Deep Learning algorithm to detect floor type

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Project Overview

- Floor detection feature in the handheld vacuum cleaner
  - Difference between classical machine learning and deep learning

- The goals
  - To develop a deep learning algorithm to detect hard floor and soft floor with 95% accuracy using motor current data
  - Develop 2nd model using Lis2dh12 sensor

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Technology used:

Hardware

- Bluetooth module
- Saturn vacuum cleaner with nozzle
- Working computer

Software

- Python 3.11
- TensorFlow and Keras
- Putty
- Jupyter notebook from Anaconda

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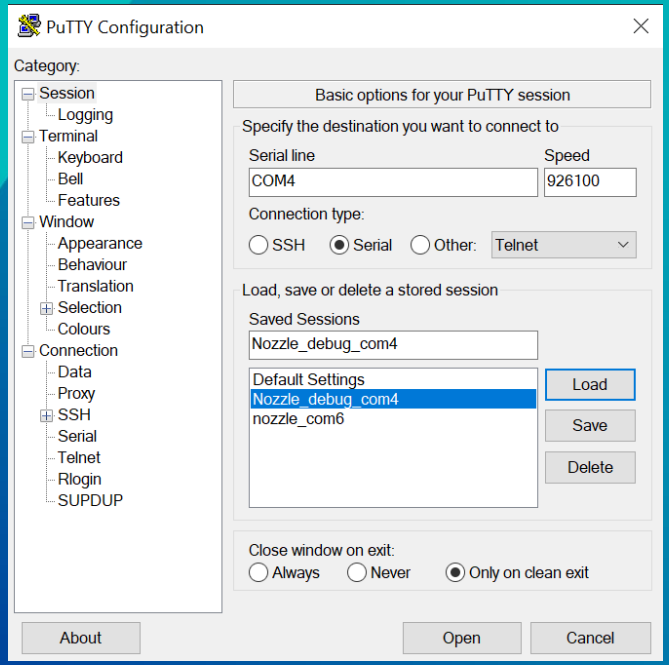
Steps

- Data collection
  - Data was collected via a Bluetooth using putty
- The sampling rate
  - 50 milliseconds each
  - Data received every 50 milliseconds

	Raw_Timestamp
138	12351
139	12401
140	12451
141	12501
142	12551
143	12601
144	12651
145	12701
146	12751
147	12801
148	12851
149	12901
150	12951
151	13001
152	13051
153	14251
154	14301
155	14351
156	14401
157	14451
158	14502
159	14552
160	14602
161	14652
162	14702
163	14752

Hard_floor_



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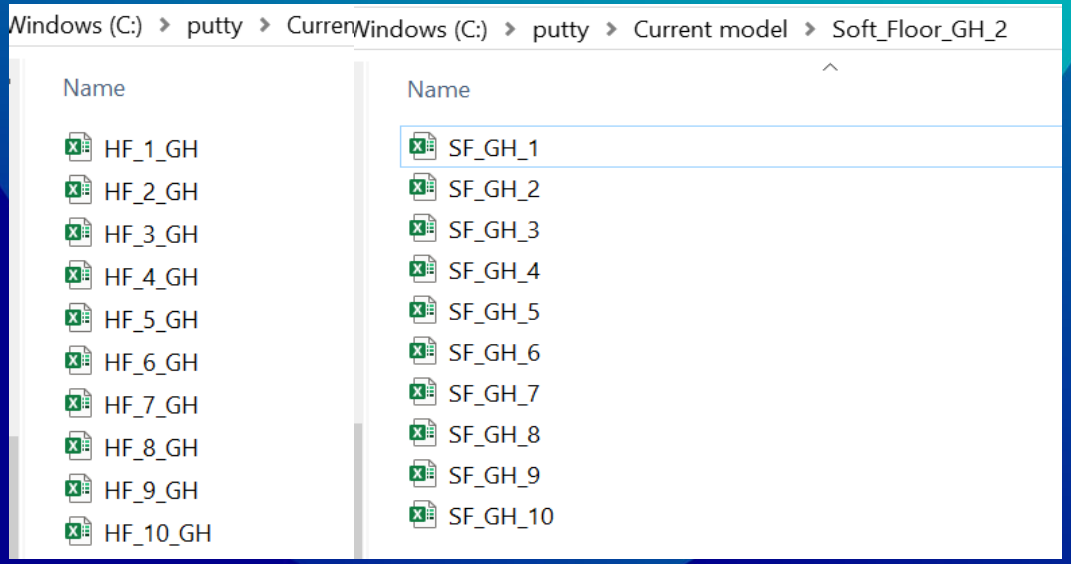
Steps

