Smartwatch-Based User Monitoring for Human-Robot Interaction

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Introduction

- X2 world population in 50 years

- Over 65:

    - 357 million (1997)

    - 761 million (2025)
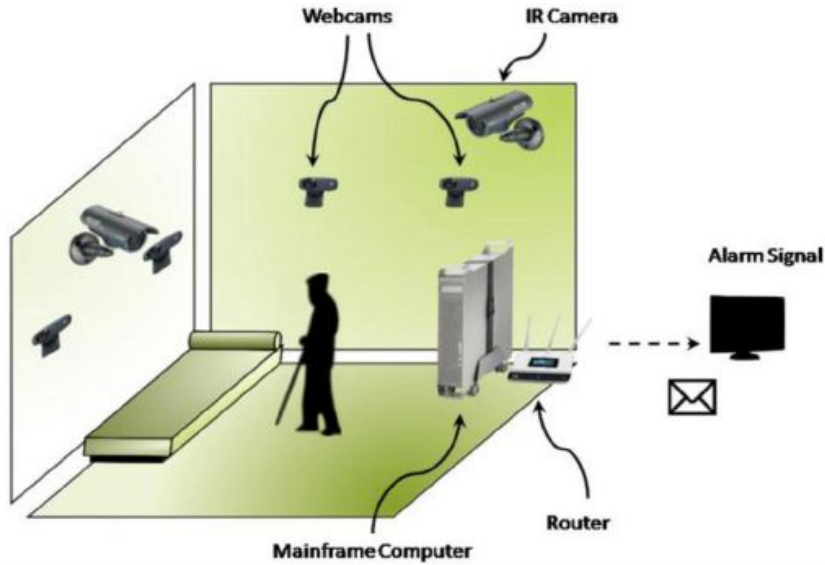
- 424.000 yearly deaths (fall-related)

Joel E Cohen. "Human population: the next half century". In: science 302.5648 (2003), pp. 1172–1175.

Jeanette Takamura and Bob Williams. "Informal caregiving: Compassion in action". In: Department of Health and Human Services: Washington, DC, USA (1997).

State of the Art: Medical Alert Systems

Fall-Detection Systems

Button-Pressing Systems

Objectives

Implement real-time alert application for a social robot using a smartband

- Ergonomic medical alert system without user interaction
- Data collection application
- Heart rate (HR) statistical study
- Real robotic application
    - Human-Robot Interaction (HRI)
    - Real-time Machine Learning Algorithm

Used Tools

Xiaomi Mi Band 2

Mini Maggie Robot

Android Studio

Robot Operating System (ROS)

GadgetBridge

Used Tools

Xiaomi Mi Band 2

Mini Maggie Robot

Android Studio

Robot Operating System (ROS)

GadgetBridge

3 units

+ Cheap
+ Waterproof
- Obscure Database
- Encrypted
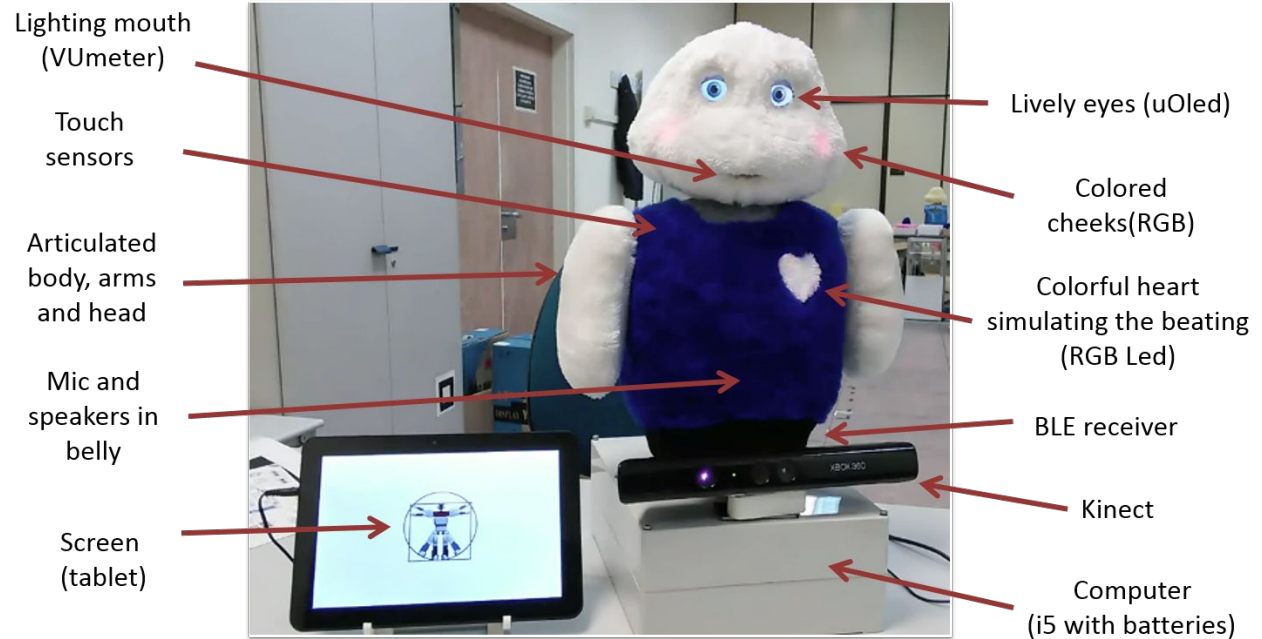- Proprietary application (Mi Fit)

