Sensing Playgrounds Pilot Project

Version: June 4th, 2020

Authors: [redacted] (AMS Institute), [redacted] (CTO Amsterdam); [redacted] (TU Delft), [redacted] (AMS Institute)

Introduction

The Corona - situation will require people to keep their distance for the unforeseeable future and will need to be monitored even as the rules and regulations are being scaled down.

The city needs information to see if the citizens of Amsterdam comply with the rules. If it becomes too crowded in a particular place, chances are that people cannot keep to the 1,5 meter distance rule. The police or BOAs need to be aware of this, so they can intervene. Sensing systems can play an important role in creating this awareness.

During the last months, some public spaces still became too crowded. The city responded by installing CCTV cameras at the Zaandammerplein in West, Piet Mondriaanplein in Overtoomse Veld, het Henrick de Keijserplein in De Pijp and the Oetgensstraat near the Amstelstation. The cameras are monitored by Amsterdam enforcement personnel, and police are dispatched when it gets too crowded.





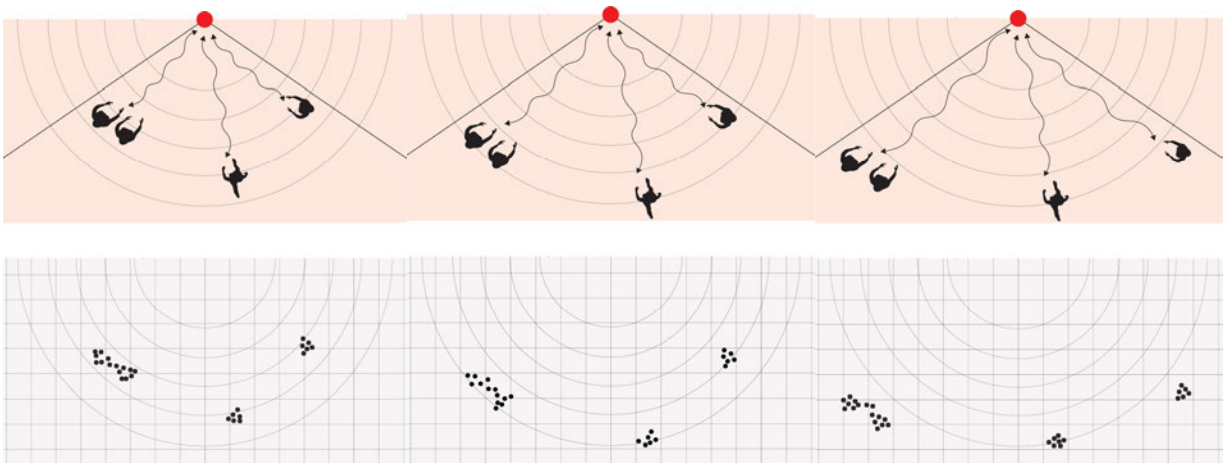
While this system is useful for their stated purpose, there are downsides as well. The gathering of data by these systems can contribute to growing the surveillance state. It is unclear how long the cameras will remain in place, and if this solution is proportional to the problem. The CCTV systems capture more data than necessary and does not conform to the principle of data minimization that was introduced in the 2018 coalition agreement.

Given the concerns about the effectiveness of legal safeguards, the abundance of function creep (technology designed for one use being repurposed for another use) and the impossibility of anonymization, we worry about the use of CCTV cameras in this context.

Current crowd sensing systems frequently make use of ‘counting cameras’. These cameras use (on board) algorithmic models to translate a visual image into a number which represents the amount of people in the image. The original image is then deleted. However, under European and Dutch privacy laws, the deletion of an image is seen as an act of data processing and hence should comply with the GDPR. This setup also introduces other risks. The system can be compromised, attacked or repurposed and can then be adapted to collect personal data after all.

To still be effective and accurate and taking care of privacy concerns, we need alternatives.The need for accurate data by the municipality could also be satisfied with a sensing system that does not introduce the aforementioned risks. If we use an alternative system that guarantees not to collect personal data, much of the potential harm disappears. New technology, such as Milli-meter wave (mmWave) sensing has the potential to be such a technology.

mmWave is a sensing technology that works like a radar, where moving objects are registered by the system as dots. The only information gathered is the range, velocity and angle of these objects. mmWave sensors transmit signals with a wavelength which is in the millimeter (mm) range. The technology promises not to collect personal data in the first place. In lay-men terms, this is done because the resolution is simply not good enough to distinguish people. Initial checks with privacy officers are promising and show that this tech is either already not legally gathering personal data or can probably be redesigned easily to not gather personal data.



The technology was adapted for sensing of crowdedness and in 2019 a pilot project was carried out between the City of Rotterdam and the TU Delft Embedded System Engineering Group to test the technology. In this project, a Master student worked on a proof of concept for the sensing of occupancy of playgrounds. As part of this project, various technologies were studied on their suitability for the purpose. Ultimately milli-meter wave sensing was chosen as the best technology, considering aspects such as accuracy, privacy-proofness, ease of applicability on existing playgrounds and low-energy use . The Proof of Concept model has been tested in controlled outdoor settings.

The design constraints were:

- Minimum data acquisition: as little data as possible should be acquired
- Anonymity: ensure privacy of the users of the playground
- Electrical power: the playgrounds don’t have a power connection (battery or solar power should be used
- Aesthetics: instrument should not stand out
- Vandalism-proof: the instrument should be resistant to vandalism.
- Mobile / Retro-fittable: the instrument should be easily moved and applied on existing playgrounds

In this proposal, we propose to repurpose this technology for the sensing crowdedness in public space for corona sensing.

