.1.4 Model 4

Data acquisition

- recorded bagfiles: 80
- recorded images: 4800
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.5
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_4.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_4.h5
- No. of epochs: 2
- Steps: 10
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

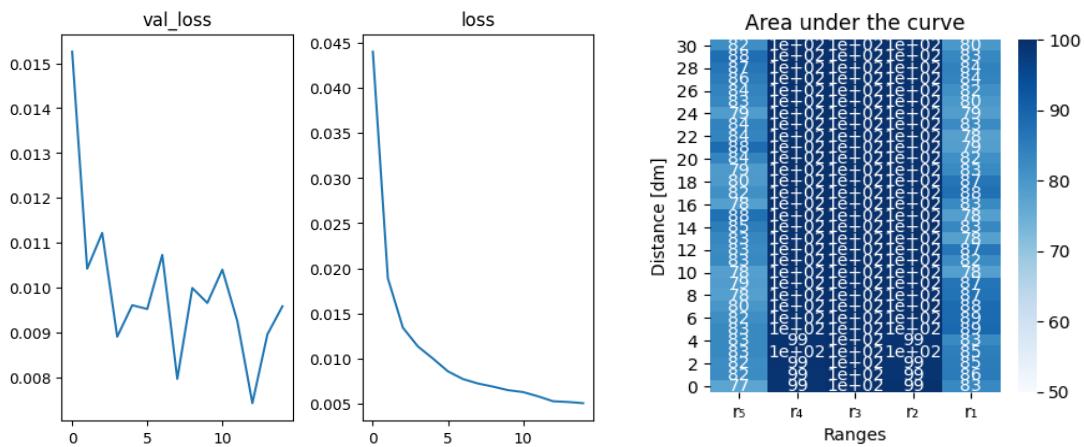


Fig. 5 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.1.5 Model 5

Data acquisition

- recorded bagfiles: 160
- recorded images: 9600
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.5
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_5.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_5.h5
- No. of epochs: 2
- Steps: 10
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

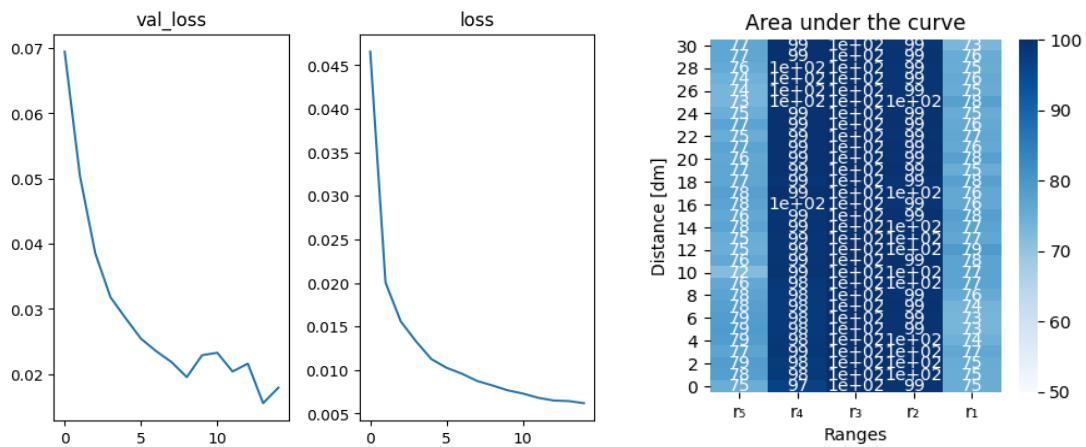


Fig. 6 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.1.6 Model 13

Data acquisition

- recorded bagfiles: 320
- recorded images: 19200
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_13.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_13.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

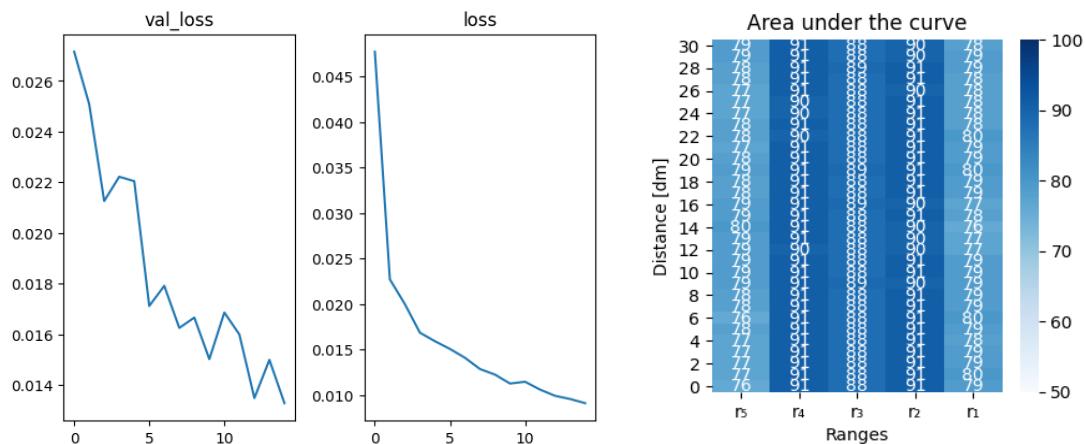


Fig. 7 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.1.7 Model 14

Data acquisition

- recorded bagfiles: 320
- recorded images: 19200
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_13.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_14.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

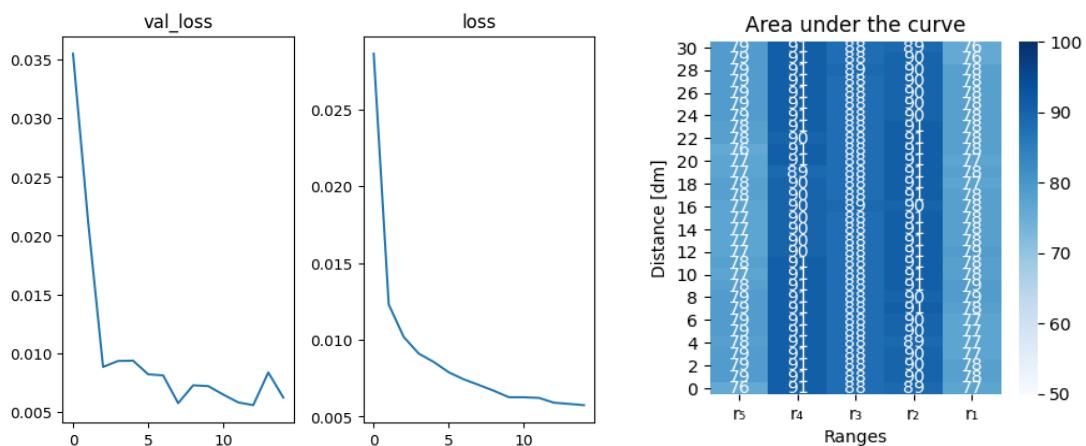


Fig. 8 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.1.8 Model 15

Data acquisition

- recorded bagfiles: 320
- recorded images: 19200
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_13.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_15.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.02
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

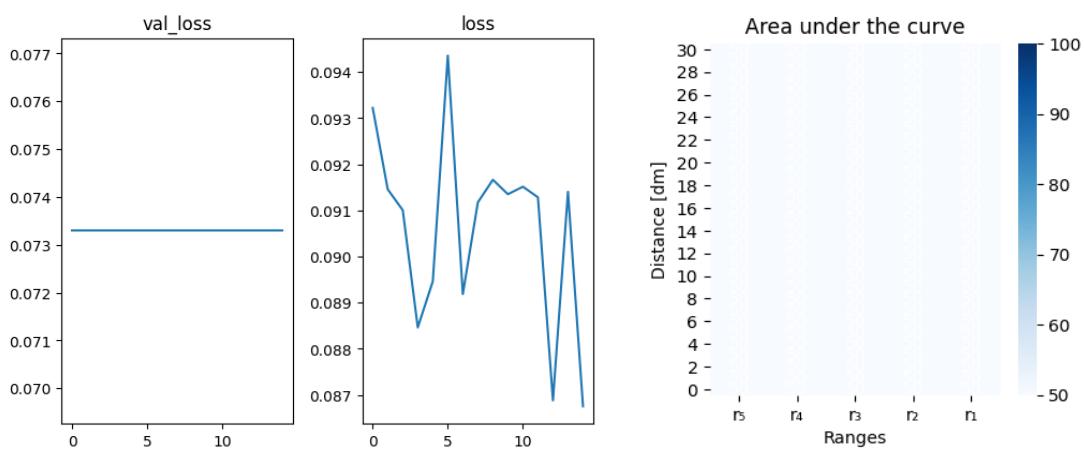


Fig. 9 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.1.9 Summary

Table 1 displays the summary of this batch. The tests are defined in Section 4.4.3 in the main paper. The table contains the following information:

- **Laser ranges:** Lowest to highest AUC result defined for each range
- **Unknown obstacles:** Performance result on unknown obstacles as two elements. The first element defines whether the model is able to properly recognize distances, while the second value represents if ranges are predicted accurately.
- **Correct Distances:** Performance result for distances containing three elements. Each element represents a range of 1 meter, starting with the first element from 0m to 1m with all subsequent elements alike.
- **Empty instances:** Result whether empty instance are recognized or not
- **Correct range:** Performance result for correct ranges to be recognized
- **Images recorded:** Amount of images recorded

Model name	r_5	r_4	r_3	r_2	r_1	Learning rate	Unknown obstacles	Correct distances	Empty instances	Correct range	Images recorded
M_1	50 - 50	53 - 100	50 - 100	43 - 100	50 - 50	.0002	[0,0]	[0,0,.5]	yes	[0,0,1,0,0]	600
M_2	74 - 75	91 - 100	94 - 100	100 - 100	75 - 75	.0002	[0,0]	[0,0,.5]	yes	[0,0,0,0,0]	1200
M_3	50 - 50	84 - 87	74 - 75	79 - 87	50 - 50	.0002	[0,1]	[0,0,0]	yes	[.5,.5,.5,.5,.5]	2400
M_4	77 - 87	99 - 100	90 - 96	99 - 100	78 - 89	.0002	[0,1]	[0,0,0]	yes	[.5,.5,1..5,.5]	4800
M_5	73 - 79	99 - 100	75 - 84	99 - 100	74 - 79	.0002	[0,1]	[0,0,.8]	yes	[1,1,1,1,1]	9600
M_{13}	76 - 79	90 - 91	88 - 89	90 - 91	77 - 80	.0002	[0,1]	[0,0,8]	yes	[0,1,1,1,0]	19200
M_{14}	77 - 79	89 - 91	88 - 89	89 - 91	76 - 78	.002	[0,0]	[0,0,.8]	yes	[0,1,1,1,0]	19200
M_{15}	50 - 50	50 - 50	50 - 50	50 - 50	50 - 50	.02	[0,0]	[0,0,0]	no	[0,0,0,0,0]	19200

tab. 1 Summary table

1.2 Batch 2

These are the test results for the second training batch, which consists of 6 different models with its input images increased from 600 to 30000. Fig. 10 displays the environment used for this batch. For this batch, a higher different amount of obstacles to train with is used, which intuitively suggests resulting in lower performance, as the same amount of images are used.

