Dataset from a microphone array measurement of a rotating fan

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1 Overview

The following instruction gives a summary of an microphone array measurement conducted at the TU Berlin in October 2019. The setup consists of a five-bladed fan with a diameter of 800 *mm* and a sunflower array with 63 microphones as well as a laser trigger. Figure 1 shows a Photograph of the experiment. The given dataset contains 9 measurement files with different rpm speeds and distances between the array and the fan as well as a modified blade and a bluff body in front of the leading edge as a disruption. Overall about 200 different cases were measured. Additional data can be provided on request.

2 Microphone array

The array consists of 63 microphones which are ordered in a single sunflower spiral [1]. The spiral parameter H which defines the radial distribution of the microphones is chosen to be 1.0 and the parameter V defining the azimuthal distribution of points is set to 5.0. The parameters are chosen according to Sarradj [2]. The array aperture of the array is $d_{spiral} = 1.5\,\mathrm{m}$. The array is shown in Figure 2. The type of microphones used is GRAS 40PL-1 Short CCP and the distance between the array center and the fan was from 0.715 m to 1.210 m.

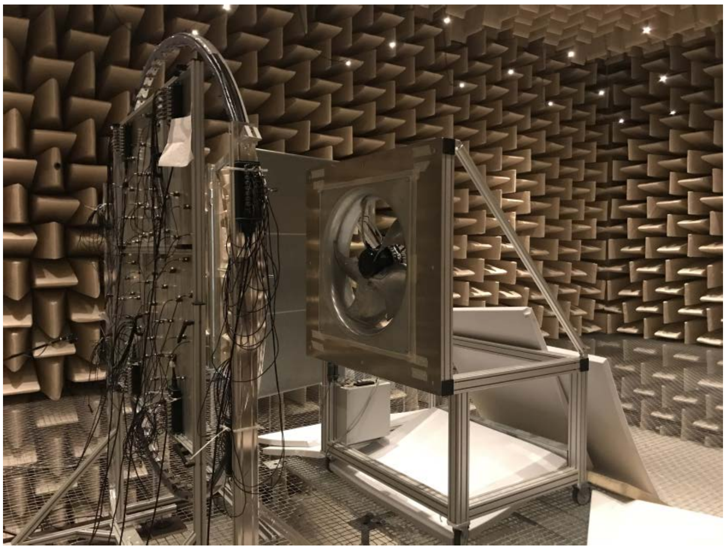


Figure 1: Photograph of the fan measurement setup in the anechoic chamber at TU Berlin.

3 Fan

The revolution per minutes of the fan are set by a control voltage between 0% and 100% fan power. At 0 % the fan is not moving and at 100 % the fan reaches a rotational speed of approximately 1050 revolutions per minute. A Sketch of the front view of the fan as well as the side view of the setup is shown in Figure 3.

4 Purpose of the measurement

The measurement is conducted to localize the sound distribution of a rotating source using multichannel microphone measurements. The spiral Array configuration was chosen to test an extension of the virtual rotating array method for arbitrary microphone configurations [3].

5 Measurement data

The measurement time is 40 s with a sampling frequency of 51200 Hz. The sound pressure data is stored in the channels 0 to 62. The trigger-per-revolution signal was synchronized to the pressure measurement and is stored in channel 63. The trigger data has a peak to 70 when the laser is hitting the reflector and is 0 elsewhere. The trigger point is marked by the rising slope of the trigger signal. An exemplary trigger signal is shown in Figure 4. All data is stored in a HDF5 data format under the time_data key. The sampling frequency is stored under the time_data key as well. The air temperature during the measurements is between 20.5°C and 21.6°C . Table 1 shows the configuration

