Abstract:

Fall Guardian detects accidents such as falls (of you relatives) by using motion tracker on the wrist and alerts relatives automatically.

Problem: Falls are considered as major health hazards for elderly, individuals with epilepsy fall during seizure or people with neurodegenerative diseases such as dementia. Living alone increases the risk of falls, e.g. being unconscious, resulting in severe physical injuries such as disabling fractures.

Solution: To mitigate the adverse consequences of falling, falls must be detected(sensed), analyzed and communicated to relatives, doctors and caregivers. Our motion tracker records position and acceleration and is kept on the wrist. In case of an accident the algorithm is trained to detect only falls and no other event, inducing acceleration. Relatives or caregivers receive a notification from a dashboard.

Benefits: The sooner help arrives, the less is the risk of severe insurgencies with long-term effects. Caregivers don’t have to cope with uncertainty and need to invest a lot of time and frustration visiting their relatives too often.

Table of content

1. Sensing

Hardware: The underlying hardware is a motion tracker, worn on the wrist, delivered by Kinemic. The motion tracker includes sensors such as three-axis Accelerometer, three-axis Gyroscope, barometer, temperature.

Software: Kinemic is a software company specialized on gesture control using hardware from mbient. Due to special requirements like measuring the acceleration, instead of pre-defined movements, to detect falls the API from Kinematic could not be used. Thus, linking the SDK from mbient was necessary.

2. Analyzing

In order to make preliminary decisions about a potential fall event, these algorithms usually compare the sensor's output with predefined threshold value. **lukas.r@mail.com**Threshold-based algorithms use these acceleration values for calculating Signal Magnitude Vector by using the following relation:

$$Signal\ Magnitude\ Vector = \sqrt{|A_x|^2 + |A_y|^2 + |A_z|^2}$$

Figure 1: Signal Magnitude Vector

The tri-axial accelerometer for sensing measure simultaneous accelerations in three orthogonal directions. If the value of signal magnitude vector for a particular incident exceeds a predefined threshold value, then the algorithm primarily identifies that incident as a fall event.

Data-Generation: To find the right signal magnitude vector, several experiments have been conducted in order to generate data. Within the experiments, reality-near falls have been simulated to receive acceleration values. The test-person wore the hardware and let himself fall.

To not falsely detect falls, data from other events inducing acceleration has been gathered. For example, regular movements within the household, such as lifting chairs or cleaning or throwing the hardware somewhere. That allowed us to distinguish falls from other situations inducing acceleration more precisely.
Table 1 shows the acceleration values, induced by several real falls and regular movements, falls are highlighted. Acceleration on the y-axis and time on the x-axis.

The results show, that within a regular fall, the acceleration values do not exceed values less between -8 and +8 on average. Furthermore, falls have a minimum acceleration value between -5 and +5.

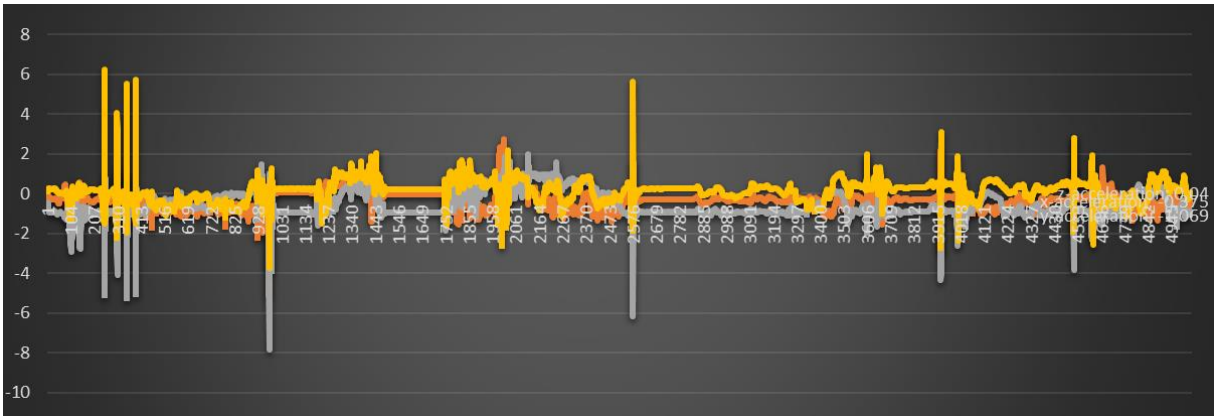

Table 1: Acceleration values induced by falling over time

Table three and four shows acceleration values induced by throwing the hardware on a couch. The figures show that the acceleration values induced by throwing the hardware have an acceleration around +10 or -10.

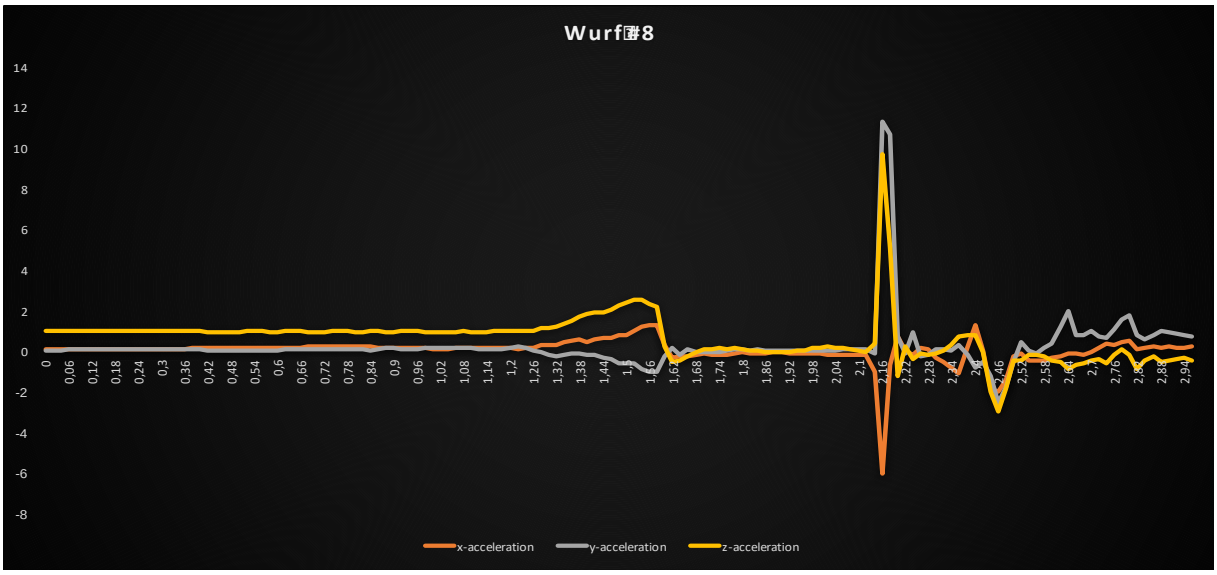

Table 2: Acceleration values induced by throwing over time

Table 3: Table 2: Acceleration values induced by throwing over time

Thus, our threshold or range is between +5/-5 and +8/-8.

3. Communication

For communicating the accident, a browser-based dashboard has been implemented. It shows the acceleration values in real-time and give alerts, when threshold is exceeded. The dashboard has been developed in netbeans and receives the data of the webserver.