



Data Article

Indoor and outdoor environmental data: A dataset with acoustic data acquired by the microphone embedded on mobile devices



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ABSTRACT

All mobile devices include a microphone that can be used for acoustic data acquisition. This article presents a dataset of acoustic signals related to nine environments, captured with a microphone embedded on off-the-shelf mobile devices. The mobile phone can be placed in the pants pockets, in a wrist-band, over the bedside table, on a table, or on other furniture. Data collection environments are bar, classroom, gym, kitchen, library, street, hall, living room, and bedroom. The data was collected by 25 individuals (15 men and 10 women) in different environments around Covilhã and Fundão municipalities (Portugal). The microphone data was sampled with 44,100 Hz into an array with 16-bit unsigned integer values in the range [0, 255] with a 128 offset for zero. The dataset presented in this paper presents at least 2000 samples of 5 s of data for each environment, corresponding to around 2.8 h for each environment into text files. In total, it includes at least 25.2 h of acoustic data for the implementation of data

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processing techniques, e.g., Fast Fourier Transform (FFT), and other machine learning methods for the different analysis.
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Specifications Table

Subject	Acoustics and Ultrasonics Electrical and Electronic Engineering Biomedical Engineering Health
Specific subject area	Environments Microphone Mobile Devices
Type of data	Table
How data were acquired	The data was acquired from the microphone available in a BQ Aquaris 5.7 smartphone [1] with a mobile application. The mobile device has a Quad Core CPU and 16 GB of internal memory. Different places were used to position the mobile device during the data acquisition, including the front pocket of the pants, a wristband, a bedside table, a table, or other furniture. The mobile device automatically acquires the acoustic data related to the different environments, and the user selects the environment where the mobile device is placed. There are no specific specifications needed for the acquisition of the data. Still, it was acquired at the same time as the inertial sensors data for the activities presented in [2].
Data format	Raw text files
Parameters for data collection	Depending on the environments, the mobile device was placed in different places according to the environments' restrictions. Initially, the individual selects the environment in the mobile application to label the various records. The protocol of using the mobile application and its actions were explained to the participants before starting the data acquisition.
Description of data collection	After selecting the environment in the user interface of the mobile application, the user places the mobile device in a position that she/he chooses, including the front pocket of the pants, a wristband, a bedside table, a table, or other furniture. The microphone data is collected as a byte array and stored in text files for further analysis during the data acquisition. The microphone acquires the data with a sample rate of 44,100 Hz in a mono channel as an array of 16-bit unsigned integer values in the range [0, 255] with a 128 offset for zero.
Data source location	Primary data sources: City/Town/Region: Covilhã Country: Portugal Latitude and longitude (and GPS coordinates, if possible) for collected samples/data: 40° 16' 50.037'' N 7° 30' 15.555'' W City/Town/Region: Fundão Country: Portugal Latitude and longitude (and GPS coordinates, if possible) for collected samples/data: 40° 7' 30.129'' N 7° 30' 39.966'' W
Data accessibility	Repository name: Raw dataset with acoustic data for environments - Part 1 Data identification number: 10.17632/yjp2cdyrnj.2 Direct URL to data: http://dx.doi.org/10.17632/yjp2cdyrnj.2 Repository name: Raw dataset with acoustic data for environments - Part 2 Data identification number: 10.17632/yczyfrx2rp.2 Direct URL to data: http://dx.doi.org/10.17632/yczyfrx2rp.2 Repository name: Raw dataset with acoustic data for environments - Part 3 Data identification number: 10.17632/bmgn76p7b6.2

(continued on next page)

Related research article

Direct URL to data: <http://dx.doi.org/10.17632/bmgn76p7b6.2>

Repository name: Raw dataset with acoustic data for environments - Part 4

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Value of the Data

- The importance of this dataset is related to the creation of methods and/or patterns for the automatic and easy identification of environments for the monitoring systems for different types of people. The presented dataset includes general environments that can be frequented by diverse people;
- The data will allow the development of automatic methods for the identification of the environments that the persons are frequenting, and the promotion of healthy habits at the different locations [3];
- The use of mobile devices for the data acquisition allows the identification of uncontrolled environments in different circumstances, allowing the identification of the environments for the improvement of the results of a Personal Digital Life Coach;
- Some people need assistance during the daily activities with the monitoring of the environment with acoustic data that is largely available around the world, allowing to prevent some possible problems that may occur with different people;
- Big data and machine learning techniques may be combined to support the different daily activities [4]. These data may be the start of developing a solution for the identification of environments that may be combined with other data around the world.

