Ethical analysis of the project “Remote sensoric detection of human vital signs”

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Introduction

As a part of my M.Sc. studies of Computer Science / Artificial Intelligence at the Faculty of Mathematics and Physics of the Charles University in Prague I work on a M.Sc. Thesis “Remote sensoric detection of human vital signs”.

Objectives

The objective of the Thesis is to explore and understand limitations of a frequency-modulated continuous wave (FMCW) radar for a remote detection of human vital signs, namely respiratory rate (and as a stretch goal possibly also heart rate), in industrial settings.

Methodology

In the R&D setting employed in the Thesis project, the radar is placed on a solid surface, detecting human vital signs of up to two human test participants (the core research team), in order to understand limitations of the detection (human respiration observation, device capabilities, environment) and to develop a SW package to perform the data analysis, possibly providing and comparing several approaches to data processing.

In a possible future production setting, the FMCW radar is meant to be mounted on an arm of a mobile robot. The robot would be controlled by a remote operator, a member of a Fire & rescue team. The robot equipped with a FMCW radar sensor would remotely monitor vital signs of personnel in an emergency situation, e.g. in an accelerator tunnel.

Legislature & jurisdiction

This research project is carried out at CERN, therefore it is governed by CERN’s Operational and Administrative Circulars and regulations.

Research Impacts

The impact of the R&D phase of the project results in understanding of limitations of the FMCW radar w.r.t. the conditions of the industrial settings. The following characteristics are considered to contribute to the “ambient environment” limitations:

- distance of the sensor from the human participant,
- direction focus of the sensor (including angular dependence of the radar beam cone on the signal gain),
- obstacles around the human participant (notably along the line of sight),
- changes in the local atmosphere composition (e.g. smoke or dust dispersed in the atmosphere),
- dependence of the sensor temperature on its operationality (and hence, a need for an active cooling mechanism).

Additionally, we study dependence of the human vital sign detection on:

- clothing characteristics of the human participant (e.g. different upper body clothing layers, such as a t-shirt, sweater, jacket),
- human participant body position (e.g. sitting / lying down, detection from different parts of the body),
- human participant breathing patterns (e.g. standard breathing, fast or slow breathing, shallow or deep inhalation, gasping).

Understanding these conditions and their impact is fundamental for development of the SW package for data analysis, and interpretation of the detected human vital signs.

Environment

The R&D phase of the project is carried out in a way gentle to the environment. We use the already assembled/existing radar sensor and other computer equipment, and leverage the laboratory space to conduct the measurement. The utilities consumption overhead is minimal, and consists of power consumption of the radar sensor. We do not make use of any liquids or fossil fuels to directly conduct the research, therefore we do not introduce any foreign agent into the local environment. Local transportation of the equipment across the laboratory is performed in an environment-friendly way (walking).

Stigmatisation & Exclusion, Malicious Exploitation

This research is inclusive, strongly supporting diversity of the CERN’s Member of Personnel as one of the CERN’s core values. In fact, the core research team represents women and men equally. The R&D phase of the project excludes a malicious exploitation of the project, similarly the possible future production phase will exclude it, based on CERN’s internal regulations.

Ethics Issues

This research project involves human participants, and involves non-invasive physical intervention of human participants. The research project involves personal data collection and processing, including further processing of the collected personal data in order to

optimise the data analysis algorithms. This research project does not involve human embryos / foetuses, human cells / tissues, nor animals.

Data Privacy Protection and Security

The personal data collection and processing is carried out in a way compliant with the CERN's Operational Circulars, particularly Operational Circular No.11 [1] and Operational Circular No.05 [2]. The data is stored on facilities of the Organization. Access to data is granted only to the core research team members, in order to develop and optimise a SW package for data analysis.

Safety

The R&D phase of the project is carried out with safety in mind in every step of the project. All members of the core research team have been trained in the basics of safety in the workplace. Additionally, a member of the core research team has passed the CERN First Aider certification.

The laboratory environment (place where the measurement takes place) is secured prior to commencing the measurements, and adapted as needed during the experimentation sets, to assure safety of the personnel and equipment at all times.

Risk / Benefit Assessment

The research involves minimal risk to participants:

- physical risk (e.g. pain, bruising and infection, muscle soreness and pain as a consequence of exercise testing, health emergencies),
- psychological risk (e.g. stress associated with experiments and testing),
- social risk (e.g. invasion of privacy, loss of community standing),
- legal risk (e.g. criminal prosecution), and
- economic risk (e.g. loss of employment, loss of potential monetary gain).

The research provides no prospect of direct benefits to individual participants, but likely will yield generalizable knowledge to further society's understanding of this remote detection technique.

References

[1] CERN Operational Circular No.11. The processing of personal data at CERN. Traitement des données à caractère personnel au CERN. Jan 2019. https://cds.cern.ch/record/2651311 Accessed 20th April 2022.
[2] CERN Operational Circular No.05. Use of CERN computing facilities. Utilisation des installations informatiques du CERN. Oct 2000. https://cds.cern.ch/record/1202776/ Accessed 20th April 2022.