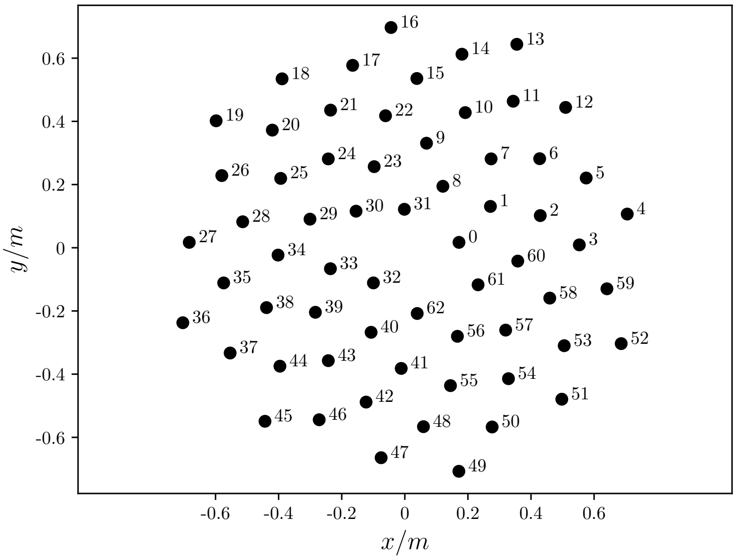
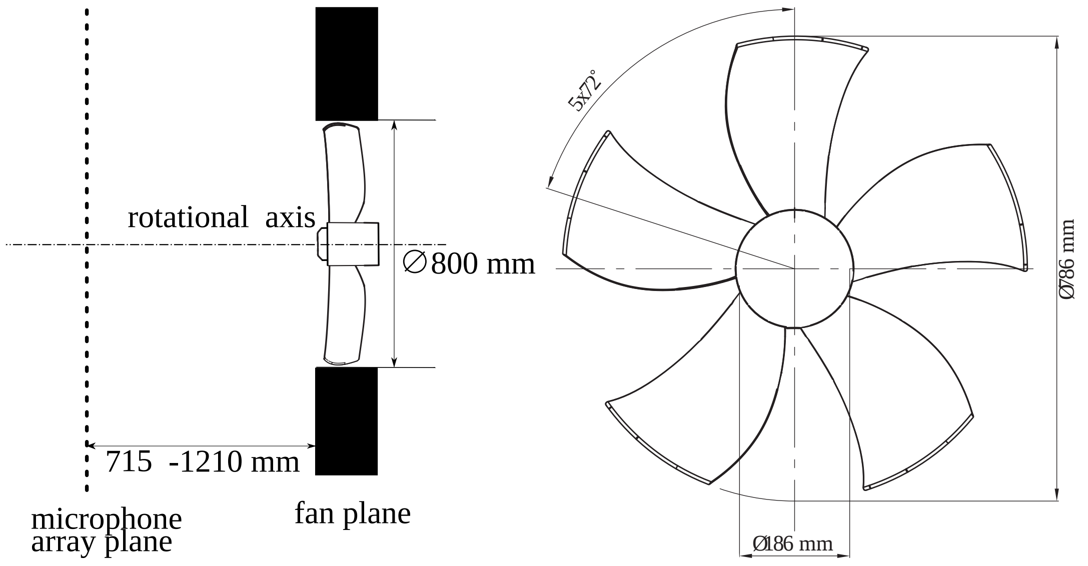


Figure 2: Distribution of microphone sensors in the array.

for each measurement file. The Modifies column indicates three different modifications to the experimental setup: 'Bluff body' indicates a 0.04×0.04 m metal square rod in front of the suction side at 0° angle. 'Blade modified' points out a tripping wire at the pressure side on one fan blade and the modification 'Rotational Axis' specifies that the rotational axis of the fan is moved $+0.20$ m in vertical direction. The modifications 'Blade modified' and 'Bluff body' are shown in Figure 5.

Table 1: Measurement data files.

Filename	Distance	Temperature	Rpm	Modifies
2019-10-23_10-57-15_767607.h5	1.21 m	20.9 [°C]	40%	-
2019-10-23_11-10-13_488297.h5	1.21 m	20.9 [°C]	60%	-
2019-10-23_11-24-10_702272.h5	1.21 m	21 [°C]	80%	-
2019-10-23_11-30-27_924582.h5	1.21 m	21 [°C]	100%	-
2019-10-23_13-34-55_206129.h5	1.21 m	21 [°C]	100%	Bluff body
2019-10-24_10-47-39_584220.h5	0.829 m	20.5 [°C]	100%	-
2019-10-23_18-33-36_788290.h5	0.829 m	21.6 [°C]	100%	Blade modified
2019-10-24_11-20-51_276506.h5	0.829 m	20.7 [°C]	100%	Bluff body
2019-10-24_13-38-58_084273.h5	0.859 m	20.9 [°C]	100%	Rotational Axis



(a) (b)

Figure 3: Sketch of the fan measurement setup. (**a**) shows the side view of the setup and (**b**) shows the front view of the fan.

6 List of files

- tub_vogel63.xml - Microphone positions in the array
- Measurement_data.zip - Archive of the time data. Contains the .h5 files listed in Table 1
- Fan_position_at_trigger.jpg - A photograph of the orientation of the fan at the trigger point
- Fan_dimensions.pdf - A sketch of the fan
- calib.xml - The calibration file for each microphone channel

References

[1] H Vogel. "A Better Way to Construct the Sunflower". In: *Mathematical Biosciences* 44 (1979), pp. 179–189.

[2] E Sarradj. "A Generic Approach To Synthesize Optimal Array Microphone Arrangements". In: *Proceedings of the 6th Berlin Beamforming Conference* (2016), pp. 1–12.