9:43

Used Tools

Xiaomi Mi Band 2

Mini Maggie Robot

Android Studio

Robot Operating System

GadgetBridge

Lighting mouth (VUmeter)

Touch sensors

Articulated body, arms and head

Mic and speakers in belly

Screen (tablet)

Lively eyes (uOled)

Colored cheeks(RGB)

Colorful heart simulating the beating (RGB Led)

BLE receiver

Kinect

Computer (i5 with batteries)

Used Tools
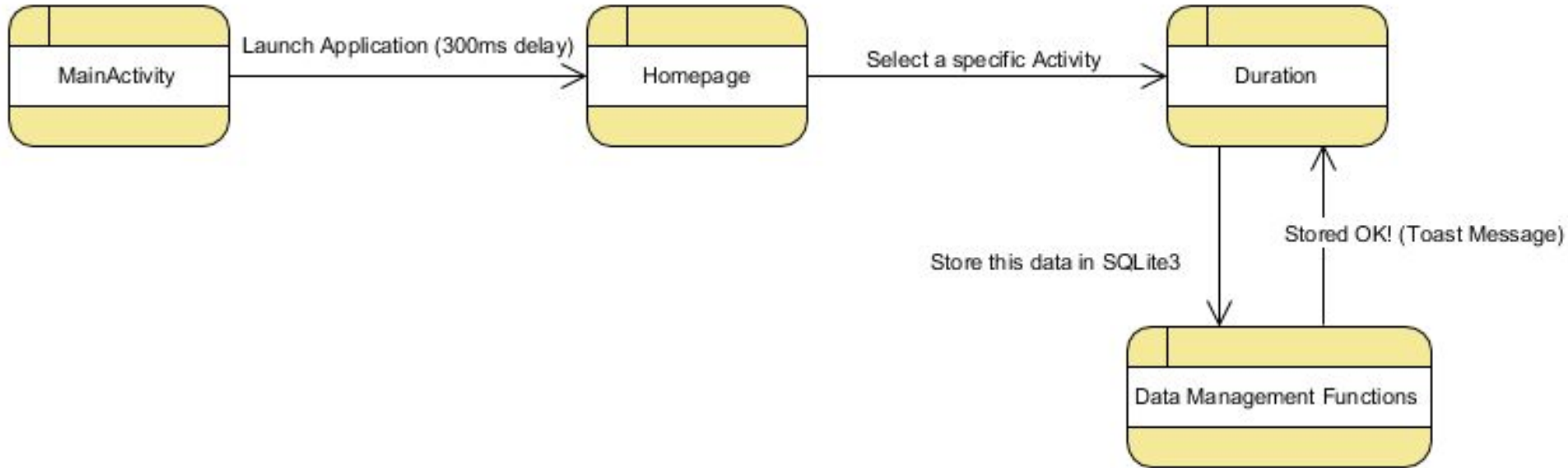
Xiaomi Mi Band 2

Mini Maggie Robot
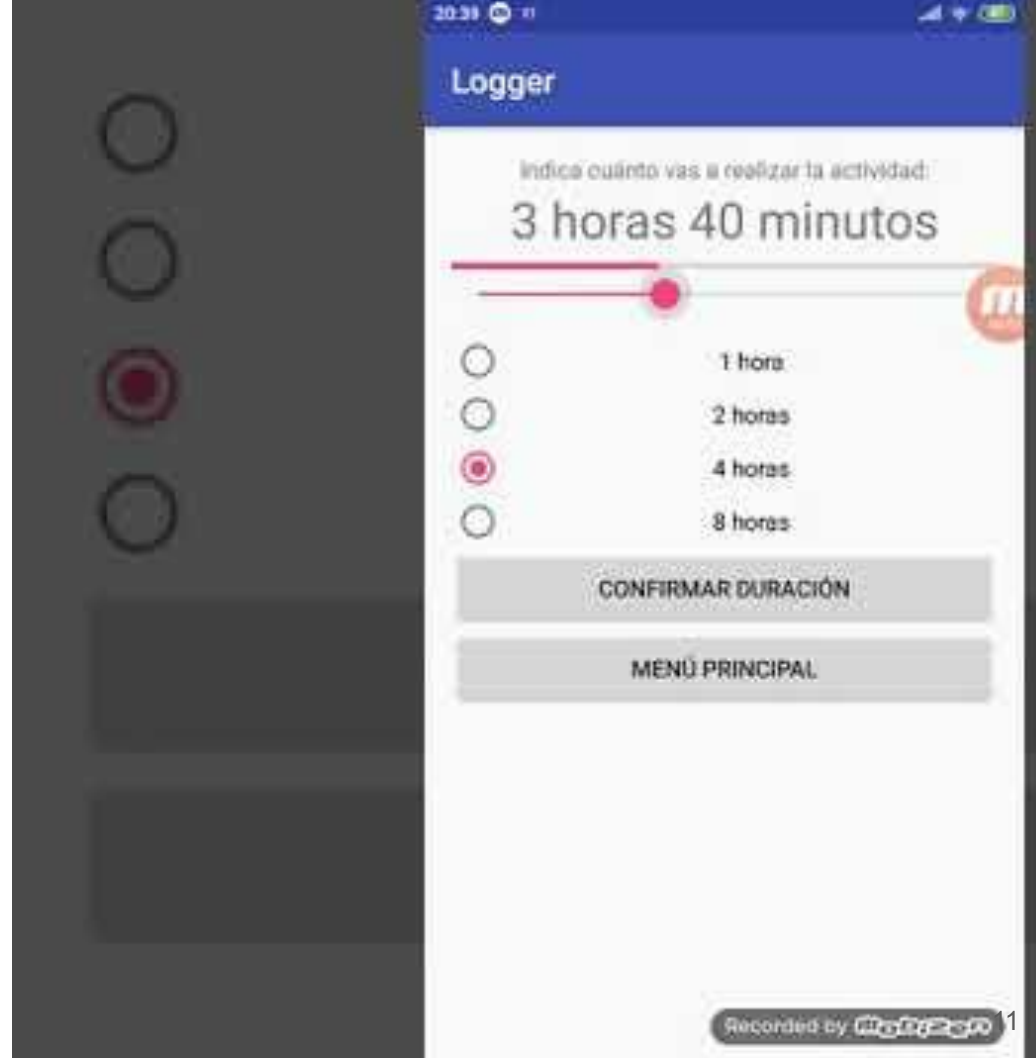
Android Studio

Robot Operating System

GadgetBridge → Limitation of rate (1 measurement per minute)
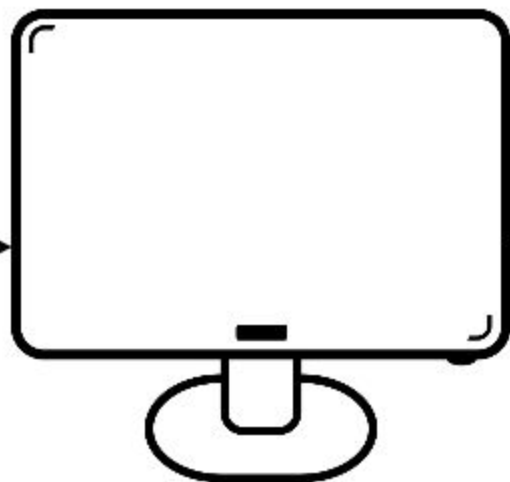
Data collection application

1. Loading Screen

2. Homepage (select activity)

3. Duration (select duration)
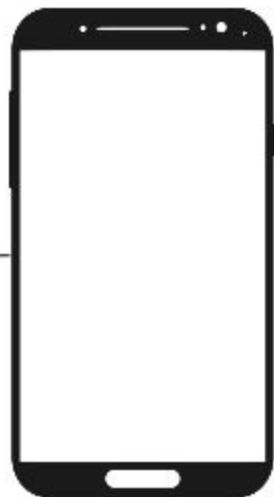
4. Confirm Duration

5. Data stored in mobile device

GadgetBridge

Android Debug Bridge (ADB)

Developed Tools

Data Collection application

+ Offline monitoring
+ Cross-referencing data

Xiaomi Mi Band 2