- how much data collected initially
  - 10 sets of hard floor and 10 sets of soft floor



	A	B	C
1	Time stam	Motor dat	Label
2	5552	1728	1
3	5602	1709	1
4	5652	1673	1
5	5702	1701	1
6	5752	1802	1
7	5802	1773	1
8	5852	1692	1
9	5902	1790	1
10	5952	1783	1
11	6002	1783	1
12	6052	1883	1
13	6102	1924	1
14	6152	1905	1
15	6202	1895	1
16	6252	1924	1
17	6302	1859	1
18	6352	1775	1
19	6402	1766	1
20	6452	1740	1
21	6502	1821	1
22	6552	1885	1
23	6602	1730	1

	A	B	C	D
1	Time stam	Motor dat	Label	
2	6702	3438	2	
3	6752	3443	2	
4	6802	3514	2	
5	6852	3301	2	
6	6902	3227	2	
7	6952	3221	2	
8	7002	3142	2	
9	7052	3175	2	
10	7102	3130	2	
11	7152	3156	2	
12	7202	3172	2	
13	7252	3139	2	
14	7302	3246	2	
15	7352	3179	2	
16	7402	3300	2	
17	7452	3274	2	
18	7502	3146	2	
19	7552	2919	2	

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Steps

- Data preprocessing
  - Stitched all the collected data into 1 training file and testing file
- Correct labels were added into separate file based on the data length

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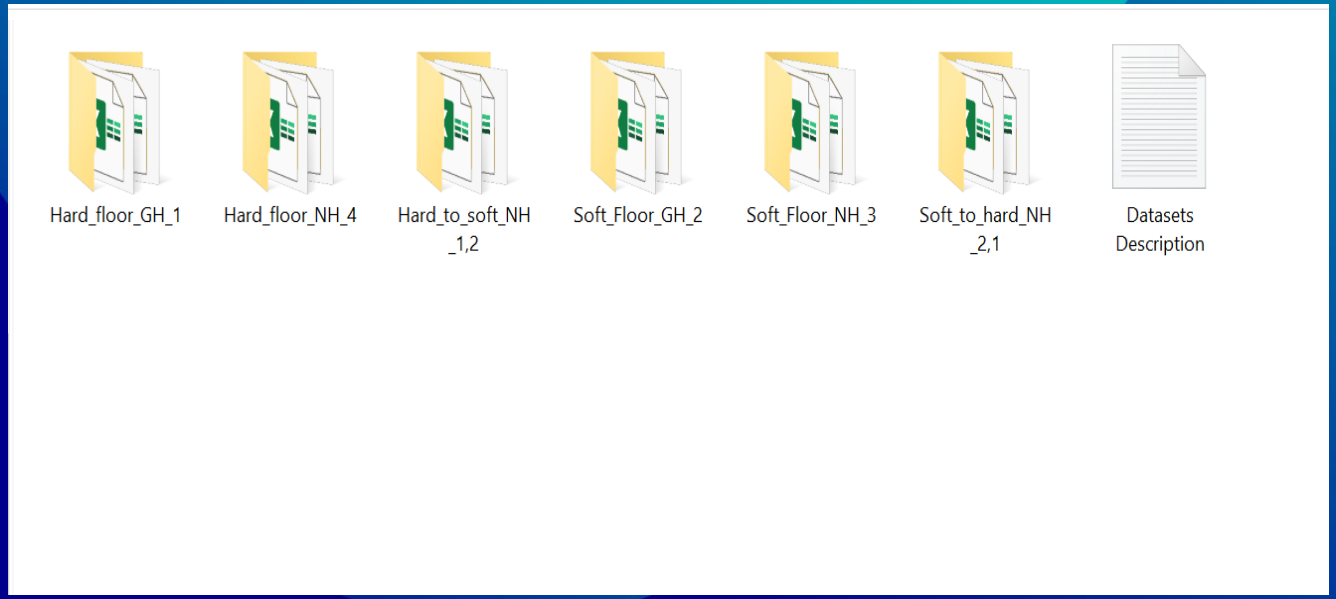
Steps

- Data handling
  - Folder and file formats were created

	Label	Training	Testing
Hard floor(T1) greater height	1	10	2
Soft floor(T1) Greater height(3. Loop pole)	2	10	2
Hard to soft floor(T1) greater height (loop hole)	1,2	10	2
Soft to Hard floor(T1) Greater height(6. Long pile thin)	2,1	10	2
Soft floor(T1) Normal height(4,Short pile)	3	10	2
Hard floor(T1) Normal height	4	10	2
		60	12