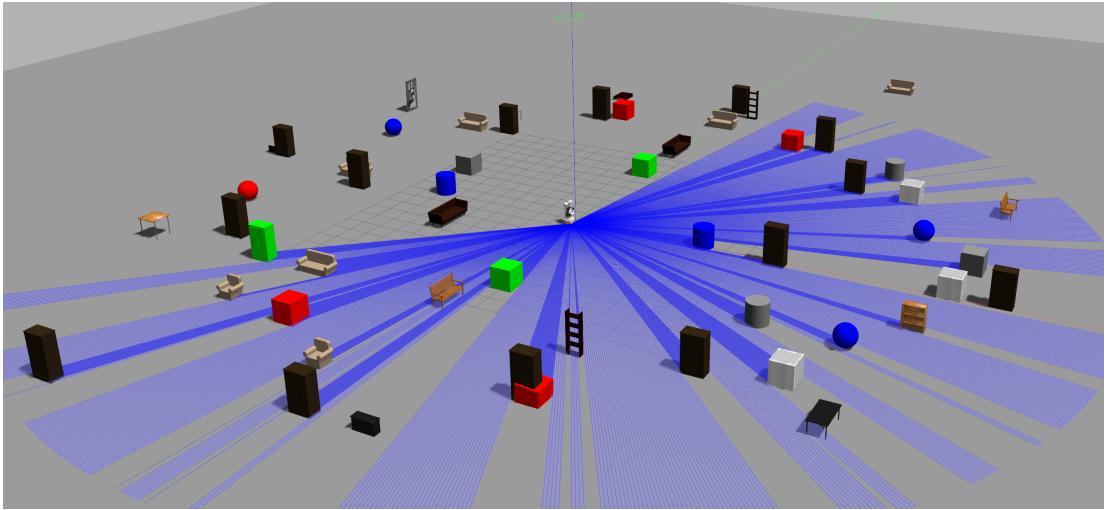


Fig. 10 Environment used for Batch 2.

The following subsections will list the parameters and graphs used for each model created by the pipeline. As defined in Section 4.4.3 in the main paper, the manual test results are summarized in Section 1.2.7.

1.2.1 Model 6

Data acquisition

- recorded bagfiles: 10
- recorded images: 600
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_6.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_6.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

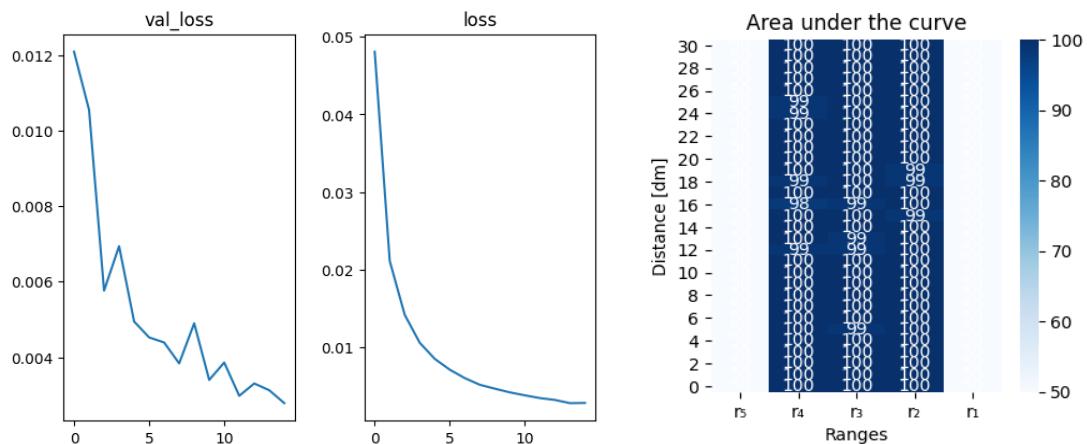


Fig. 11 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.2.2 Model 7

Data acquisition

- recorded bagfiles: 20
- recorded images: 1200
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_7.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_7.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

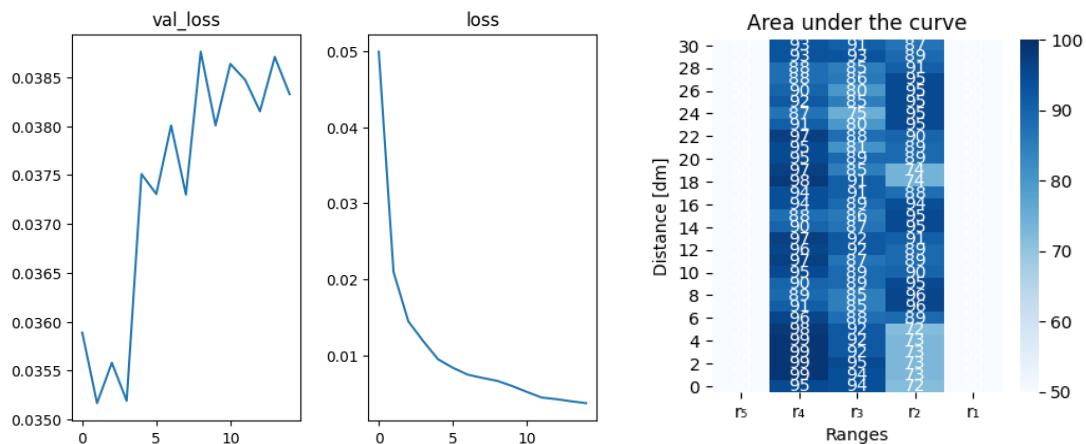


Fig. 12 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.2.3 Model 8

Data acquisition

- recorded bagfiles: 40
- recorded images: 2400
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_8.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_8.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

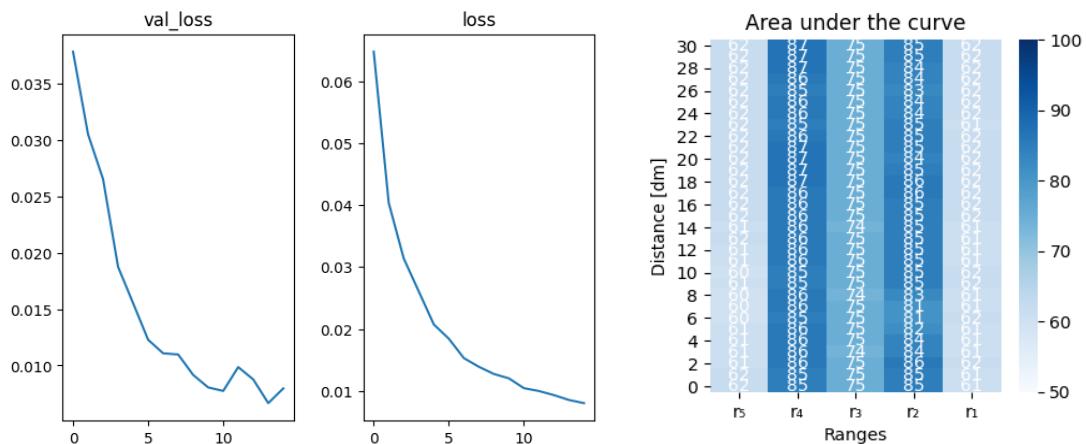


Fig. 13 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.2.4 Model 9

Data acquisition

- recorded bagfiles: 80
- recorded images: 4800
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_9.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_9.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

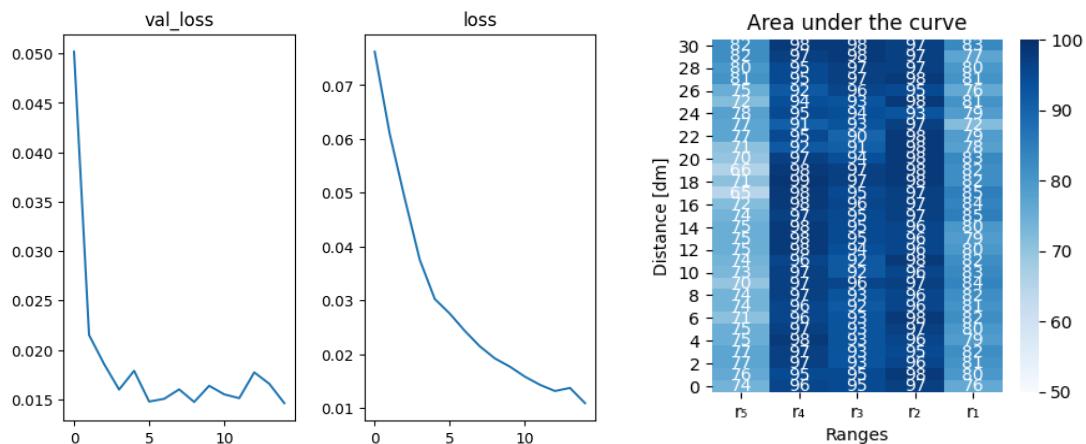


Fig. 14 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.2.5 Model 10

Data acquisition

- recorded bagfiles: 160
- recorded images: 9600
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_10.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_10.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

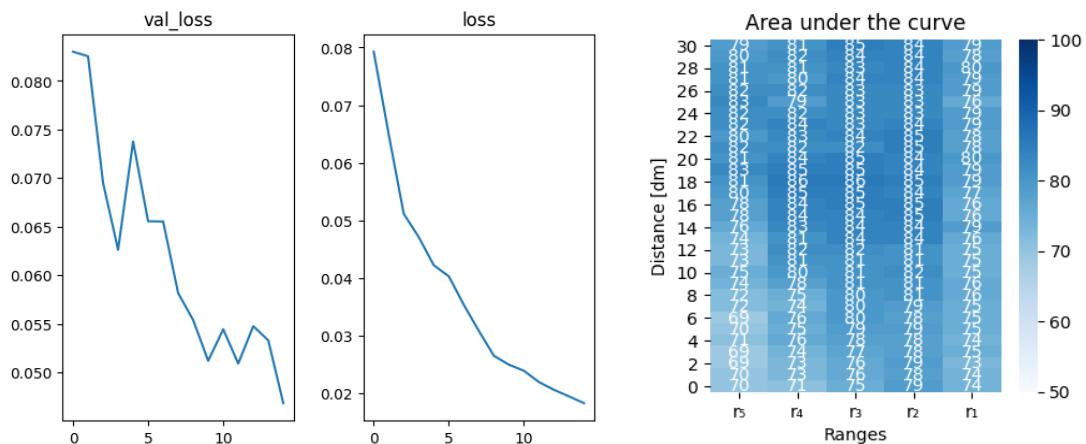


Fig. 15 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.2.6 Model 11

Data acquisition

- recorded bagfiles: 500
- recorded images: 30000

Feature Extraction

- Dataset name: dataset_11.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.8

