README

Dataset & code:	**https://doi.org/10.4121/e1d6a078-9022-4f48-9aa6-e22389980fee**
Citable code:	https://zenodo.org/doi/10.5281/zenodo.10594434
GitHub code:	https://github.com/rgundel/public_multipath_data_read

Dataset: Continuous Human Activities Utilizing Three Pulsed Radars Exploiting Multipath

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Table of Contents

Referencing the dataset

Guendel, R.G., Fioranelli, F., Yarovoy, A.. *'Dataset: Continuous Human Activities Utilizing Three Pulsed Radars Exploiting Multipath'*. (4TU.ResearchData, 2024 [Online]. doi: https://doi.org/10.4121/e1d6a078-9022-4f48-9aa6-e22389980fee.

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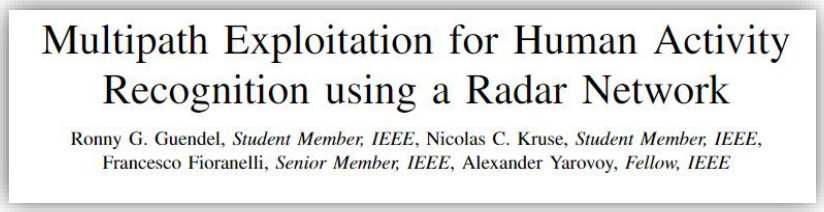
@misc{Guendel:Dataset:multipath,
author={Guendel, Ronny Gerhard and Fioranelli, Francesco and Yarovoy, Alexander},
title={Dataset: Continuous Human Activities Utilizing Three Pulsed Radars Exploiting Multipath},
DOI={10.4121/e1d6a078-9022-4f48-9aa6-e22389980fee},
publisher={4TU.ResearchData},
year = {2024},
month={Feb} }
```

Background reading for the dataset and its collection:

Multipath Exploitation for Human Activity Recognition using a Radar Network
R. G. Guendel, N.C. Kruse, F. Fioranelli, A. Yarovoy: *Multipath Exploitation for Human Activity Recognition using a Radar Network*. in IEEE Transactions on Geoscience and Remote Sensing.

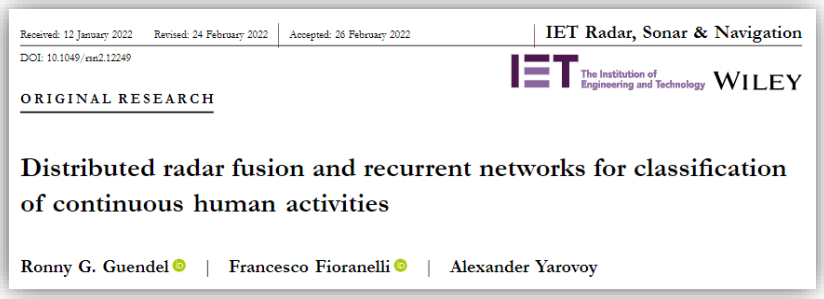

Multipath Exploitation for Human Activity Recognition using a Radar Network

Ronny G. Guendel, *Student Member, IEEE*, Nicolas C. Kruse, *Student Member, IEEE*, Francesco Fioranelli, *Senior Member, IEEE*, Alexander Yarovoy, *Fellow, IEEE*

Background reading for the used radar system:

Distributed radar fusion and recurrent networks for classification of continuous human activities
Guendel, R.G., Fioranelli, F.,Yarovoy, A.: *Distributed radar fusion and recurrent networks for classification of continuous human activities*. IET Radar Sonar Navig. 1–18 (2022). https://doi.org/10.1049/rsn2.12249

Link: https://doi.org/10.1049/rsn2.12249


Received: 12 January 2022 Revised: 24 February 2022 Accepted: 26 February 2022
DOI: 10.1049/rsn2.12249
IET Radar, Sonar & Navigation
The Institution of Engineering and Technology WILEY

ORIGINAL RESEARCH

Distributed radar fusion and recurrent networks for classification of continuous human activities

Ronny G. Guendel | Francesco Fioranelli | Alexander Yarovoy

Continuous human activity recognition for arbitrary directions with distributed radars
R. G. Guendel, M. Unterhorst, E. Gambi, F. Fioranelli and A. Yarovoy, "*Continuous human activity recognition for arbitrary directions with distributed radars,*" *2021 IEEE Radar Conference (RadarConf21)*, 2021, pp. 1-6, doi: 10.1109/RadarConf2147009.2021.9454972.