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Steps

- Data usability
  - 85%(8500 samples) for training and 15%(1500 samples) for testing

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Iteration 1

- Collected raw time series data used during 1st iteration
  - Default functions values used
- Accuracy achieved around 40%

Summary:

- The amounts of the training data were low
  - The data should be more

$$\text{Accuracy} = \frac{\text{Number of Correct Predictions}}{\text{Total Number of Predictions}} \times 100$$

Iteration	Accuracy
Iteration 1	40%

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Iteration 2

- Increased data collection(31000 & 5000)
- Batch size enhanced
  - Accuracy increased to 50%

Summary:

- Improved the data quality to get more accurate results

Iteration	Accuracy
Iteration 1	40%
Iteration 2	50%

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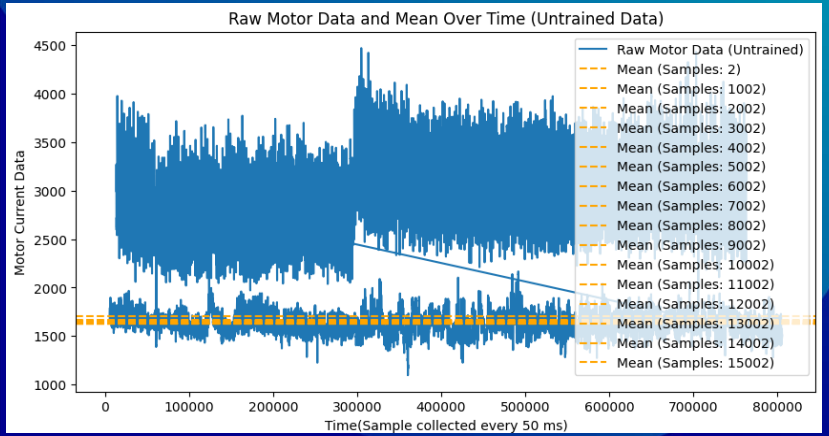
Iteration 3

- Median filtered data size 10,20,30,40 used and checked the algorithm
  - Results were same



B
Motor data
1653
1663
1711
1701
1721
1779
1789
1711
1796
1779
1779
1819
1839
1819
1723
1741

	Time stamp	Motor data
40	7451	47
41	7501	-10
42	7551	-46
43	7601	-46
44	7652	-37
45	7702	-149
46	7752	-56
47	7802	-29
48	7852	-19
49	7902	-29
50	7952	-66
51	8002	-29
52	8052	47
53	8102	44
54	8152	34
55	8202	-32
56	8252	8
57	8302	17
58	8352	54
59	8402	17
60	8452	74
	2	-49
	2	-12
	2	-12
	2	-68

et1

Iteration	Accuracy
Iteration 1	40%
Iteration 2	50%
Iteration 3	No changes

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Iteration 4

- Updated batch_size parameter, modified the alpha value (Learning rate to 0.0001)
  - The efficiency number decreased the accuracy to 49%

Summary:

- Outcome reduced the accuracy

Iteration	Accuracy
Iteration 1	40%
Iteration 2	50%
Iteration 3	No changes
Iteration 4	Decreased

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Definitions(hyperparameters) to remember

Verbose:

- Progress printed during training process

Epochs:

- Refers to going through the entire training data once during the learning process

Batch_size:

- The number of data samples utilized in one run of model training

Rmsprop(Root Mean Square Propagation):

- It will reduce the error function

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Iteration 5

- Replaced the optimizer function from Adam to Rmsprop
- One extra layer of filtering
- Kept the learning rate of the model to 0.0001
- Model accuracy achieved 70%

Iteration	Accuracy
Iteration 1	40%
Iteration 2	50%
Iteration 3	No changes
Iteration 4	Decreased
Iteration 5	70%

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Achievements

- Developed machine learning model work from scratch to achieve accuracy 70% to detect the floor type

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Future Improvements

- Dataset handling
- More data collection
- Hyperparameter tuning
  - Epochs, batch_size, optimizer, learning rate, filter size
- Smart(with i7 atleast) or extra computer for Prediction speed
- Test repetition
- Add extra push button for Labels
- Achieve 95% accuracy
- Using Lis2dh12 data for 2nd model

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Q&A

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Thank you for listening!
Have a smart cleaning ;)

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