Training Model

- Model name: model_11.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

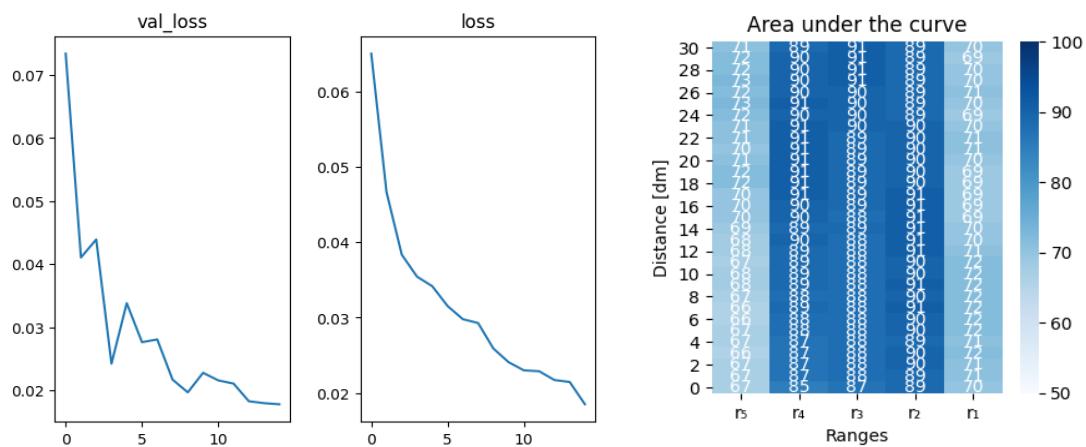


Fig. 16 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.2.7 Summary

Table 2 displays the summary of this batch. The tests are defined in Section 4.4.3 in the main paper. The table contains the following information:

- **Laser ranges:** Lowest to highest AUC result defined for each range
- **Unknown obstacles:** Performance result on unknown obstacles as two elements. The first element defines whether the model is able to properly recognize distances, while the second value represents if ranges are predicted accurately.
- **Correct Distances:** Performance result for distances containing three elements. Each element represents a range of 1 meter, starting with the first element from 0m to 1m with all subsequent elements alike.
- **Empty instances:** Result whether empty instance are recognized or not
- **Correct range:** Performance result for correct ranges to be recognized
- **Images recorded:** Amount of images recorded

Model name	r_5	r_4	r_3	r_2	r_1	Learning rate	Unknown obstacles	Correct Distance	Empty instances	Correct range	Images recorded
M_6	50 - 50	98 - 100	99 - 100	99 - 100	50 - 50	.0002	[0,0]	[0,0,0]	no	[0,0,0,0,0]	600
M_7	50 - 50	88 - 98	80 - 94	72 - 96	50 - 50	.0002	[0,5]	[0,5,8]	yes	[6,6,6,6,6]	1200
M_8	60 - 62	85 - 87	74 - 75	81 - 86	61 - 62	.0002	[0,8]	[0,0,8]	yes	[8,8,8,8,8]	2400
M_9	65 - 81	91 - 99	90 - 96	93 - 98	76 - 85	.0002	[0,9]	[0,0,8]	partially	[7,7,7,7,7]	4800
M_{10}	69 - 83	71 - 85	75 - 84	78 - 85	74 - 80	.0002	[0,9]	[0,0,9]	yes	[9,9,9,9,9]	9600
M_{11}	66 - 73	85 - 91	87 - 91	89 - 91	69 - 71	.0002	[0,9]	[0,0,9]	yes	[9,9,9,9,9]	30000

tab. 2 Summary table

1.3 Batch 3

These are the test results for the third training batch. It consists of 7 different models, with the number of images increased from 600 to 9600. Fig. 17 displays the environment used for this batch.

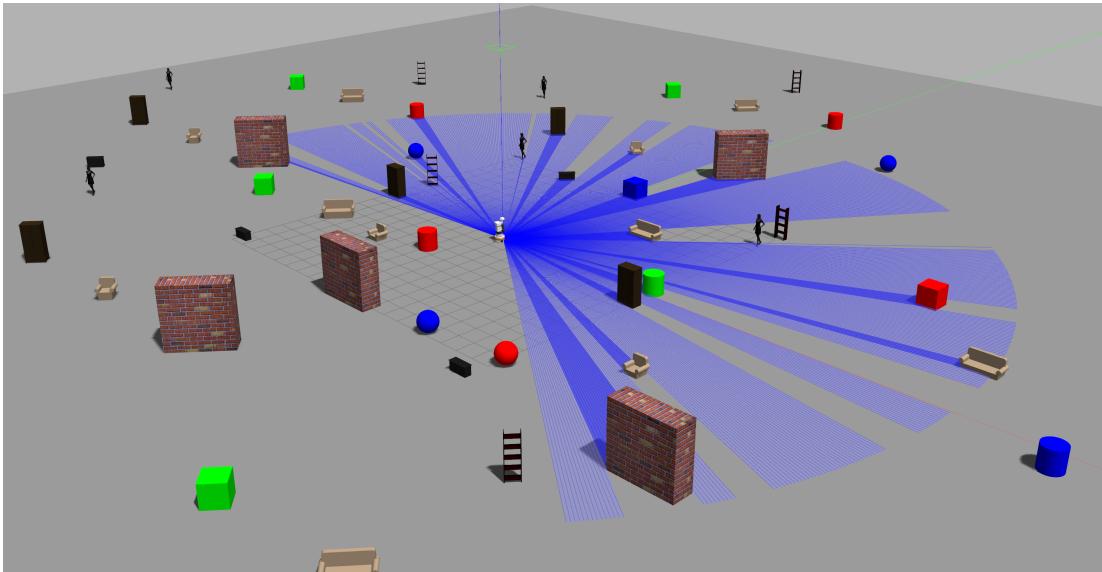


Fig. 17 Environment used for Batch 3.

The following subsections will list the parameters and graphs used for each model created by the pipeline. As defined in Section 4.4.3 in the main paper, the manual test results are summarized in Section 1.3.8.

1.3.1 Model 17

Data acquisition

- recorded bagfiles: 10
- recorded images: 600
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_17.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 0.8

Training Model

- Model name: model_17.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

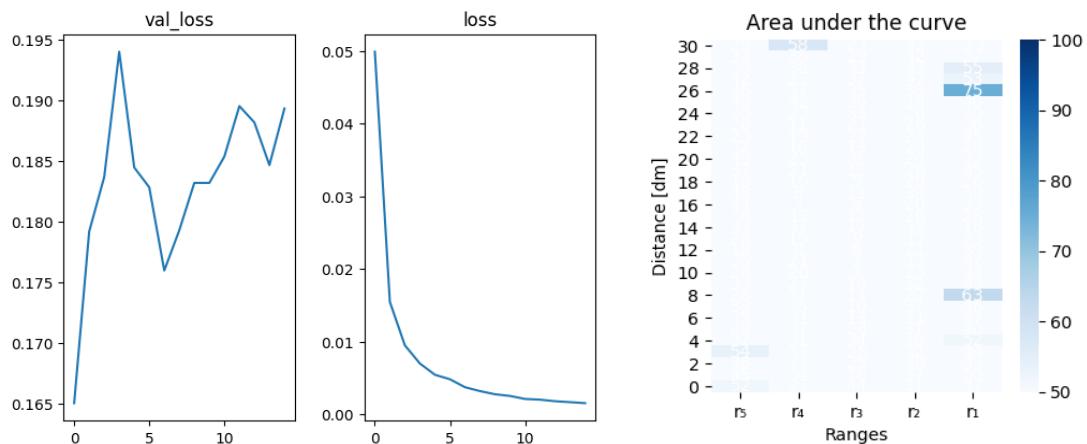


Fig. 18 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.3.2 Model 19

Data acquisition

- recorded bagfiles: 20
- recorded images: 1200
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_19.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.0

Training Model

- Model name: model_19.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

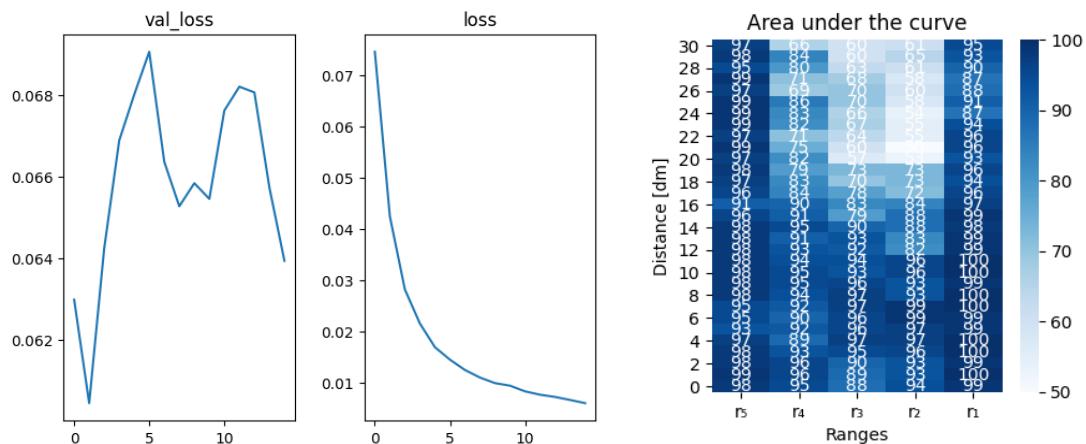


Fig. 19 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.3.3 Model 20

Data acquisition

- recorded bagfiles: 40
- recorded images: 2400
- angle avoidance: 45
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_20.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.0