1. Data Description

Recently, various studies have been performed for the identification of the different acoustic environments using the data acquired from mobile devices, since complex algorithm or simple methods implemented locally in a mobile device [5–7]. The data intends to present acoustic data related to different environments for the future development of a Personal Digital Life Coach [8–10]. The acquisition of data with people with various lifestyles, and different locations allows the future generalization of the acquired data for the including in a reliable instrument for the identification of different environments [11].

This paper presents a dataset with the microphone data byte values related to nine environments, including bar, classroom, gym, kitchen, library, street, hall, living room, and bedroom. A BQ Aquaris 5.7 smartphone [1], placed in the several positions, including pants' front pocket, on a wristband, over the bedside table, on a table, or on other furniture, was used for the data acquisition.

The dataset is distributed by five repositories composed, in total, of eleven main folders, i.e., one folder for each environment, and each folder contains more than 2000 numbered folders with the files related to the data acquired from the raw data of the microphone available in the off-the-shelf mobile device. Each subfolder contains one file named as "sound.txt". In total, the dataset contains around 18,000 files related to the acoustic data. The different files contain

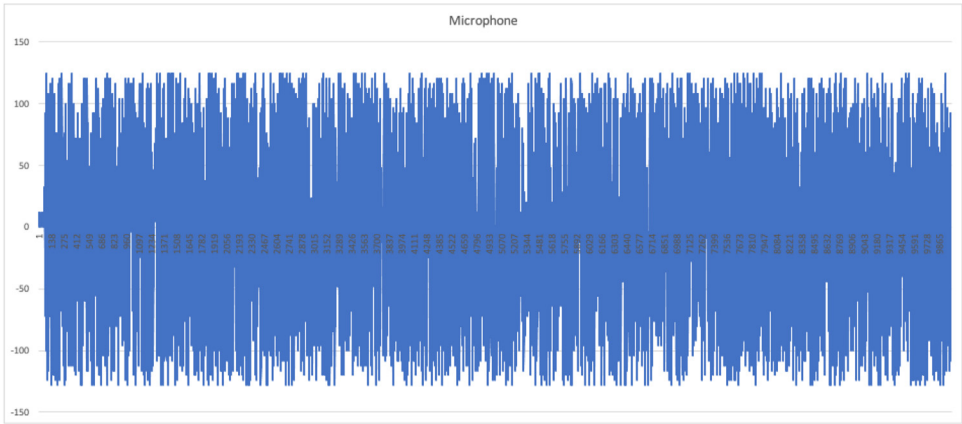


Fig. 1. Example of microphone data related to gym environment are byte array.

the values of the bit arrays acquired for 5 s, where each value of the byte arrays acquired during the defined time are presented in only one column with integer values.

As an example, Fig. 1 presents an excerpt of the data acquired in the gym environment. The original file contains 348,160 rows, where Fig. 1 presents 10,000 rows.

The analysis of the raw data acquired from the microphone available in the off-the-shelf mobile device. For the analysis, 26 Mel-frequency cepstral coefficients (MFCC) [12] and statistical features are extracted from the data recorded in the different files. For the calculation of MFCC, the Fast Fourier Transform (FFT) was applied. Thus, the MFCC coefficients retrieves data related to the sound as a short-term power spectrum composed by a linear cosine transform of a log power spectrum on a nonlinear Mel-scale of frequency, which, as previously used in other studies, e.g., [7,13], it consists in the codification of audio data for the identification of the different frequencies. It allows the categorization of the different data collected, because it discretizes the data for the correct identification. Finally, the statistical features are:

- Standard deviation: The standard deviation of values was calculated;
- Average: The mean of values was calculated;
- Variance: The variance of values was calculated;
- Median: The median of values was calculated.