Link: https://ieeexplore.ieee.org/document/9454972


Continuous human activity recognition for arbitrary directions with distributed radars

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Matlab read file

Reading the range time data files: main_1_rt_processing_ex.m
Reading the micro Doppler data files: main_2_mD_spectrogram_processing_ex.m
Reading the range Doppler data files: main_3_rD_processing_ex.m

Radar setup

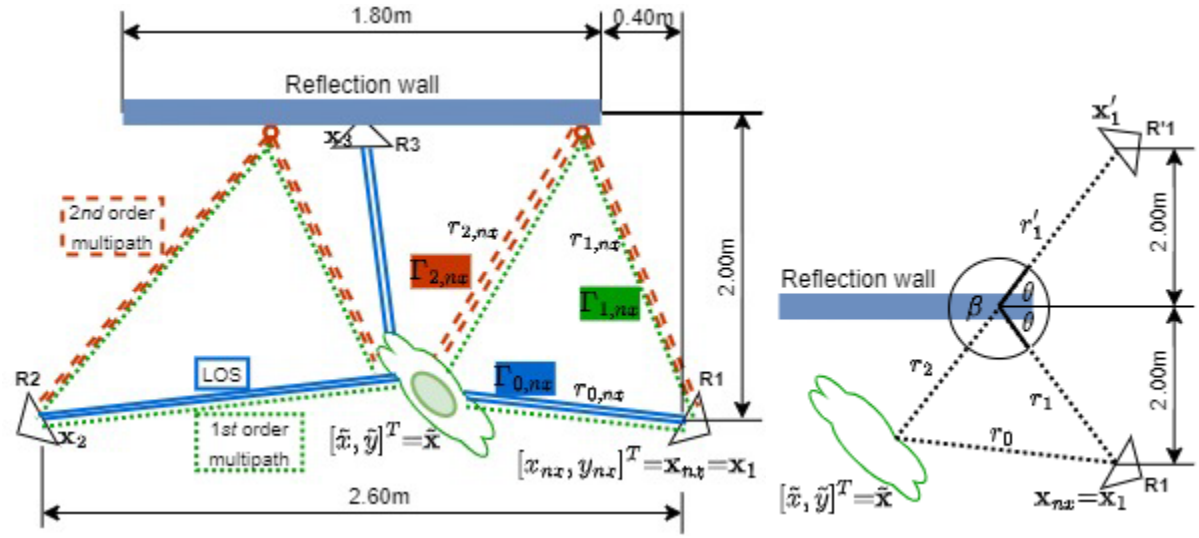

Figure 1: (left) A sketch of the room layout shows three radars, with two of them, R1 and R2, capable of benefiting from multipaths. R3 is positioned on the reflection wall and provides the range for calculating the target location $\tilde{x}$ using trilateration. (right) Geometrical relationships are illustrated to show the multipath ranges, denoted as r_1, r'_1, and r_2

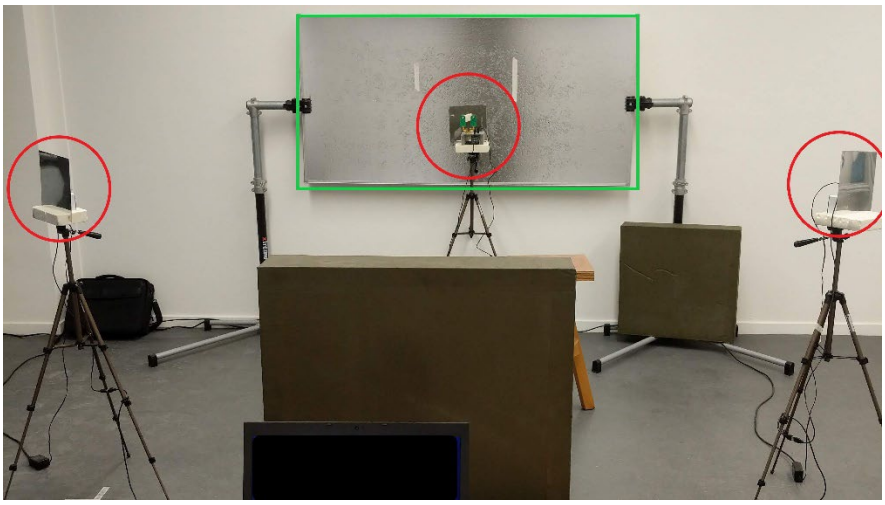

Figure 2: Experimental setup showing the radar nodes circled in red and the reflector in the green rectangle.