Training Model

- Model name: model_20.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

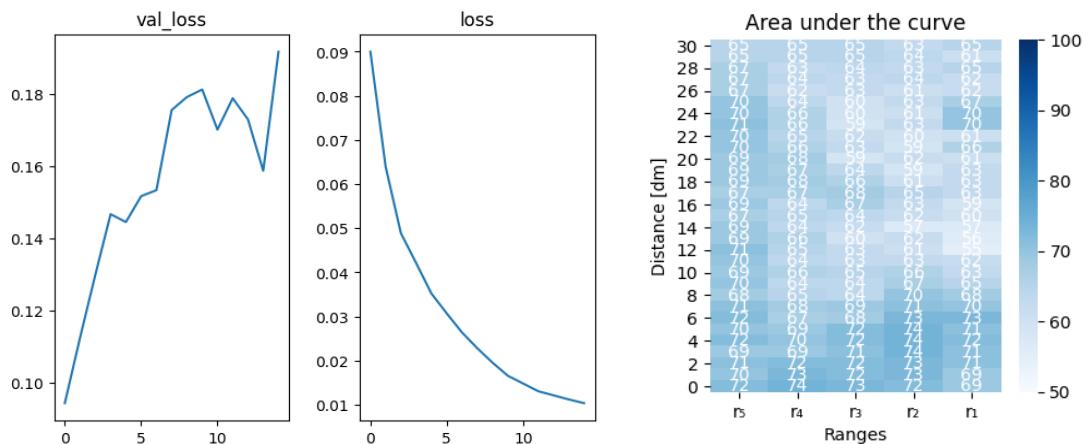


Fig. 20 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.3.4 Model 25

Data acquisition

- recorded bagfiles: 80
- recorded images: 4800
- angle avoidance: 89
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_25.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.35

Training Model

- Model name: model_25.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

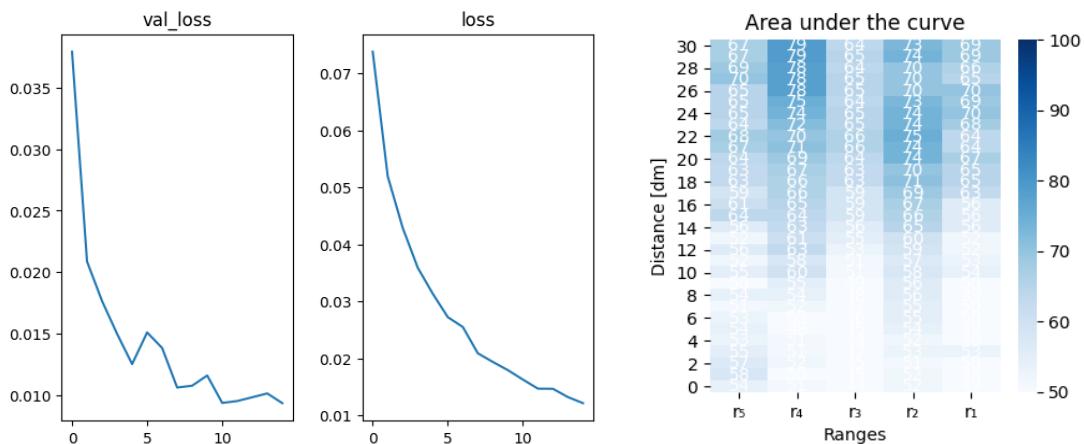


Fig. 21 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.3.5 Model 26

Data acquisition

- recorded bagfiles: 160
- recorded images: 9600
- angle avoidance: random int
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_26.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.35

Training Model

- Model name: model_26.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

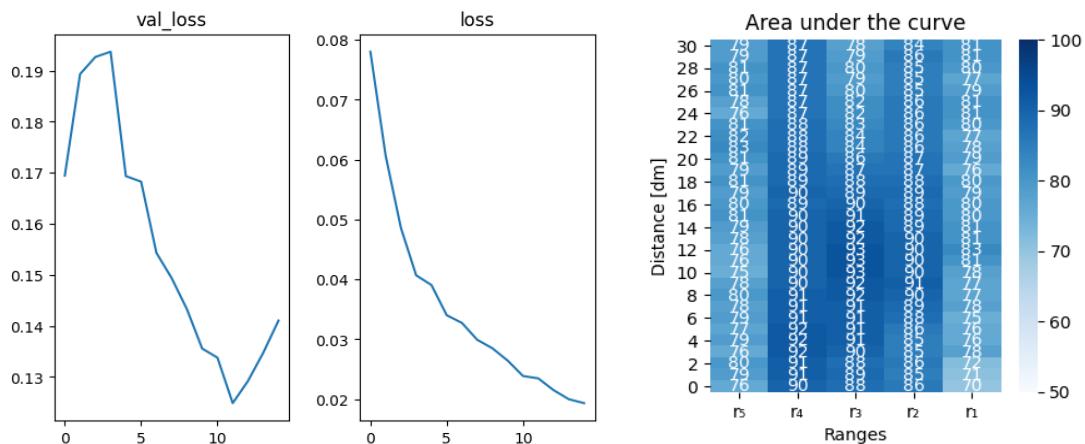


Fig. 22 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.3.6 Model 27

Data acquisition

- recorded bagfiles: 160
- recorded images: 9600
- angle avoidance: random int
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_26.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.35

Training Model

- Model name: model_27.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.002
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

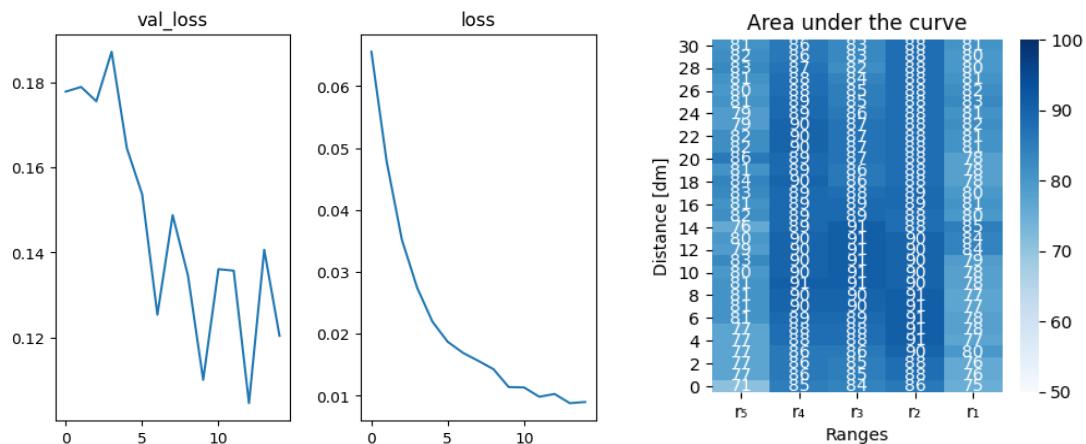


Fig. 23 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.3.7 Model 28

Data acquisition

- recorded bagfiles: 160
- recorded images: 9600
- angle avoidance: random int
- timeout limit: 20
- recording distance: 3.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_26.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 2
- target count: 31
- laser threshold: 1.35

Training Model

- Model name: model_28.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

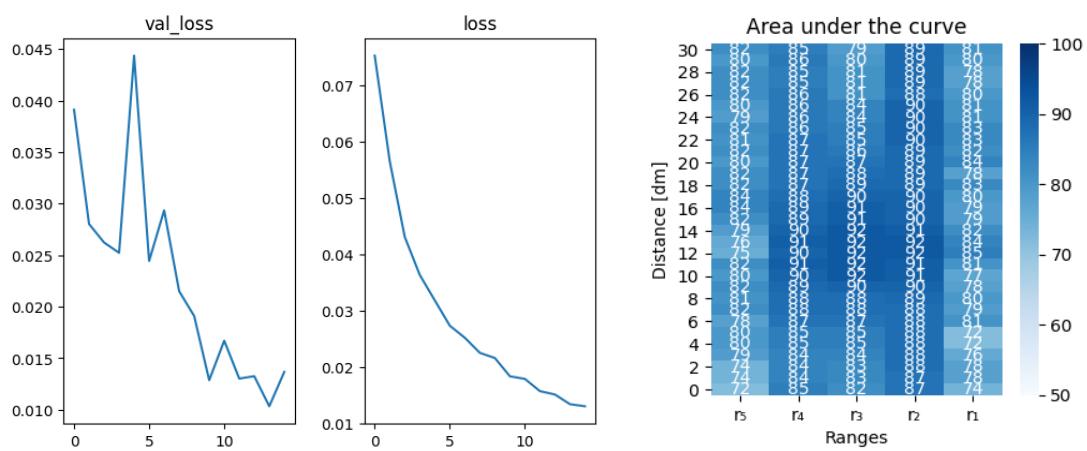


Fig. 24 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.3.8 Summary

Table 3 displays the summary of this batch. The tests are defined in Section 4.4.3 in the main paper. The table contains following information:

- **Laser ranges:** Lowest to highest AUC result defined for each range
- **Unknown obstacles:** Performance result on unknown obstacles as two elements. The first element defines whether the model is able to properly recognize distances, while the second value, represents if ranges are predicted accurately.
- **Correct Distances:** Performance result for distances containing three elements. Each element represents a range of 1 meter starting with the first element from 0m to 1m with all subsequent elements alike.
- **Empty instances:** Result whether empty instance are recognized or not
- **Correct range:** Performance result for correct ranges to be recognized
- **Images recorded:** Amount of images recorded

Model name	r_5	r_4	r_3	r_2	r_1	Learning rate	Unknown obstacles	Correct distances	Empty instances	Correct range	Images recorded
M_{17}	50 - 54	50 - 58	50 - 50	50 - 50	50 - 75	.0002	[0.0]	[0.0,.2]	no	[0.0,0.0,0]	600
M_{19}	93 - 99	66 - 96	57 - 95	50 - 99	87 100	.0002	[0.0]	[0.0,0]	no	[2.,2.,2.,2,2]	1200
M_{20}	65 - 71	64 - 74	60 - 73	59 - 74	61 - 73	.0002	[0.0]	[0.0,0]	yes	[2.,2.,2.,2,2]	2400
M_{25}	50 - 70	50 - 79	50 - 65	52 - 74	50 70	.0002	[0.1]	[0.0,4,0.8]	yes	[.5,.5,.5,.5]	4800
M_{26}	76 - 83	87 - 90	78 - 91	84 90	70 - 83	.0002	[0.0]	[0.6,.9]	yes	[.8,.9,.9,.9,.6]	9600
M_{27}	71 - 86	86 - 91	82 - 91	86 - 91	78 - 85	.002	[0.3]	[0.5,.9]	yes	[.6,.8,.8,.8,.5]	9600
M_{28}	72 - 84	85 - 91	79 - 91	87 - 92	72 - 83	.0004	[0.3]	[0.4,.9]	yes	[.6,.7,.7,.7,.5]	9600

tab. 3 Summary table

1.4 Batch 4

These are the test results for the fourth training batch. It consists of 5 different models, with the number of images increased from 1540 to 12320. Fig. 17 displays the environment used for this batch.

