Readme

Dataset of Fully Polarimetric Rough Surface Scattering from Sandpaper and Road Surfaces in Various Conditions Measured at 75 to 85 GHz

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Referencing the Dataset

W. Bouwmeester, F. van der Zwan, F. Fioranelli, and A. Yarovoy, "Dataset of fully polarimetric rough surface scattering from sandpaper and road surfaces in various conditions at 75 to 85 GHz." doi: 10.4121/3df8777a-3c9a-4a1f-a2d5-f487ca211897.

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@misc{bouwmeester-data-2023,
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and Road Surfaces in Various Conditions Measured at 75 to 85 {{GHz}}},
  author = {Bouwmeester, Wietse and {van der Zwan}, Fred and Fioranelli, Francesco
and Yarovoy, Alexander},
  doi = {10.4121/3df8777a-3c9a-4a1f-a2d5-f487ca211897}
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Reference for reading material of the used dataset

W. Bouwmeester, F. Fioranelli, and A. Yarovoy, "Road Surface Conditions Identification via HaA Decomposition and Its Application to mm-Wave Automotive Radar," *Under review for IEEE Transactions on Radar Systems*, 2023.
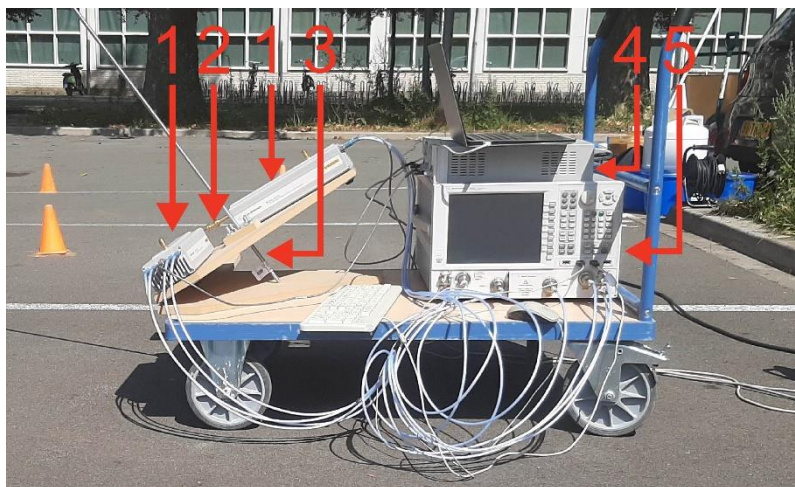
Dataset collection

Measurement Setup

Fig. 1. Photograph of the setup as used for outdoor measurements to record surfaces-under-test at various angles of incidence.

In Fig. 1, a picture of the measurement setup is shown. The measurement consists of:

1. N5260-60003 Millimetre wave frequency extenders to perform measurements at 75-85 GHz.
2. SAR-1532-122-S2-DP Dual polarised horn antenna and corresponding waveguides to connect it to the frequency extenders.
3. Antenna support structure, allowing to change the orientation angle of the antenna with respect to the surface normal.
4. Power supplies to power the frequency extenders
5. N5242A Vector Network Analyser

Port 1 of the VNA was connected to the V polarised port of the antenna while port 2 is connected to the H polarised port.

The settings of the measurement system are shown in the table 1.

Table 1. Settings of the Vector Network Analyser and Frequency Extenders.

Centre Frequency	80 GHz
Bandwidth	10 GHz
Sweep Points	1001
Intermediate Frequency Bandwidth	10 kHz
Sweep Time	120.82 ms
Power	+16 dBm
Frequency Extender Attenuator	0 dB

Measurement Geometry

Fig. 2 shows the geometry of the measurement setup. The sample is indicated by the orange surface while its normal vector is indicated by $\hat{n}$. The antenna orientation angle is measured between the surface normal $\hat{n}$ and the antenna broadside direction and is indicated by α. Lastly, the antenna is placed at a height h above the surface. For the indoor measurements, this height is 26.5 cm while for the outdoor measurements, this height was 38 cm.
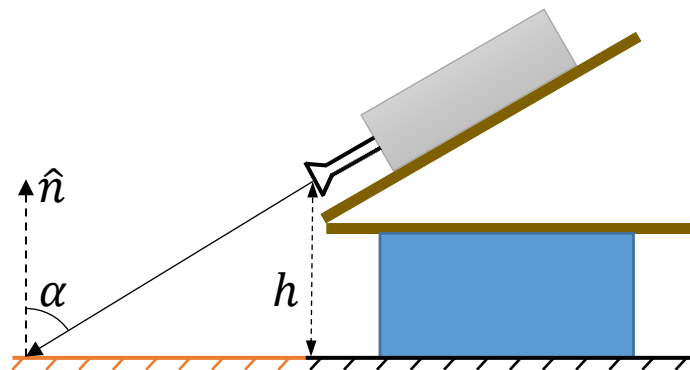

Fig. 2. Schematic drawing of the measurement geometry.

