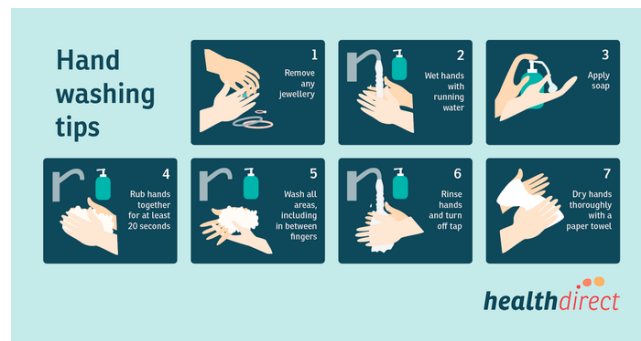


Excessively frequent hand washing

Real-time detection from time-series data in the wild

Motivation

We do it several times a day, most of us do not have to think about it, and we also teach young children not to forget it. During the pandemic it came into special focus and even from official authorities we received tips and guidelines on how to do it *right*. We are talking about hand washing, of course. Washing hands is an effective and useful tool to limit the spread of germs and remove dirt. Modern smartwatches can automatically detect hand washing and, by showing a timer, instruct the user to wash their hands for a certain time.



But what if the fear of contamination becomes so intense that hand washing takes on extreme dimensions? Excessively frequent hand washing can be a symptom of obsessive-compulsive disorder (OCD) and is then often referred to as compulsive washing. However, the challenge is to distinguish regular hand washing from compulsive hand washing. An automated detection of compulsive hand washing could be useful, as it may be beneficial for therapeutic reasons to alert the patient to *stop* the (washing) compulsion.

Background

This thesis is part of a collaboration with psychologists from the University Basel and computer scientists from the University Siegen. Over the last years they researched on the topic of detecting compulsive hand washing with wearable devices. They developed a system to record data from daily life over a long period of time and get feedback from the user about their hand washing activities. Based on this, a dataset of motion data (accelerometer and gyroscope data) from 22 subjects wearing smartwatches was recorded over a period of up to four weeks. All subjects said they had a strong urge to wash their hands excessively often during the day, and some were even diagnosed with compulsive washing. During the study, all participants permanently wore a smartwatch, which was used to record hand washing and to answer questions about urge and tension.

¹ <https://www.healthdirect.gov.au/hand-washing>

Goal

Analyzing data from studies in the wild (outside the laboratory) is still a challenging task. Sometimes the data is incomplete, contains noise and phases where no information is given about what was happening. Nonetheless, these studies are extremely valuable as they reflect real life and it is then up to the analysts and software developers to draw information and conclusions from the data. The research questions and possibilities offered by the hand washing dataset are varied and can be adapted to your interests and experiences by mutual agreement. Possible questions and technologies could include:

- **Clustering** and (re-)labeling the data (e.g., Dynamic Time Warping)
- **Correlation analyses** between hand washing activities (normal and compulsive) and subjective feelings (tense, urge)
- **Classification** between normal and compulsive hand washing and/or NULL data (conventional **machine learning** and/or **deep learning**)
- General machine learning models vs. **personalized models**
- **Improving** the existing **system** to prevent “alarm-fatigue” and boost the results by using the real-time data (**online learning**)
- ... and many more!

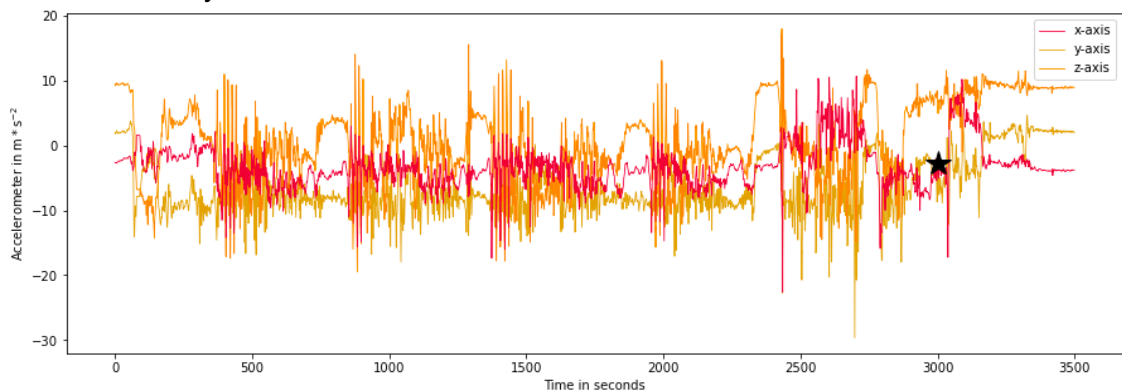


Figure 1: Visualization of the raw signal data for one hand washing activity where the star indicates the label set by the subject.

About You

- You are interested in working with a multidisciplinary team
- Working with time-series data from sensors sounds fun to you
- You are motivated to deepen your machine learning knowledge, you are not afraid of statistics and you want to try out and compare various approaches

Contacts

Do you have any questions? Come and visit us at our chair on campus 3 (Digital Health Center) on the first floor or send us an e-mail. We are looking forward to meeting you!

Kristina Kirsten, M.Sc.

Room: G-2.1.13

E-Mail: kristina.kirsten@hpi.de

Prof. Dr. Bert Arnrich

Room: G-2.1.14

E-Mail: bert.arnrich@hpi.de