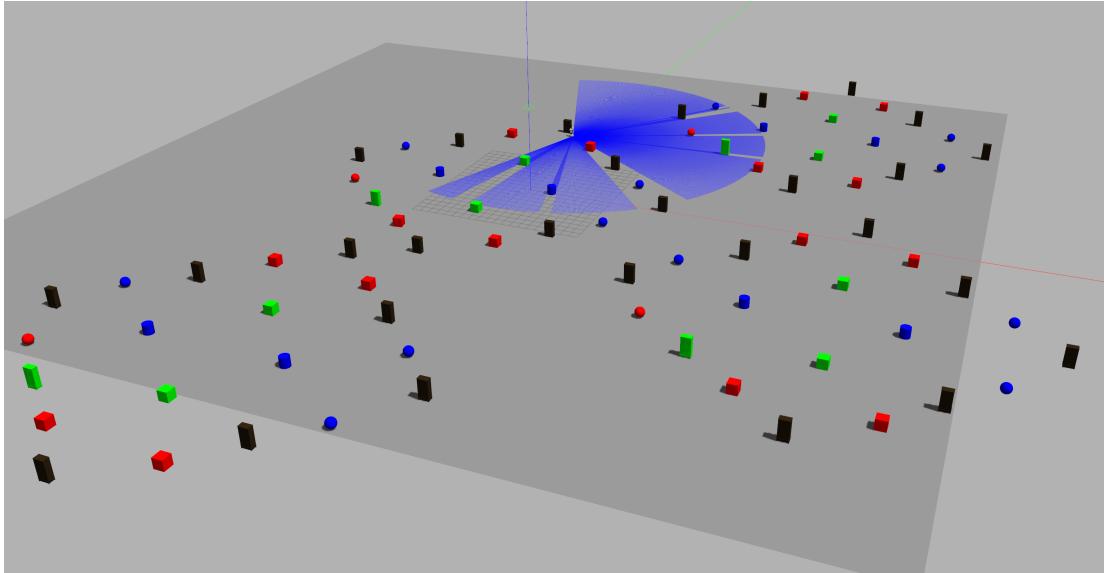


Fig. 25 Environment used for Batch 4.

The following subsections will list the parameters and graphs used for each model created by the pipeline. As defined in Section 4.4.3 in the main paper, the manual test results are summarized in Section 1.3.8.

1.4.1 Model 29

Data acquisition

- recorded bagfiles: 10
- recorded images: 1540
- angle avoidance: random int
- timeout limit: 20
- recording distance: 8.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_29.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 81
- laser threshold: 1.8

Training Model

- Model name: model_29.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

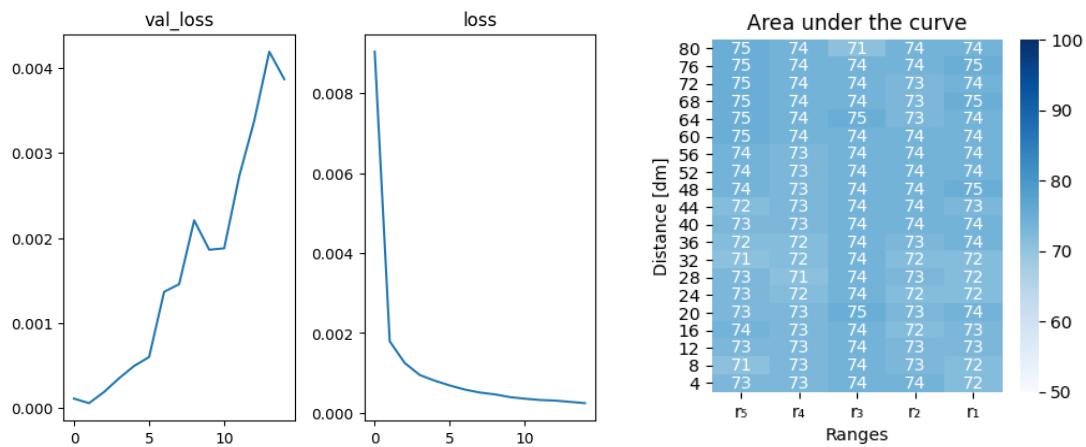


Fig. 26 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.4.2 Model 30

Data acquisition

- recorded bagfiles: 20
- recorded images: 3120
- angle avoidance: random int
- timeout limit: 20
- recording distance: 8.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_30.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 81
- laser threshold: 1.8

Training Model

- Model name: model_30.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

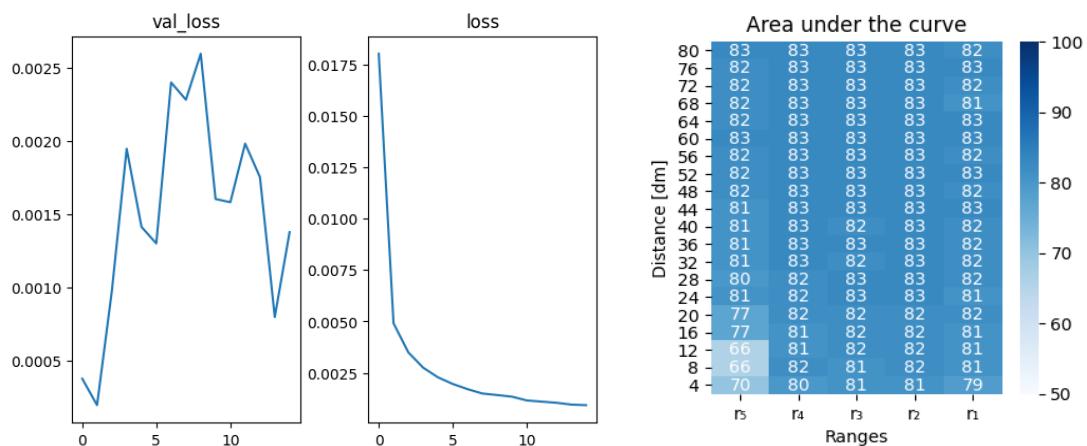


Fig. 27 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.4.3 Model 31

Data acquisition

- recorded bagfiles: 40
- recorded images: 6160
- angle avoidance: random int
- timeout limit: 20
- recording distance: 8.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_31.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 81
- laser threshold: 1.8

Training Model

- Model name: model_31.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

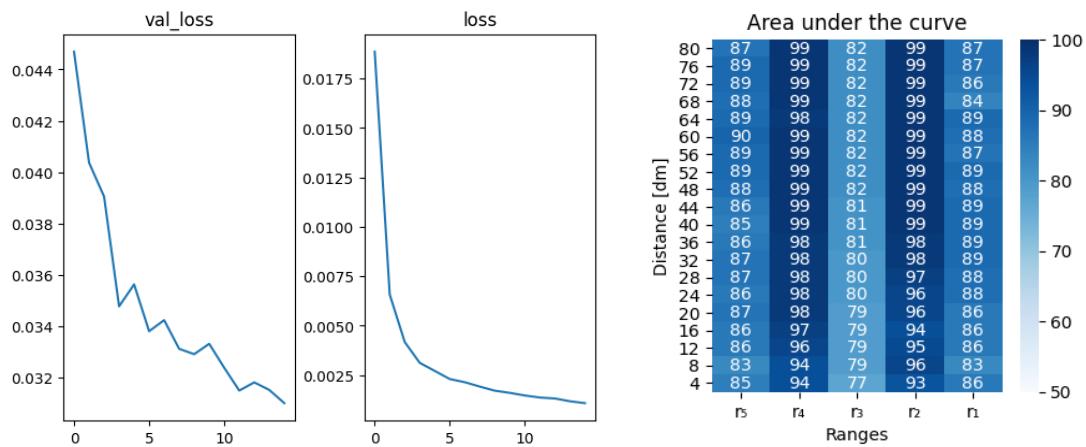


Fig. 28 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.4.4 Model 39

Data acquisition

- recorded bagfiles: 80
- recorded images: 12320
- angle avoidance: random int
- timeout limit: 20
- recording distance: 8.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_39.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 81
- laser threshold: 1.8

Training Model

- Model name: model_39.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

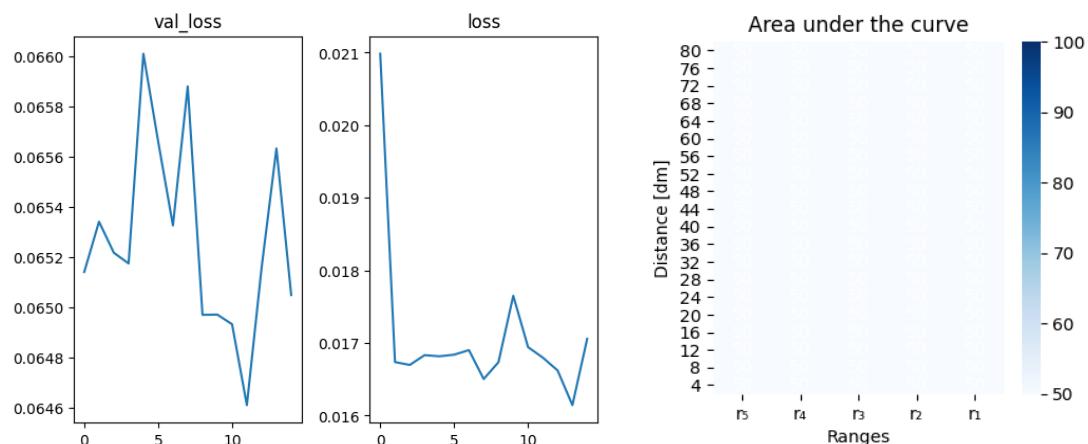


Fig. 29 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.4.5 Summary

Table 4 displays the summary of this batch. The tests are defined in Section 4.4.3 in the main paper. The table contains the following information:

- **Laser ranges:** Lowest to highest AUC result defined for each range
- **Unknown obstacles:** Performance result on unknown obstacles as two elements. The first element defines whether the model is able to properly recognize distances, while the second value represents if ranges are predicted accurately.
- **Correct Distances:** Performance result for distances containing three elements. Each element represents a range of 1 meter, starting with the first element from 0m to 1m with all subsequent elements alike.
- **Empty instances:** Result whether empty instance are recognized or not
- **Correct range:** Performance result for correct ranges to be recognized
- **Images recorded:** Amount of images recorded

Model name	r_5	r_4	r_3	r_2	r_1	Learning rate	Unknown obstacles	Correct distances	Empty instances	Correct range	Images recorded
M_{29}	71 - 75	71 - 74	71 - 75	72 - 74	72 - 75	.0004	[2.,3]	[0.,3.,1]	yes	[1.,1.,1.,1.,1]	1540
M_{30}	70 - 83	81 - 83	81 - 83	81 - 83	79 - 83	.0004	[4.,5]	[0.,6.,4]	yes	[4.,5.,8.,5.,4]	3120
M_{31}	83 - 90	94 - 99	60 - 73	59 - 74	61 - 73	.0004	[2.,8]	[0.,5.,4]	yes	[2.,5.,8.,5.,2]	6160
M_{39}	50 - 50	50 - 50	50 - 50	50 - 50	50 - 50	.0004	[0.,0]	[0.,0.,0]	no	[0.,0.,0.,0.,0]	12320

tab. 4 Summary table

1.5 Batch 5

These are the test results for the fourth training batch. It consists of 5 different models, with the number of images increased from 730 to 12410. Fig. 17 displays the environment used for this batch.