[3] Simon Jekosch and Ennes Sarradj. "An extension of the virtual rotating array method using arbitrary microphone configurations for the localization of rotating sound sources ." In: *MDPI Acoustics* 2 (2020), pp. 1–13.

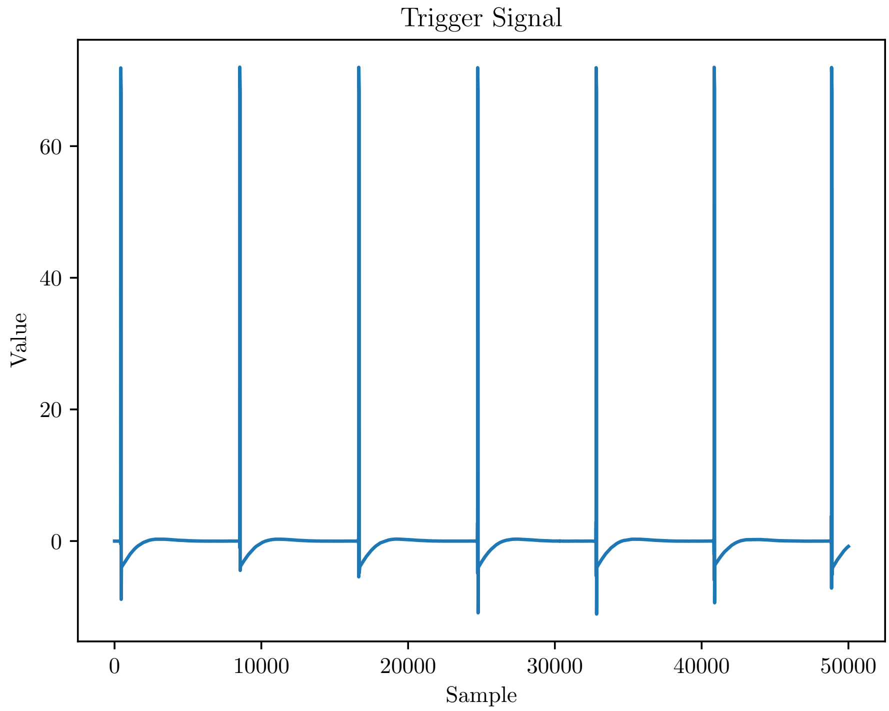
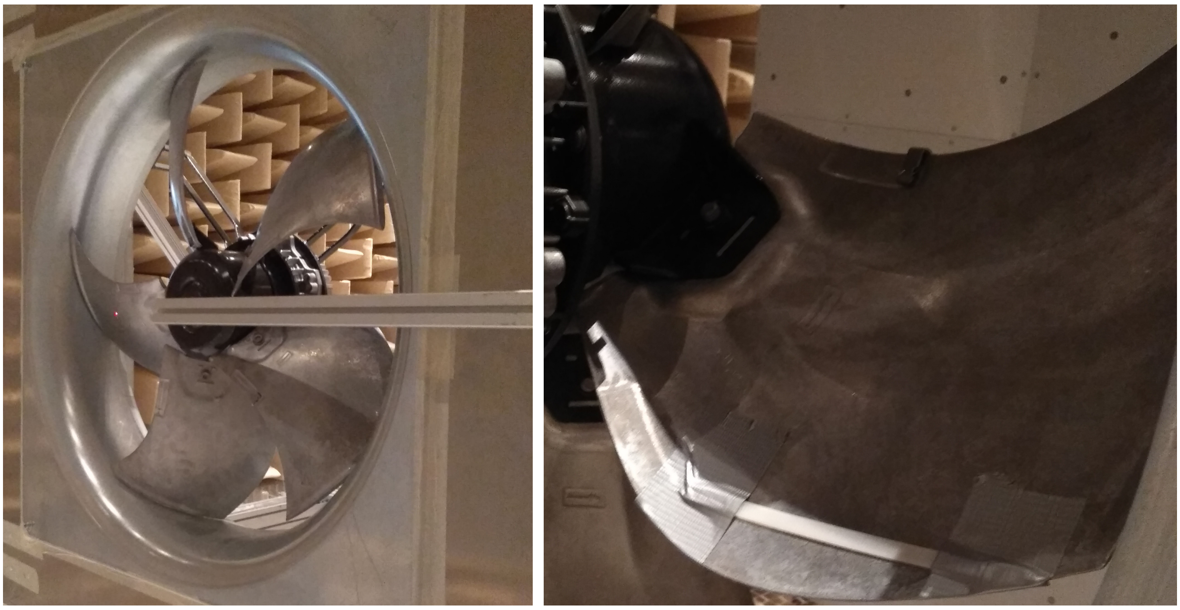


Figure 4: A trigger signal over time.



(a)

(b)

Figure 5: Modifications of the measurement setup. (**a**) Bluff body and (**b**) Blade modified.