Figure 1 illustrates the geometric relationship between the radar system and the reflection wall. The radar system, depicted in Figures 2 and 3, is the PulsON P410 - Time Domain (Humatics), operating as an Ultra Wideband radar. The Humatics P410 (formerly PulsON) possesses key operational parameters: a center frequency (f_c) of 4.3 GHz, bandwidth (B) of 2.2 GHz, and a range resolution (r_res) of 68 mm, calculated using the formula r_res = c / (2 * B).

In terms of temporal characteristics, it features a slow-time Pulse Repetition Frequency (PRF) of 122 Hz, Pulse Repetition Interval (PRI) of 8.2 ms, and the ability to discern unambiguous Doppler frequencies (f_max ±61 Hz) and velocities (v_max ±2.2 m/s).

Additionally, it has a nominal pulse interval (t_pulse) of approximately 100 ns, a nominal pulse width (τ_pulse) of around 2 ns, and a sampling resolution (T_s) specified at 61 ps. These parameters collectively define the radar's operational performance and are vital for its various applications.

Center frequency:	4.3 GHz
Bandwidth:	2.2GHz
Oeration mode:	Monostatic
Pulse integration Index:	10 (1024 coherent integrations)
PRI/PRF:	8.2ms / 122Hz
Antennae:	Omnidirectional broadband antennas

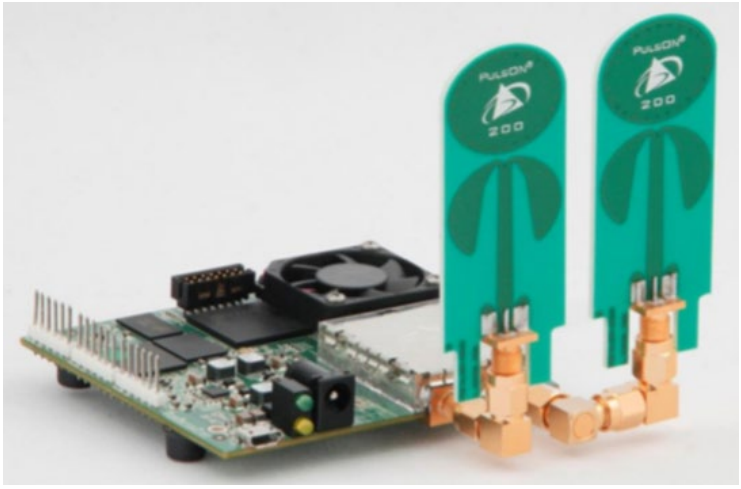

Figure 3: The PulsON P410 - Time Domain (Humatics) radar.

Statistics of the participants

Participant	Year of birth	Age	Height	Weight	Gender
1	1986	36	183	81	M
2	1991	31	162	70	F
3	1994	28	168	75	M
4	1985	37	170	73	M
5	1996	26	170	48	F
6	1998	24	166	52	F
7	1998	24	155	52	F
8	1999	23	158	73	F
9	1997	25	169	58	F
10	1993	29	167	77	M
11	2000	22	192	90	M
12	1999	23	180	90	M
13	1998	24	175	48	M
14	1994	28	173	60	F
std	4.737	4.737	9.788	14.663	
mean	1994.857	27.143	170.571	67.643	7:7 = 50%:50%

Data description and information:

Folder description

The dataset consists of 45 folders, dedicated to 14 participants and containing the data of, range-time data, micro Doppler spectrogram data, and range Doppler data. Within this dataset, a total of 12 distinct classes have been defined to categorize various activities and behaviors. These classes include *'Junk/BRN,' 'Walking,' 'Stationary,' 'Sitting down,' 'Standing up (Sit),' 'Bending (Sit),' 'Bending (Sta),' 'Falling (Wlk),' 'Standing up (Fal),' 'Falling (Sta),' 'Micro Gesture,'* and *'Walking (Obj)'*. Each class represents a specific type of movement or action performed by the participants during the three repetitions of 60 seconds of data recording.