Table 1 presents the average of the features of all samples of the microphone raw data related to each environment.

2. Experimental Design, Materials and Methods

The smartphone acquired samples with five seconds of acoustic data collected from the microphone of the smartphone. The data were collected with a smartphone in different places according to the different environments, as presented in Table 2.

2.1. Participants

The experiments were performed by twenty-five randomly selected individuals aged between 16 and 60 years old. The participants' lifestyle is significant for the Bar, Gym, Hall, and Street environments, where the mobile device is positioned related to the user's body. Thus, from the

Table 1
Average of the features calculated for each environment with the acoustic data.

Parameters	Bar	Classroom	Gym	Hall	Kitchen	Library	Bedroom	Street	Living room
MFCC 1	1.425	3.202	1.300	1.210	3.941	1.940	0.716	1.139	1.631
MFCC 2	1.904	4.324	1.707	1.678	5.255	2.595	1.010	1.578	2.238
MFCC 3	1.609	3.768	1.366	1.584	4.394	2.195	1.000	1.486	2.047
MFCC 4	1.227	3.014	0.937	1.447	3.234	1.662	0.985	1.354	1.771
MFCC 5	0.863	2.238	0.551	1.288	2.066	1.131	0.968	1.202	1.459
MFCC 6	0.586	1.580	0.285	1.130	1.120	0.704	0.951	1.055	1.154
MFCC 7	0.410	1.101	0.145	0.984	0.505	0.419	0.933	0.929	0.885
MFCC 8	0.309	0.792	0.088	0.858	0.209	0.258	0.915	0.834	0.664
MFCC 9	0.249	0.606	0.069	0.752	0.150	0.177	0.898	0.768	0.488
MFCC 10	0.206	0.490	0.059	0.664	0.229	0.135	0.879	0.726	0.350
MFCC 11	0.174	0.409	0.055	0.590	0.364	0.107	0.859	0.699	0.242
MFCC 12	0.156	0.343	0.057	0.529	0.501	0.086	0.838	0.677	0.158
MFCC 13	0.157	0.287	0.063	0.479	0.601	0.071	0.816	0.654	0.090
MFCC 14	0.172	0.237	0.063	0.440	0.632	0.061	0.793	0.624	0.034
MFCC 15	0.192	0.193	0.052	0.409	0.578	0.055	0.768	0.585	−0.012
MFCC 16	0.208	0.153	0.036	0.384	0.441	0.049	0.742	0.537	−0.049
MFCC 17	0.214	0.117	0.023	0.363	0.253	0.045	0.715	0.483	−0.078
MFCC 18	0.208	0.087	0.022	0.344	0.065	0.041	0.686	0.427	−0.100
MFCC 19	0.190	0.066	0.031	0.326	−0.063	0.039	0.657	0.376	−0.115
MFCC 20	0.161	0.053	0.041	0.307	−0.093	0.038	0.628	0.333	−0.127
MFCC 21	0.127	0.049	0.042	0.287	−0.025	0.038	0.599	0.304	−0.138
MFCC 22	0.090	0.050	0.034	0.265	0.108	0.036	0.571	0.290	−0.150
MFCC 23	0.053	0.049	0.025	0.241	0.250	0.033	0.543	0.286	−0.161
MFCC 24	0.019	0.045	0.019	0.217	0.349	0.028	0.515	0.289	−0.170
MFCC 25	−0.011	0.035	0.021	0.195	0.380	0.023	0.485	0.292	−0.173
MFCC 26	−0.034	0.021	0.026	0.175	0.352	0.019	0.455	0.291	−0.171
Standard Deviation	0.037	0.034	0.038	0.040	0.017	0.047	0.005	0.041	0.031
Average	0.632	0.517	0.701	0.570	0.505	0.439	0.772	0.527	0.573
Variance	0.001	0.001	0.002	0.002	0.001	0.003	0.000	0.002	0.001
Median	0.632	0.517	0.701	0.570	0.505	0.439	0.772	0.527	0.573

Table 2
Position of the smartphone in different environments.

