DATA SCIENCE CANVAS

Project name: EMMA by Datanauts | Iteration 3 | Date: 2nd February 2024

Problem Statement

Over 37 million falls occur annually, resulting in injuries such as bruises, broken bones and head trauma. About 600,000 of them are fatal.
WHO reports reveal that 28% to 35% of individuals aged 65 and above experience falls yearly. Elderly individuals are particularly vulnerable to a "long lie" scenario, where they are unable to stand after a fall, requiring assistance. This prolonged immobility poses physical and mental challenges, along with significant economic and caregiving burdens on families and society.

Solution

Senior citizens wear EMMA, which is a compact device that is equipped with an accelerometer sensor. Using a neural network, the accelerometer data is used to classify whether a fall happened or not. In the event of a fall, the device promptly dispatches a message containing precise location coordinates and timestamp information to a designated contact capable of providing assistance.

Users & Use

Target group: Elderly individuals, with applicability to every age group.
Having a prompt notification to their emergency contacts can significantly contribute to preserving their well-being and peace of mind for people living alone and, in some cases, even saving their lives.
Users simply wear the device on their waist.

Data Acquisition

Available: Data set with falls and activities of daily living from the internet.
Acquisition: own data of falls and other movements to improve the model for the specific sensor.
System integration: the end device that displays the result

Analytics Formulation

Target: Binary categorical variable (whether fall happened or not)
Input features: Accelerometer data
Methodology: Classification

Modeling

Suitable models: Any classification models
To model temporal patterns, neural networks are particularly effective.
After testing CNN, LSTM and combined CNN-LSTM-models, we have found that CNN works best for our data.

Data Preparation

Transform all data to the same unit (gravitational unit g for accelerometer data).
Normalize and segment the data applying the Sliding window method with overlap.

Evaluation

Metrics: AUC-ROC, F1-Score, Recall, Precision, Accuracy, Balanced Accuracy, and Error Rate.
In-field testing with the sensor.

Success Criteria

Objective:
- High model performance (AUC-ROC/F1-Score, over 80%)
- Real-world effectiveness with an acceptable higher False Positive Rate (FPR) but still bounded to prevent unnecessary user anxiety.
- Small delay between fall and notification (< 5s).

Subjective: Easy to use, low maintenance, reliable, and energy efficient.

Constraints

Some activities such as sports could be wrongly detected as fall. This might be especially important for active people that wear the device.

Technology stack

Backend: Python, Tensorflow, Flask, C
Development environments: Visual Studio Code, Jupyter Notebook, PyCharm, Arduino IDE
Frontend: HTML, CSS, JavaScript
Connection: Bluetooth, Websocket
Version control: Github
Task: Management: Trello, Zoom, WhatsApp

Business Value

EMMA improves the safety and independence of individuals by providing them with the confidence to live alone without the constant fear of falling and being unable to seek help. The device is designed to be worn on the waist, ensuring precise and reliable fall detection compared to conventional arm-worn alternatives.
By eliminating unnecessary features and focusing on essential functionality, EMMA is an affordable alternative to conventional smart-watches for senior citizens.

MVP

A sensor that measures accelerometer data and analyzes the data directly on the device. If a fall happens, it sends a message via Bluetooth to an end device.

Key Actors

Tech resources: Software Developers, Hardware Engineers, Maintenance
Customer stakeholder: elderly individuals (end-users), family members and emergency contacts, caregiver, healthcare providers
External: Data Privacy and Protection Expert