File Index description and data examples

Explanation:
Index number 01 … 14 associated to each of the 14 participants
Index number 0 is a background noise measurement of the room without a participant in the scene

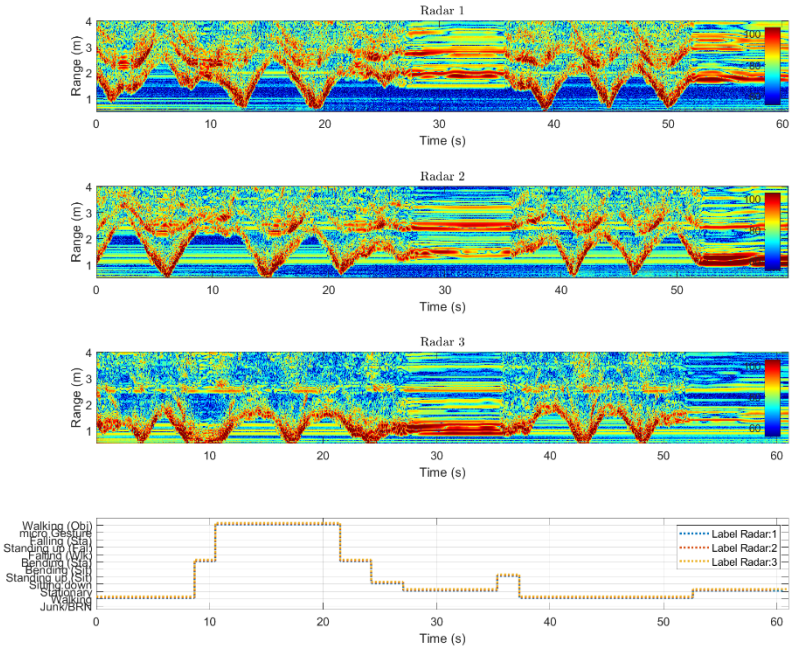

Figure 4: 1_range_time_maps_labeled.zip … is the range time data of participant 1

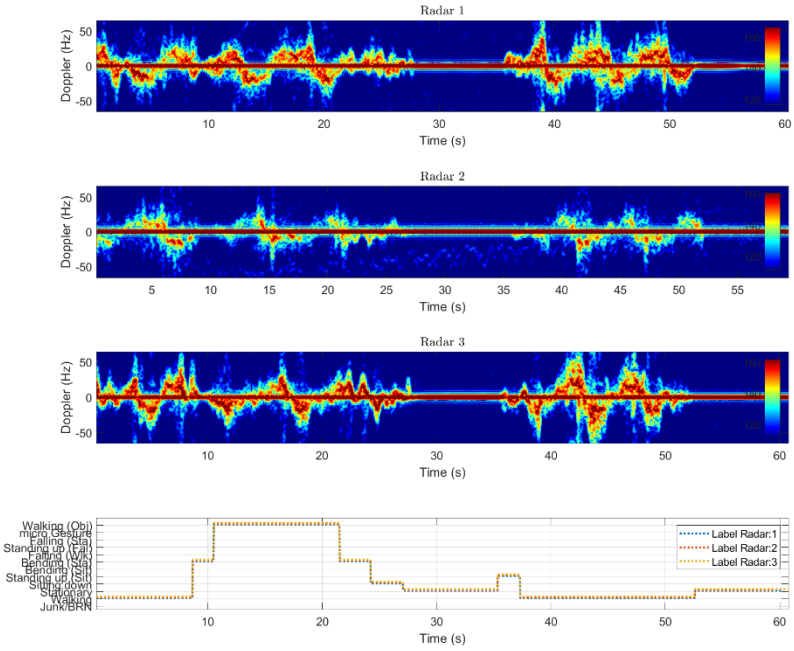

Figure 5: 1_microDoppler_spectrograms_labeled.zip … is the micro Doppler data of participant 1

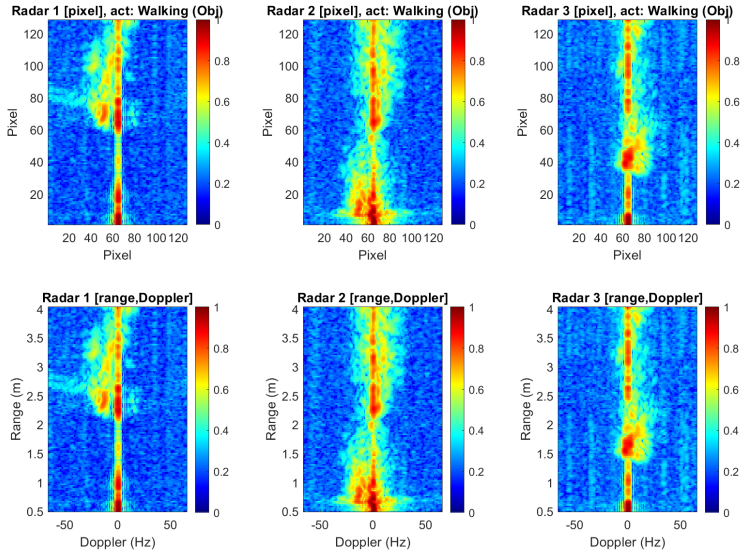

Figure 6: 1_rangeDoppler_maps_labeled.zip … is the range Doppler data of participant 1

Description and notification table

Participant	File	Sub file
0 (Backgr. noise)	'0_microDoppler_spectrograms_labeled.zip'	'0_1_microDoppler_spectrograms_labeled.mat'
0 (Backgr. noise)	'0_rangeDoppler_maps_labeled.zip'	'0_1_rangeDoppler_maps_labeled.mat'
0 (Backgr. noise)	0_range_time_maps_labeled.zip'	'0_1_range_time_maps_labeled.mat'
0 (Backgr. noise)	'0_microDoppler_spectrograms_labeled.zip'	'0_2_microDoppler_spectrograms_labeled.mat'
0 (Backgr. noise)	'0_rangeDoppler_maps_labeled.zip'	'0_2_rangeDoppler_maps_labeled.mat'
0 (Backgr. noise)	0_range_time_maps_labeled.zip'	'0_2_range_time_maps_labeled.mat'
1	'1_microDoppler_spectrograms_labeled.zip'	'1_1_microDoppler_spectrograms_labeled.mat'
1	'1_rangeDoppler_maps_labeled.zip'	'1_1_rangeDoppler_maps_labeled.mat'
1	'1_range_time_maps_labeled.zip'	'1_1_range_time_maps_labeled.mat'
1	'1_microDoppler_spectrograms_labeled.zip'	'1_2_microDoppler_spectrograms_labeled.mat'
1	'1_rangeDoppler_maps_labeled.zip'	'1_2_rangeDoppler_maps_labeled.mat'
1	'1_range_time_maps_labeled.zip'	'1_2_range_time_maps_labeled.mat'
1	'1_microDoppler_spectrograms_labeled.zip'	'1_3_microDoppler_spectrograms_labeled.mat'