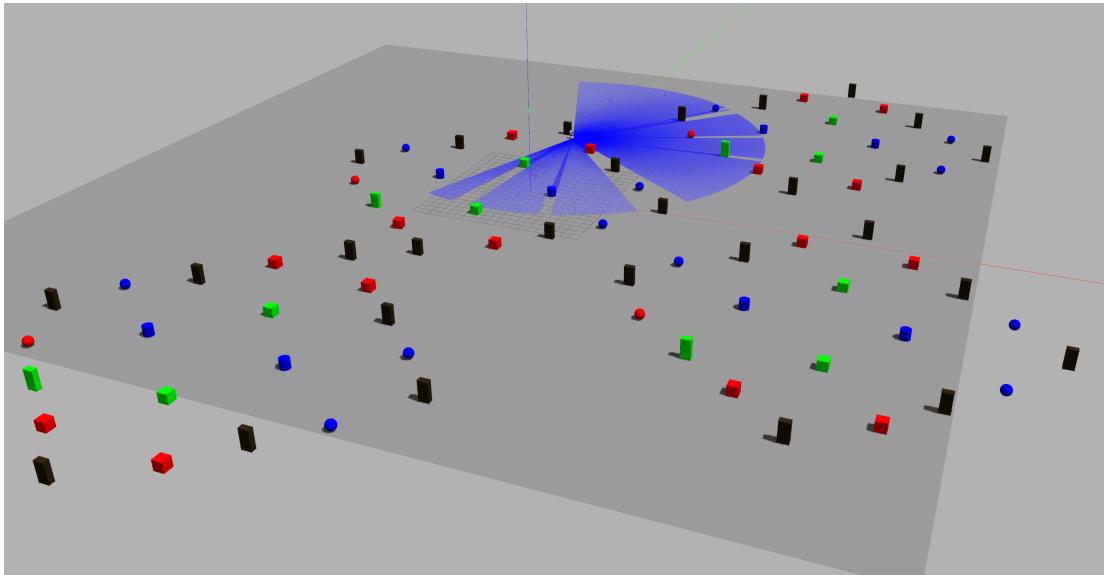


Fig. 30 Environment used for Batch 4.

The following subsections will list the parameters and graphs used for each model created by the pipeline. As defined in Section 4.4.3 in the main paper, the manual test results are summarized in Section 1.4.5.

1.5.1 Model 41

Data acquisition

- recorded bagfiles: 10
- recorded images: 730
- angle avoidance: random int
- timeout limit: 20
- recording distance: 4.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_41.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 41
- laser threshold: 1.4

Training Model

- Model name: model_41.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

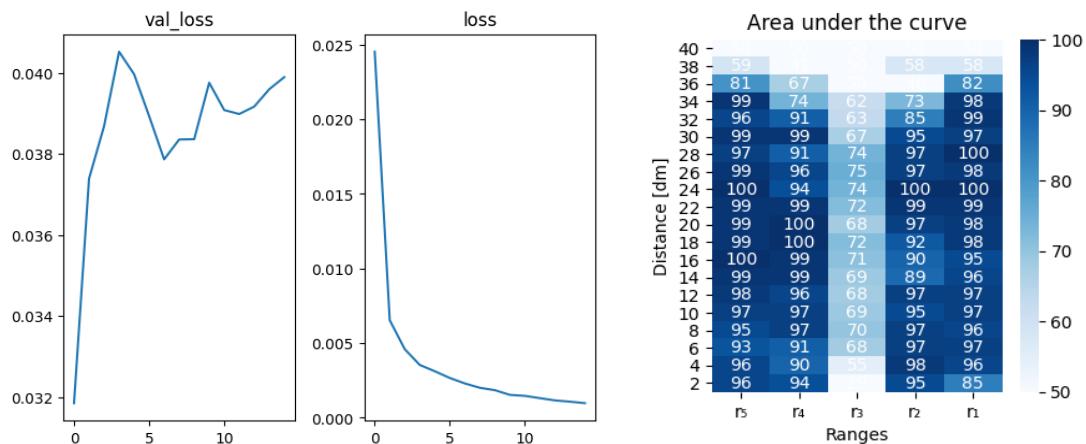


Fig. 31 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.5.2 Model 42

Data acquisition

- recorded bagfiles: 20
- recorded images: 1460
- angle avoidance: random int
- timeout limit: 20
- recording distance: 4.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_42.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 41
- laser threshold: 1.4

Training Model

- Model name: model_42.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

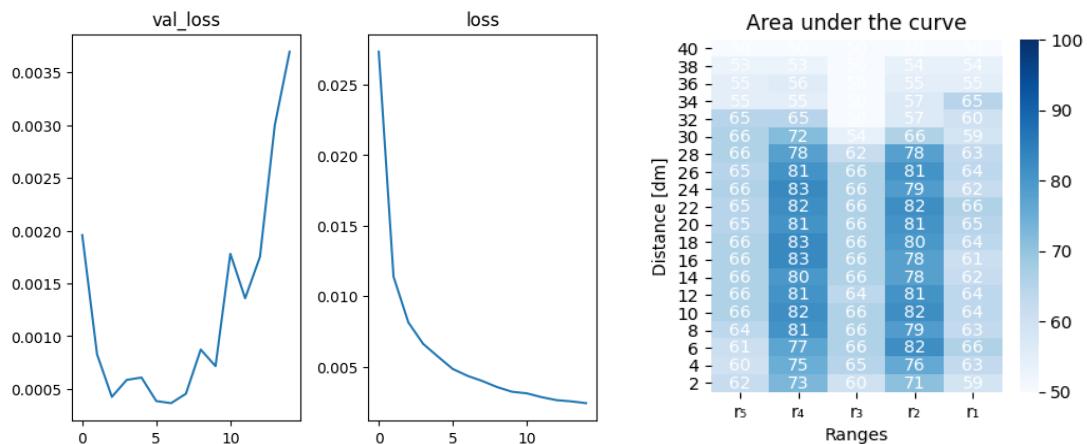


Fig. 32 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.5.3 Model 43

Data acquisition

- recorded bagfiles: 40
- recorded images: 2920
- angle avoidance: random int
- timeout limit: 20
- recording distance: 4.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_43.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 41
- laser threshold: 1.4

Training Model

- Model name: model_43.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

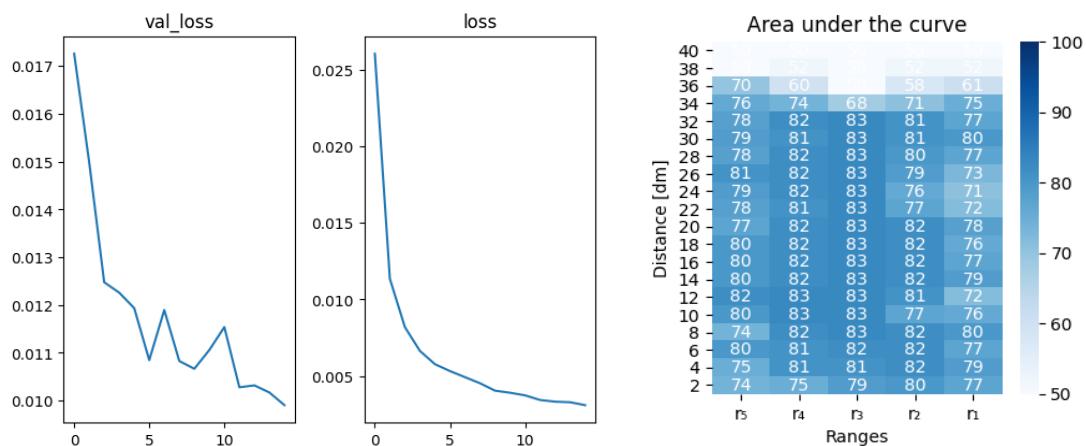


Fig. 33 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.5.4 Model 44

Data acquisition

- recorded bagfiles: 80
- recorded images: 5840
- angle avoidance: random int
- timeout limit: 20
- recording distance: 4.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_44.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 41
- laser threshold: 1.4

Training Model

- Model name: model_44.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

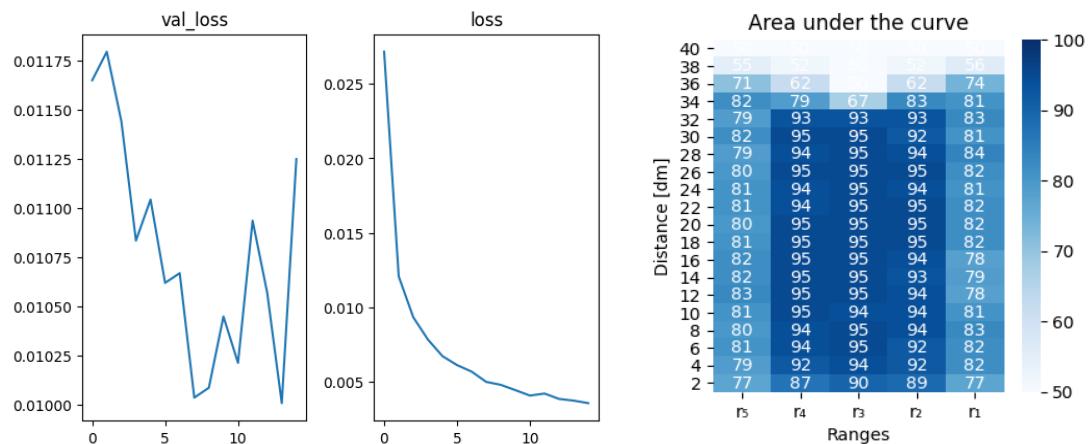


Fig. 34 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.5.5 Model 45

Data acquisition

- recorded bagfiles: 170
- recorded images: 12410
- angle avoidance: random int
- timeout limit: 20
- recording distance: 4.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_45.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 41
- laser threshold: 1.4