Measurement Procedure

Measurements of sandpaper were performed indoor in the lab, while road surfaces in different conditions were measured outdoors.

Before measurement sessions started, first the VNA was calibrated using a short-open-load-through procedure to move the reference planes to the ports of the frequency extenders.

The measurement procedure for measurements in the lab worked as follows:

1. Set the correct antenna orientation angle by adjusting the antenna support structure.
2. Perform background measurement of floor and environment.
3. Place the sandpaper sample in front of the antenna.
4. Move the sandpaper sheet a few centimetres such that the surface within the antenna beam footprint is uncorrelated to the surface area measured during the previous measurements.
5. Perform single sweep measurement and save data.
6. Remove sample from the measurement area and perform more background measurements after a number of measurements.
7. Repeat from step 3, until 50 measurements are completed.

The measurement procedure for outdoor measurements is as follows:

1. Set the correct antenna orientation angle by adjusting the antenna support structure.
2. Prepare the road surface to be in the to-be-measured condition.
3. Move the trolley with the measurement setup a few centimetres such that the surface within the antenna beam footprint is uncorrelated to the surface area measured during the previous measurements.
4. Perform single sweep measurement and save data.
5. Repeat from step 2, until 50 measurements are completed.

Outdoor background measurements were performed by pointing the antenna towards the sky before and after all surface conditions were measured.

Samples

The measured sandpaper were: P24, P60, and P100. A picture of the P24 sandpaper is shown in Fig. 3. All sandpaper sheets were larger than 1.5 by 2 metres.

Fig 3. Picture of the measurement of P24 sandpaper.

The measured road surface conditions were: dry asphalt, wet asphalt, asphalt covered with basalt gravel, consisting of basalt split with sizes ranging from 2 to 8 mm. These are shown in Fig. 4.

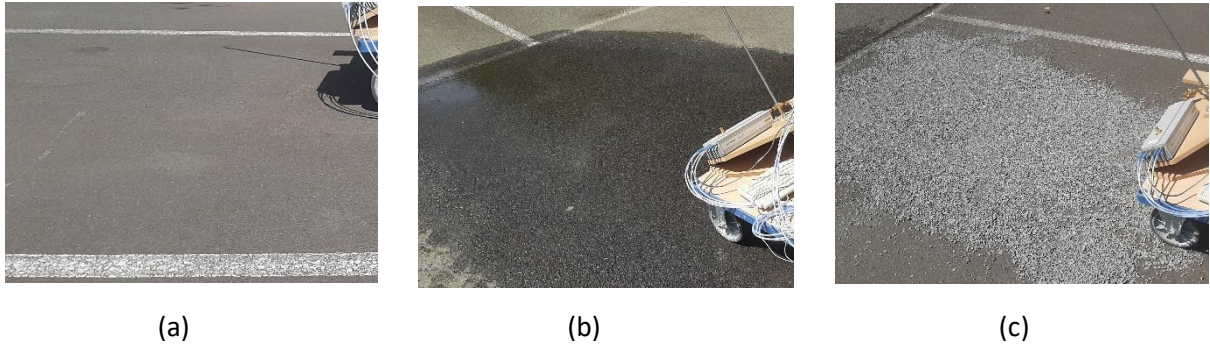(a)   (b)   (c)

Fig. 4. Pictures of the measured road surface conditions. (a) Dry asphalt. (b) Wet asphalt. (c) Asphalt covered with gravel, consisting of basalt split with sizes ranging from 2 to 8 mm.

Dataset file description

Dataset organisation description

The dataset is organised as separate folders, each representing measurements of a different surface or calibration measurement. The name of the folder indicates the target type followed by an antenna orientation angle if applicable.

Inside of the sandpaper measurement folder, also a background folder containing the background measurements is available. Inside of these background folders, subfolders exist that contain the background that were performed before the measurement as indicated by the folder name and background measurements that were performed after the measurement as indicated by the respective folder name.

The folder "Sphere 60deg" contains measurements of a metal sphere placed on a Styrofoam block. This folder contains subfolders of measurements of the foam block only before placing the sphere on the block, measurements of the sphere placed on the foam block, and measurements of the foam block after removing the metal sphere.

The folders "Background Outdoors Before" and "Background Outdoors After" contain background measurements that were performed outdoors before starting the measurements and after completing all outdoor measurements.

.CSV Description

The S-parameter measurements are stored as comma separated files. The 9 fields of the comma separated files represent the following:

$$Frequency\ [Hz], Real(S_{11}), Imag(S_{11}), Real(S_{12}), Imag(S_{12}), Real(S_{21}), Imag(S_{21}), Real(S_{22}), Imag(S_{22})$$