Fraunhofer
PORTUGAL

SmartMedBoxes

MONITORING OF MEDICATION BOXES USING WIRELESS SENSORS

The objective of SmartMedBoxes is to monitor medication intakes using the data given by the accelerometer and gyroscope from a sensor that is attached to a standard medication box.

By doing so, a caregiver (or a familiar) can understand if the user is correctly following its prescription, and if there is any obstacle for the user while taking its medication.

Context

Medication adherence is a real problem among older adults which can have serious repercussions on one's health. Low adherence caused by forgetfulness can, in many cases, undermine the treatment benefits.

Additionally, taking wrong medication at wrong scheduled times can lead to visits to the hospital, adverse health conditions or unwanted secondary effects.

The main objective of this project is to create a solution with a lighter burden on the users by using sensors on medication boxes to understand when the user has taken his medication and or warn the user when he is taking the wrong medication.

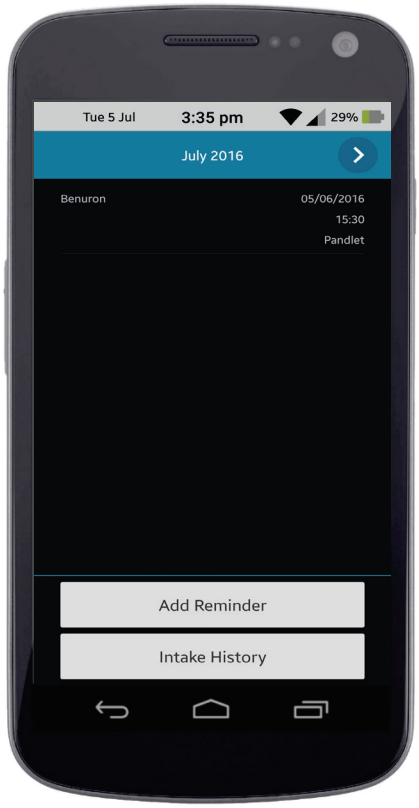

Fig1. The medication reminder application.

Implementation

The solutions consists on an Android application that connects to a Pandlet that is attached to the medication box.

The Pandlet gathers data from the medication box, by using its accelerometer and gyroscope, and send it to the smartphone via Bluetooth.

Next step is data normalisation, feature extraction and its respective processing. Android smartphones are, nowadays, powerful, which allows the following steps to be done on the mobile device. This enables the system to be used

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Pandlets

Pandlets is an hardware platform developed by Fraunhofer Portugal to measure human behavior and environmental context. It includes a set of sensing capabilities and an Android API that allows for seamlessly integration of external hardware into Android's platform.

Dataset

The data set is composed of six persons, collaborators at Fraunhofer, which were told to simulate (three times) the "taking a medicine" gesture.
The medication box had two Pandlets attached in different places.
Two different ways of doing it were considered: "picking a pill" and "letting a pill fall into the hand".
And then these two gestures were split in five different smaller gestures: "pick the box", "open the box", "take the pill", "close the box", and "leave the box on the table".

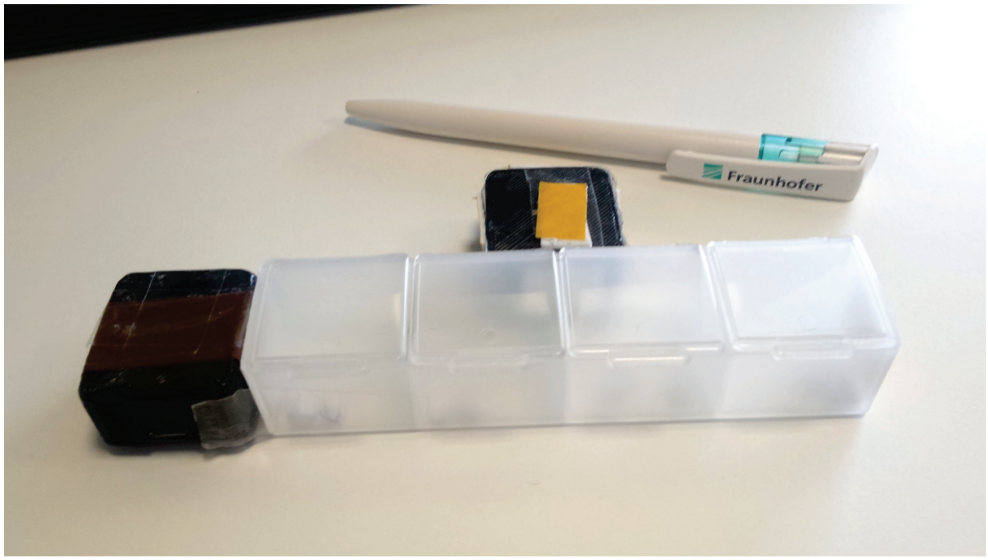

Fig2. Medication box with two Pandlets attached.

without the need of connect to any server or network.

The features are used on a machine learning that will classify them and detect whether the gesture corresponds to box opening or not.

Finally, the application will help to understand if the right pill was taken from the medication box at the right hour.

Results

Pandlets are able to get data at different frequencies: 8 Hz, 50 Hz, and 100 Hz. A first experiment was made to understand which of them the application shall use.

These tests were made in the Waikato Environment for Knowledge Analysis (WEKA) framework and with the following algorithms: K-Nearest Neighbour, Sequential Minimal Optimization (SMO), Naïve-Bayes and J48.

Data was validated with with 10-fold cross validation and percentage split (66% train - 33% test).

It was noticed that, if the inertial sensors were used without being combined, results given by the algorithms were worst.

Best results were given by SMO algorithm (81,32% sensitivity), while the worst were given by Naïve-Bayes (21,3% sensitivity).

Next steps

Add new features to improve the algorithm sensitivity.

The dataset used is based on age group that not corresponds to the target-users, to change this, it is needed to collect data with the help of older adults.

To improve the performance of the solution, it is needed to select a fewer number of features without reducing the sensitivity.

There are medication box designs that were not tested. This is a factor that can influence the results.

Test with other Machine Learning algorithms to achieve a better sensitivity.