Training Model

- Model name: model_45.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

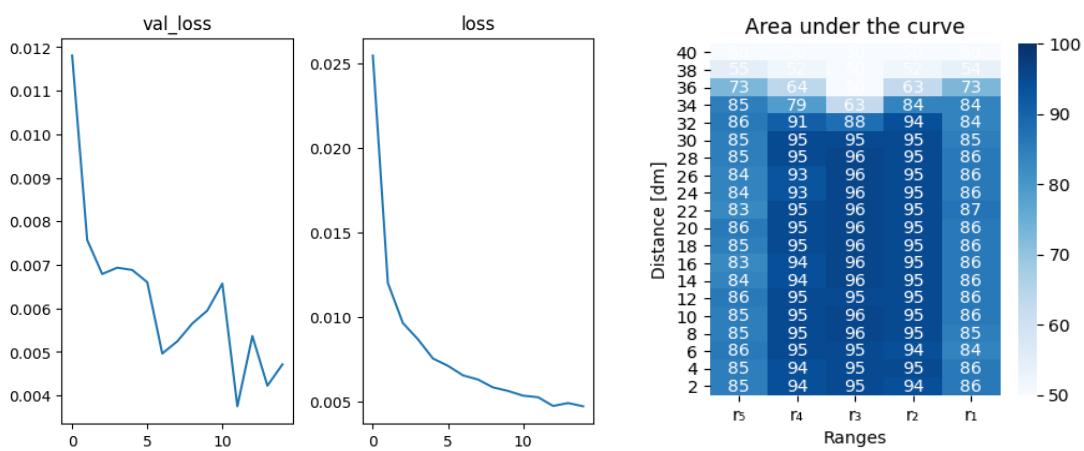


Fig. 35 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.5.6 Summary

Table 5 displays the summary of this batch. The tests are defined in Section 4.4.3 in the main paper. The table contains the following information:

- **Laser ranges:** Lowest to highest AUC result defined for each range
- **Unknown obstacles:** Performance result on unknown obstacles as two elements. The first element defines whether the model is able to properly recognize distances, while the second value represents if ranges are predicted accurately.
- **Correct Distances:** Performance result for distances containing three elements. Each element represents a range of 1 meter, starting with the first element from 0m to 1m with all subsequent elements alike.
- **Empty instances:** Result whether empty instance are recognized or not
- **Correct range:** Performance result for correct ranges to be recognized
- **Images recorded:** Amount of images recorded

Model name	r_5	r_4	r_3	r_2	r_1	Learning rate	Unknown obstacles	Correct distances	Empty instances	Correct range	Images recorded
M_{41}	50 - 100	50 - 100	50 - 75	50 - 100	50 - 100	.0004	[.1,.1]	[0,.3,.5]	no	[.0,.0,.0,.0]	730
M_{42}	50 - 66	50 - 83	50 - 66	50 - 82	50 - 66	.0004	[.3,.4]	[0,.5,.8]	no	[.1,.2,.2,.1]	1460
M_{43}	50 - 80	50 - 82	50 - 83	50 - 82	50 - 80	.0004	[.4,.6]	[4,.7,.8]	partially	[.3,.3,.3,.3]	2920
M_{44}	50 - 83	50 - 95	50 - 95	50 - 95	50 - 83	.0004	[.3,.5]	[4,.8,.9]	partially	[.4,.5,.5,.4]	5840
M_{45}	50 - 86	50 - 95	50 - 96	50 - 95	50 - 87	.0004	[.3,.8]	[4,.8,.9]	nearly	[.3,.6,.8,.6]	12410

tab. 5 Summary table

1.6 Batch 6

These are the test results for the sixth and final training batch. It consists of 7 different models, with the number of images increased from 2400 to 13840. Fig. 36 displays the environment used for this batch. While Model 47, 48, 49 and 62 are recorded with a recording distance of 4.0 meters, Model 59, 60 and 61 are recorded on a distance of 3.5 meters.

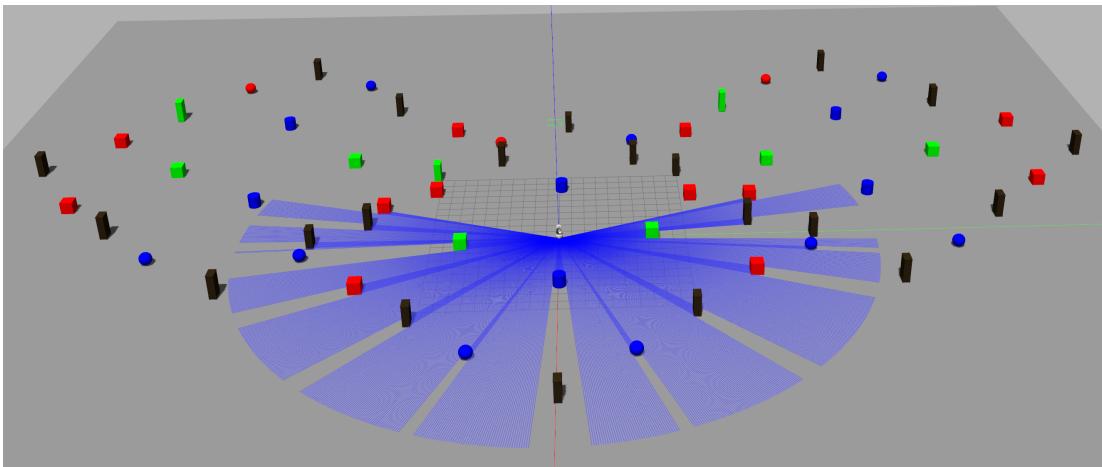


Fig. 36 Environment used for Batch 6.

The following subsections will list the parameters and graphs used for each model created by the pipeline. As defined in Section 4.4.3 in the main paper, the manual test results are summarized in Section 1.6.8.

1.6.1 Model 47

Data acquisition

- recorded bagfiles: 43
- recorded images: 3440
- angle avoidance: random int
- timeout limit: 20
- recording distance: 4.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_47.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 41
- laser threshold: 1.4

Training Model

- Model name: model_62.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

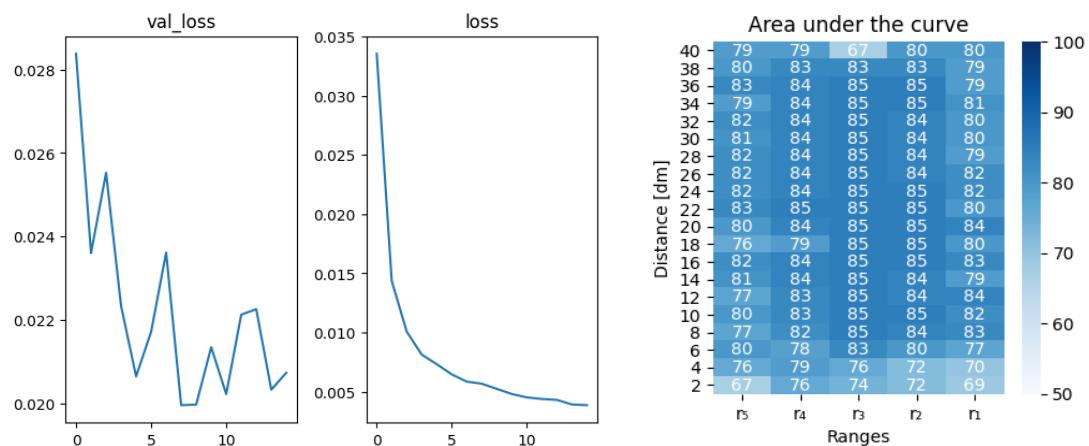


Fig. 37 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.6.2 Model 48

Data acquisition

- recorded bagfiles: 83
- recorded images: 6640
- angle avoidance: random int
- timeout limit: 20
- recording distance: 4.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_48.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 41
- laser threshold: 1.4

Training Model

- Model name: model_62.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

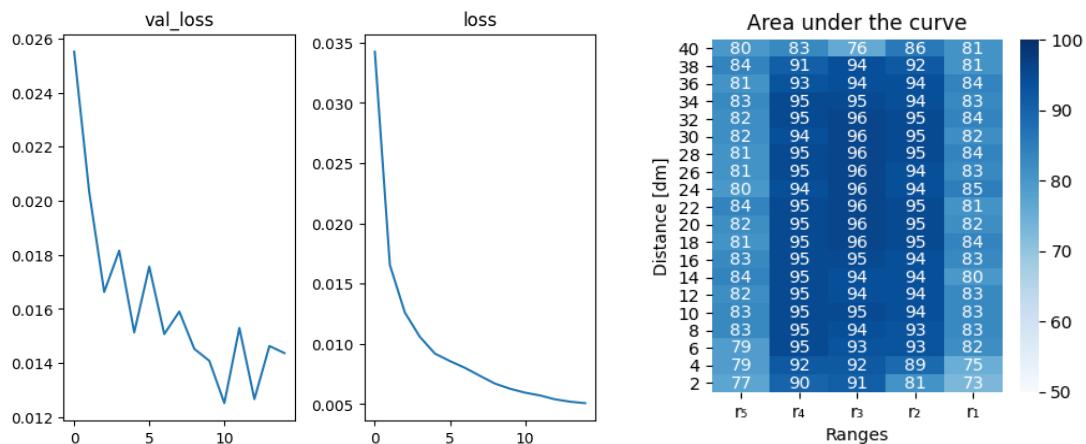


Fig. 38 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.6.3 Model 49

Data acquisition

- recorded bagfiles: 173
- recorded images: 13840
- angle avoidance: random int
- timeout limit: 20
- recording distance: 4.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_49.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 41
- laser threshold: 1.4

Training Model

- Model name: model_62.h5
- No. of epochs: 15
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

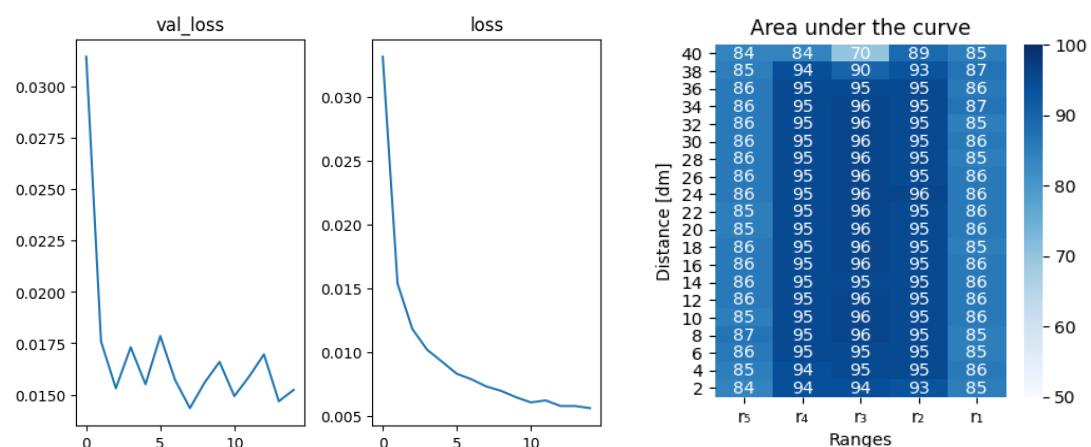


Fig. 39 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.6.4 Model 59

Data acquisition

- recorded bagfiles: 40
- recorded images: 2400
- angle avoidance: random int
- timeout limit: 20
- recording distance: 3.5
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_59.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 35
- laser threshold: 1.4