1	'1_rangeDoppler_maps_labeled.zip'	'1_3_rangeDoppler_maps_labeled.mat'
1	'1_range_time_maps_labeled.zip'	'1_3_range_time_maps_labeled.mat'
2	'2_microDoppler_spectrograms_labeled.zip'	'2_1_microDoppler_spectrograms_labeled.mat'
2	'2_rangeDoppler_maps_labeled.zip'	'2_1_rangeDoppler_maps_labeled.mat'
2	'2_range_time_maps_labeled.zip'	'2_1_range_time_maps_labeled.mat'
2	'2_microDoppler_spectrograms_labeled.zip'	'2_2_microDoppler_spectrograms_labeled.mat'
2	'2_rangeDoppler_maps_labeled.zip'	'2_2_rangeDoppler_maps_labeled.mat'
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2	'2_microDoppler_spectrograms_labeled.zip'	'2_3_microDoppler_spectrograms_labeled.mat'
2	'2_rangeDoppler_maps_labeled.zip'	'2_3_rangeDoppler_maps_labeled.mat'

2	'2_range_time_maps_labeled.zip'	'2_3_range_time_maps_labeled.mat'
3	'3_microDoppler_spectrograms_labeled.zip'	'3_1_microDoppler_spectrograms_labeled.mat'
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6	'6_range_time_maps_labeled.zip'	'6_1_range_time_maps_labeled.mat'
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6	'6_range_time_maps_labeled.zip'	'6_2_range_time_maps_labeled.mat'
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11	'11_range_time_maps_labeled.zip'	'11_3_range_time_maps_labeled.mat'

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14	'14_rangeDoppler_maps_labeled.zip'	'14_3_rangeDoppler_maps_labeled.mat'
14	'14_range_time_maps_labeled.zip'	'14_3_range_time_maps_labeled.mat'

Corresponding classes

All classes in the label vector are associated as:

Labels	Label Names
0	'Junk/BRN'
1	'Walking'
2	'Stationary'
3	'Sitting down'
4	'Standing up (Sit)'
5	'Bending (Sit)'
6	'Bending (Sta)'
7	'Falling (Wlk)'
8	'Standing up (Fal)'
9	'Falling (Sta)'
10	'micro Gesture'
11	'Walking (Obj)'