Environments	Placement
Bar	Over a table; Front pocket of the pants; Over other furniture
Classroom	Over a table; Over other furniture
Gym	Over a table; Front pocket of the pants; On a wristband; Over other furniture
Hall	Front pocket of the pants; On a wristband
Kitchen	Over a table; Over other furniture
Library	Over a table; Over other furniture
Bedroom	Over the bedside table; Over a table; Over other furniture
Street	Front pocket of the pants; On a wristband
Living room	Over a table; Over other furniture

different individuals, 10 participants are mainly active, and the remaining 15 participants are mainly sedentary.

(1) Age = 33.5200 ± 13.5250 years old

2.2. Procedure

After the smartphone placement on the furniture or in the user's garments, the microphone data was recorded with an Android application. Initially, the person selects the environment in the mobile application. Then, the user presses the button to start the data acquisition. After that, the user positions the mobile device adequately as presented in Fig. 2.

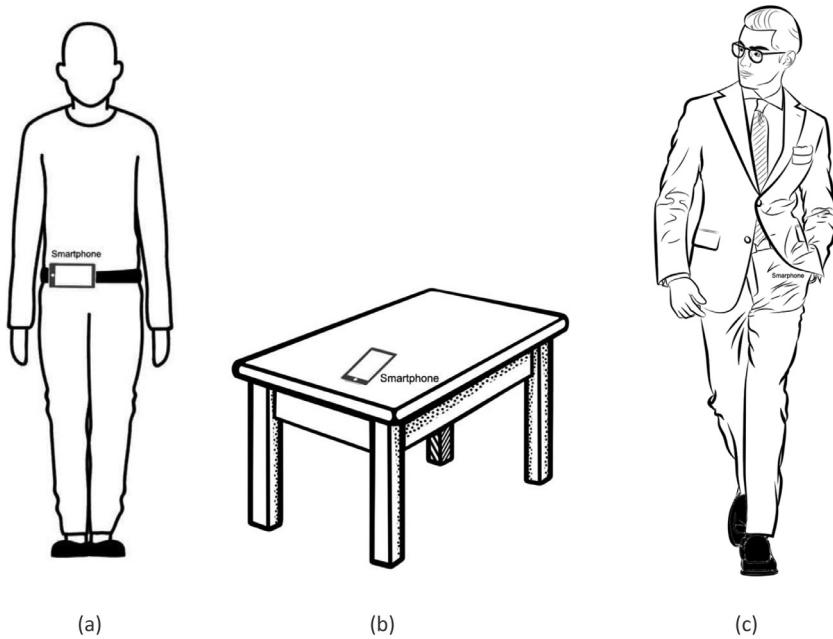


Fig. 2. Positioning of the smartphone during the data acquisition. (a) The smartphone is positioned in a waistband. (b) The smartphone is positioned over a table. (c) The smartphone is positioned in the pocket of the pants. Image partly adapted from <https://www.needpix.com/photo/1811318/man-business-man-business-person-people-tie-professional-grown-up-businessman>.

This dataset was acquired with an easy positioning of the mobile device for the data acquisition related to the different environments, such as bar, classroom, gym, kitchen, library, street, hall, living room, and bedroom. All people with different conditions can to understand the information for the data acquisition. These are:

- (1) Install the mobile application on the mobile device;
- (2) Open the mobile application designed for the acquisition of the sensors' data;
- (3) The user selects the environment where the mobile device is in;
- (4) Press the button to start the data acquisition;
- (5) The data acquisition starts after 10 s;
- (6) The user positions the mobile device adequately;
- (7) The data acquisition is performed during slots of 5 s;
- (8) The data acquisition stops for 5 min;
- (9) The flow returns to point 7, and it repeats continuously until the user press the button to stop data acquisition.

Ethics Statement

The participants signed an ethical agreement to allow us to share the results of the tests in an anonymous form. The agreement also provided the participants' informed consent considering the risks and the objective of the study. Only the data related to the individuals that sign the consent to participate in the study were recorded. The participants were also informed that about the inclusion of the data anonymously in Mendeley Data. Ethics Committee from Universidade da Beira Interior approved the study with the number CE-UBI-Pj-2020-035.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

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