Goals

1. Test whether the developed PoC technology can be successfully applied in a real life setting
2. Test whether the data from the mmWave sensor is useful for the intended aims of the departments that are responsible to prevent crowdedness (In Amsterdam: V&OR, OOV, handhaving, Police)

3. Test whether the millimetre wave sensing system classifies as / or can be developed in such a way that it will classify it as a 'non-personal data gathering device' (not falling under GDPR)
4. Develop a prototype of a sensor that can be deployed in public space, can communicate and connect this to a Municipal database.
5. Design and test the 'user experience' of being sensed such that it is empowering to people.

Results

➔ An executed pilot (3 months) on two locations: Amsterdam Marine Terrain and another suitable location in the city.

1. Report on the usability of milli-meter wave sensors
2. Report on insights into the user experiments
3. Approval of the final prototype by legal department as being outside of GDPR
4. Technology
    a. Two-four functioning prototypes of the sensor, consisting of a PCB, sensors, powering and onboard software, functioning in public space.
    b. Published Open source + open hardware designs
5. User interface design in public space
6. Report on implementation, consisting of (tender / buying) specifications
7. Defining follow up project and formulate research questions for Open Technology call project proposal

Activities

Sensor Hardware development
build 1st iteration
- functioning prototype ([redacted] design')
- build/ buy functioning casing (ugly)
- improvise power source (big battery / grid connection)
- include wireless transmission (as easy as possible)
build 2nd iteration
- Privacy officer feedback incorporated in hardware / software design to make sensor 100% privacy proof

- improved printed circuit board (PCB) that will include a sensor (mmWave radar), a processor, and a wireless unit to transmit the data (WiFi or 4G) and power management, solar panel integration
build 3rd iteration
- improved sensor / PCB design (bug fixes from 2nd iteration)
-UX design incorporated
Back-office connection
draw up data flow / backend development plan (e.g. connect with Entreprise BUS / CMSA)
set up back-end connection
Pilot
first pilot phase (quick deployment, first finds)
- outcomes in terms of effectivity
- is it a preferable alternative?
- is it as privacy friendly as expected?
second pilot phase (sensor modified to legally not-gather personal data)
- how can we design the sensor? (casing, positioning in space, user interaction, transparency, actionability, alternative interventions)
- how can we improve tech/privacy/design?
third pilot phase (public response)
- how do people react to a designed sensor?
- how can we perfect tech/ privacy / design?
UX research and design
design signage for first iteration test (the bare basics)
draw up design support assignment and hire design firm
execute, research, design sprint (3 workshops), formulate final design brief
assist building 3rd prototype
Legal

Provide DPIA assistance / AVG permit to deploy in public space
initial session to get GDPR-legal specifications for anonymous sensing, define experiments to verify whether personal data is not-collected in 'extreme' circumstances
GDPR-legal knowledge available for tech choices on-demand
evaluate 2nd iteration against GDPR-legal specifications
Define follow-up project
Start from scratch: what tech would we use for crowdedness sensing? would it be mmwave sensing?
formulate research questions for Open Technology call project proposal
Project management

Main agendas of the project

1) Energy- Budget Analysis: testing out battery capacity to understand what kind of battery size and type is required to run the sensor for the required time period (time period to be discussed and decided) 1st iteration to be battery powered, 2nd iteration to be solar powered
2) Design of PCB- integration of components (sensor + processing device + communication device), adding solar panel in phase two
3) Wireless communication- 4G chip, sending data from server device to back-end
4) Coding and Python- Code development, back-end interface design

Pilot descriptions

1. First Pilot:
    a. Focused on developing a working prototype that is able to test the area for crowdedness in terms of number of people (concentration of dots)
    b. The main goal is to check the outcome in terms of effectiveness and privacy proofing
    c. Technical development of sensor and code outsourced to beep-beep
    d. Simultaneous discussions with Privacy officers from Amsterdam and Rotterdam to check privacy-proofing and GDPR compliance
    e. Basic signage design for first prototype
    f. Initial research on UX-design, conducting interaction design session.

g. Marine terrein to be used as the testing site.

2. Second Iteration
    a. Privacy officer feedback incorporation to make sensor 100% privacy proof
    b. improved printed circuit board (PCB) that will include a sensor (mmWave radar), a processor, and a wireless unit to transmit the data (WiFi or 4G) and power management, solar panel integration
    c. Draw up a design support assignment and hire a design firm.
    d. Execute, Research and Design sprint involving relevant people.

3. Third Iteration
    a. Further development of sensor, battery and housing system
    b. UX design to test how people interact with the sensor: information systems and opt-out mechanisms. Formulate final design brief and design inputs to build the third prototype.

Work packages

Activity	**Privacy officer V&OR**	**Amsterdam CTO**	**AMS / RSL**	**TU Delft**
Sensor prototype development			Support*	Lead
Sensor maintenance			Support*	Lead
Pilot project management Amsterdam location		Lead	Support	
Legal	Support		Lead	Support
User experience / design prototyping / testing			Lead	
Overall project management		Lead	Support	
Communication			Lead	

Define follow-up project			Lead	Support

*AMS/ RSL will be covering the costs for external parties involved. TU Delft will be leading the technical development effort.

Budget

Out-of-pocket costs

Item	**Cost**
Hardware iteration 1	[redacted]
Hardware iteration 2	[redacted]
Hardware iteration 3	[redacted]
UX design	[redacted]
UX development	[redacted]
Communication	[redacted]
Total Estimate	[redacted]

Intellectual Property

Background knowledge:
TU Delft contributes the developed knowledge (background knowledge of the previous project, graduation [redacted] on Rotterdam Playground monitoring) to the public domain.

The required Texas Instrument sensor is commercially available.

Foreground knowledge
Knowledge developed during the project will be open source (GNU 3.0) & open hardware license [specify]