Training Model

- Model name: model_59.h5
- No. of epochs: 16
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

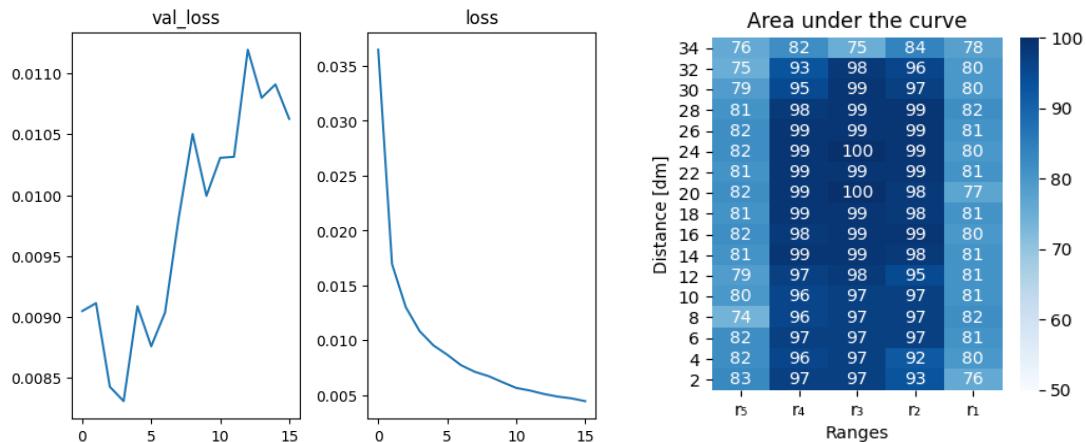


Fig. 40 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.6.5 Model 60

Data acquisition

- recorded bagfiles: 80
- recorded images: 4800
- angle avoidance: random int
- timeout limit: 20
- recording distance: 3.5
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_60.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 35
- laser threshold: 1.4

Training Model

- Model name: model_60.h5
- No. of epochs: 16
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

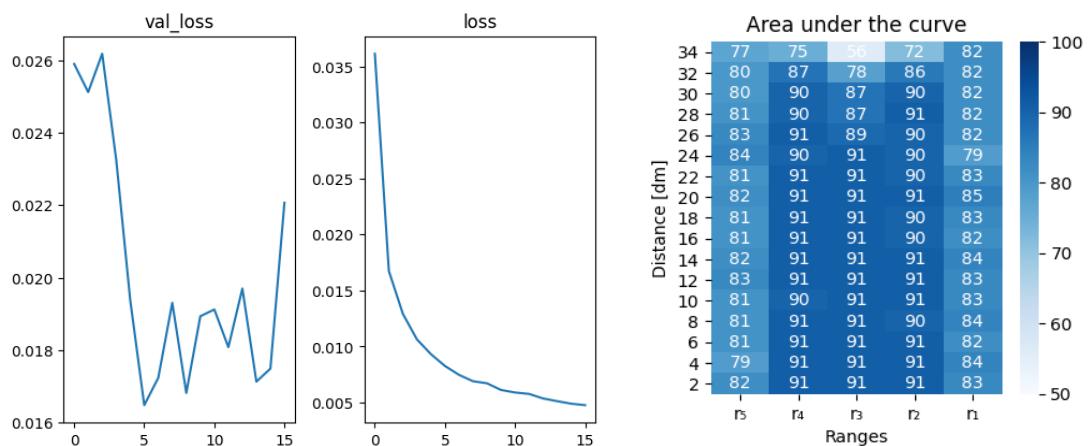


Fig. 41 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.6.6 Model 61

Data acquisition

- recorded bagfiles: 160
- recorded images: 9600
- angle avoidance: random int
- timeout limit: 20
- recording distance: 3.5
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_61.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 35
- laser threshold: 1.4

Training Model

- Model name: model_61.h5
- No. of epochs: 16
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

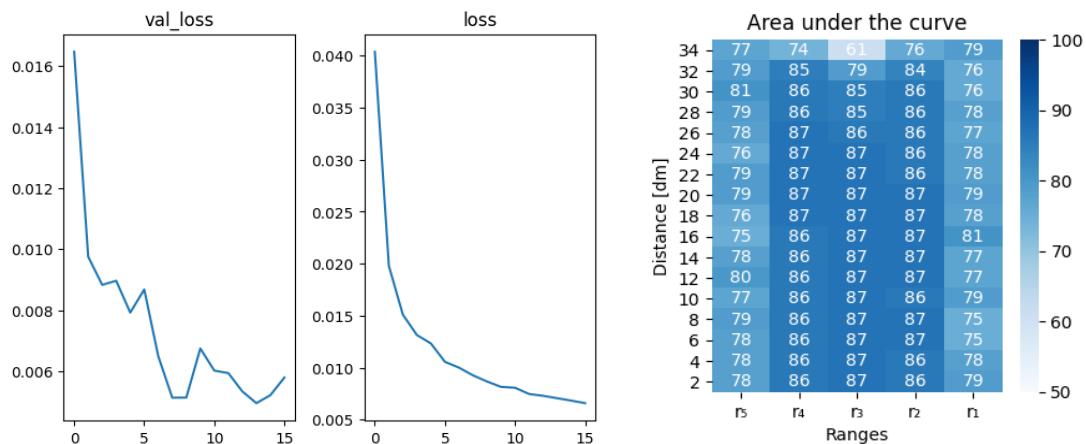


Fig. 42 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.6.7 Model 62

Data acquisition

- recorded bagfiles: 173
- recorded images: 13840
- angle avoidance: random int
- timeout limit: 20
- recording distance: 4.0
- safe passage diameter: 2

Feature Extraction

- Dataset name: dataset_49.h5
- laser range: 233:437
- laser sections: 5
- laser count: 666
- selection range: 1
- target count: 41
- laser threshold: 1.4

Training Model

- Model name: model_62.h5
- No. of epochs: 30
- Steps: 1000
- Batch Size: 64
- Learning Rate: 0.0004
- Ratio val vs training: 0.85

Testing Model

- Rounds: 100

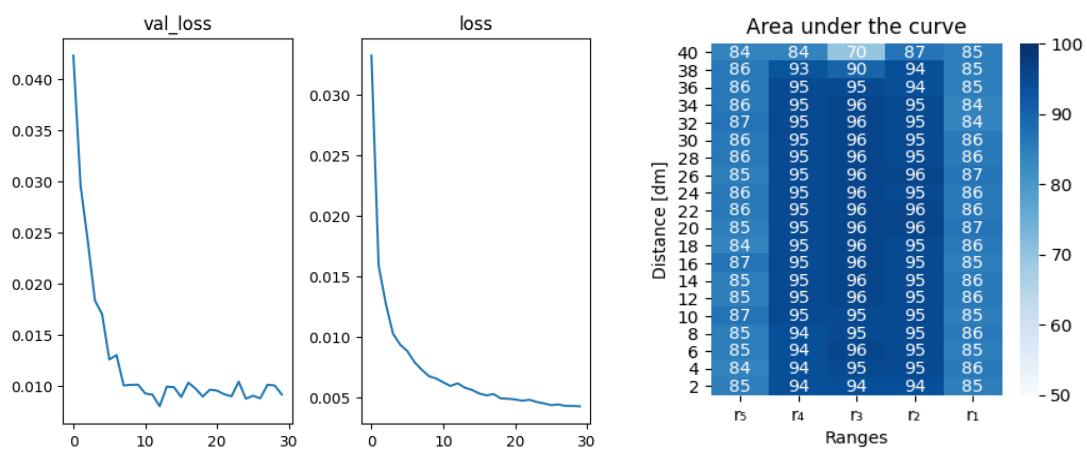


Fig. 43 The left graph shows the validation versus the training loss while the right graph shows the summary of the Area under the Receiver Operating Characteristic Curve for all ranges from $\{r_1, \dots, r_n\}$ as well for all intermediary positions (distances).

1.6.8 Summary

Table 6 displays the summary of this batch. The tests are defined in Section 4.4.3 in the main paper. The table contains the following information:

- **Laser ranges:** Lowest to highest AUC result defined for each range
- **Unknown obstacles:** Performance result on unknown obstacles as two elements. The first element defines whether the model is able to properly recognize distances, while the second value represents if ranges are predicted accurately.
- **Correct Distances:** Performance result for distances containing three elements. Each element represents a range of 1 meter, starting with the first element from 0m to 1m with all subsequent elements alike.
- **Empty instances:** Result whether empty instance are recognized or not
- **Correct range:** Performance result for correct ranges to be recognized
- **Images recorded:** Amount of images recorded

Model name	r_5	r_4	r_3	r_2	r_1	Learning rate	Unknown obstacles	Correct distances	Empty instances	Correct range	Images recorded
M_{47}	67 - 83	76 - 84	67 - 85	72 - 85	69 - 84	.0004	[3,.5]	[8,.8,.9]	yes	[5,.7,8,.6,.4]	3440
M_{48}	77 - 84	83 - 95	76 - 96	81 - 95	81 - 95	.0004	[3,.6]	[9,.9,.9]	yes	[6,.8,9,.8,.7]	6640
M_{49}	84 - 86	84 - 95	70 - 96	89 - 95	85 - 87	.0004	[4,.7]	[9,.9,.9]	yes	[8,.9,1,.9,.8]	13840
M_{59}	74 - 83	82 - 99	75 - 100	84 - 99	76 - 82	.0004	[2,.5]	[7,.8,.9]	partially	[5,.6,7,.6,.5]	2400
M_{60}	77 - 91	75 - 91	50 - 91	72 - 91	82 - 83	.0004	[2,.5]	[7,.8,.9]	nearly	[7,.8,9,.8,.7]	4800
M_{61}	77 - 80	74 - 86	61 - 87	76 - 87	75 - 79	.0004	[3,.6]	[7,.8,.9]	yes	[7,.8,9,.8,.7]	9600
M_{62}	50 - 83	50 - 95	50 - 95	50 - 95	50 - 83	.0004	[4,.7]	[9,.9,.9]	yes	[8,.9,1,.9,.8]	13840

tab. 6 Summary table