Noise mapping based on participative measurements with a smartphone

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Introduction

• **(Effect of) Noise in Europe:**
  “Excessive noise seriously harms human health and interferes with people’s daily activities at school, at work, at home and during leisure time. It can disturb sleep, cause cardiovascular and psychophysiological effects, reduce performance and provoke annoyance responses and changes in social behaviour.”

• **European Environmental Noise directive 2002/49/EC**
  “define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to the exposure to environmental noise”
Introduction

• **Noise mapping:**
  – To identify noise pollution
  – To propose action plans to reduce noise
  – To communicate with citizens

• **Methods:**
  – **Modelling** of noise emission and propagation (NMPB, CNOSSOS, ISO 9613…)
  – **Measuring** real noise in urban areas (noise observatories): need a large amount of “qualified” data.
Introduction

• **Alternative approach:**
  
  *Develop a participative approach based on collaborative noise maps using smartphones (i.e. citizens) for a massive acquisition of noise data in urban environment*


  – Made by specialists in Geomatics and in Acoustics
  – Citizen both producer and consumer of data
  – Build a qualified noise database
  – Produce “real” and relevant noise maps
  – Share database and noise maps with communities
Summary

- Introduction
- General overview
- NoiseCapture application
- Spatial Data Infrastructure (SDI)
- Processing data
- Conclusion & prospects
General overview

NoiseCapture Android App → OnoMap SDI → Raw database → Noise maps


NoiseCapture Android App

Measurement

Description

Indicators

Visualization
• **Audio restrictions** *(SHOULD / MUST since Android 4.3)*
  - Format:
    * Linear PCM, 16-bit
  - Sampling rates (Hz):
    * 8000, 11025, 16000, (22500), 44100, (48000)
  - Frequency response:
    * ±3 dB, from 100 Hz to 4000 Hz
  - Amplitude response:
    * 30 dB range from -18 dB to +12 dB @ 90 dB SPL
  - Total harmonic distortion:
    * less than 1% for 1000 Hz at 90 dB SPL

https://source.android.com/compatibility/5.1/android-5.1-cdd#5_4_audio_recording
Smartphones and Apps accuracy: see Kardous & Shaw, JASA 135(4) and JASA 140(4)
NoiseCapture Android App

- **Audio measurement**
  - Noise reduction processing disabled
  - Automatic gain control disabled
  - Respect of the audio input sensitivity 90dB@1000Hz

- **Audio processing**
  - No audio recording (anonymised data, privacy policy)
  - FFT analysis (short@1s & fast@125ms)
  - Calibration with a reference device
  - Noise indicators calculation: LAeq, LA%, spectrum
Raw database (online: http://data.noise-planet.org/noisecapture/)

3 GeoJSON files

* .areas.geojson

```json
{
"type": "Feature",
"geometry": {
   "type": "Point",
   "coordinates": [125.6, 10.1]
},
"properties": {
   "name": "Dinagat Islands"
}
}
```

* .tracks.geojson

* .points.geojson

* .areas.geojson
Raw database

Be careful on the relevance of data

![Speed distribution](image)

![GPS accuracy distribution](image)

Information provided by the user

![Pleasantness distribution](image)

![Number of tags per track](image)

Tracks

- 2,837

Points

- 470,869

Points with speed

- 116,004 (27%)

Tracks with pleasantness

- 1,972 (70%)

Tracks with tags

- 1,411 (50%)
Noise maps (first level: no filtering)
Noise maps (second level)

See P. Aumond et al, Acoustic mapping based on measurements: space and time interpolation, Internoise 2017, Hong Kong
Conclusion & prospects

- A comprehensive and open infrastructure for producing noise data from smartphones, with a special attention (but perfectible) to the audio-processing.
- A raw database for the need of the scientific community in order to produce a relevant evaluation of noise in the environment.

- Enhancement of the calibration and audio process.
- Methodologies for Data Quality Assessment.
- Production of noise maps for a more relevant assessment of the quality of the noise environment.
- Manage temporal vs spatial data.
Thank you for your attention

More information on the project:

Download NoiseCapture App on Google Play:

Community noise maps:

Download data (per country):

Follow the development of NoiseCapture on GitHub plateform:
https://github.com/Ifsttar/NoiseCapture

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Raw database

*.tracks.geojson (raw data)

- `time_ISO8601`: start time of measurement in ISO 8601
- `time_epoch`: start time of measurement in UTC
- `pk_track`: database track primary key
- `track_uuid`: track universally unique identifier
- `gain_calibration`: signal gain calibration in dB
- `noise_level`: LAeq along the track
- `Tags`: user supplied noise tags
- `Pleasantness`: user supplied pleasantness 0-100
Raw database

*.points.geojson (raw data)

- pk_track: track primary key
- time_ISO8601: measurement time in ISO 8601
- time_epoch: measurement time in UTC
- time_gps_ISO8601: GPS measurement time in ISO 8601
- time_gps_epoch: GPS measurement time in UTC
- Noise_level: LAeq,1s in dB(A)
- speed: GPS provided speed (not accurate)
- Orientation: GPS provided orientation (not accurate)
- Accuracy: GPS localization accuracy in meters
Raw database

*.areas.geojson (pre-process)

- `cell_q`: hexagon q coordinate (EPSG:3857- WGS84)
- `cell_r`: hexagon r coordinate (EPSG:3857- WGS84)
- `La50`: LA50 in dB(A)
- `laeq`: LAeq in dB(A)
- `mean_pleasantness`: mean pleasantness
- `measure_count`: number of seconds of measurements
- `first_measure_ISO_8601`: date of the first measurement
- `first_measure_epoch`: date of the first measurement
- `last_measure_ISO_8601`: date of the last measurement
- `last_measure_epoch`: date of the last measurement
- `leq_profile`: 72 hours LAeq levels