	TIMESTAMP	DEVICE_ID	USER_ID	RAW_INTENSITY	STEPS	RAW_KIND	HEART_RATE
	Filter	Filter	Filter	Filter	Filter	Filter	Filter
61123	1548831000	2	1	54	0	112	73
61124	1548834480	3	1	26	0	112	54
61125	1548834540	3	1	52	0	112	83
61126	1548834660	3	1	0	0	112	54
61127	1548834840	3	1	25	0	112	64
61128	1548834900	3	1	6	0	112	48
61129	1548838560	3	1	0	0	112	48
61130	1548838680	3	1	74	0	112	65
61131	1548848640	2	1	11	0	112	84
61132	1548848700	2	1	0	0	112	82
61133	1548848760	2	1	1	0	112	85
61134	1548849000	2	1	9	0	112	56
61135	1548849120	2	1	0	0	112	76
61136	1548849180	2	1	0	0	112	76
61137	1548849240	2	1	0	0	112	74
61138	1548849300	2	1	0	0	112	84

Data collection application

| id	date	user_action	duration
	Filter	Filter	Filter
24	2019-02-03 14:29:41	User action: caminar	Duration: No lo sé
25	2019-02-06 13:53:01	User action: ejercicio fisico	Duration: 10 horas 0 minutos
26	2019-02-06 20:30:28	User action: dormir	Duration: No lo sé
27	2019-02-19 12:16:00	User action: dormir	Duration: 4 horas 0 minutos
28	2019-02-19 15:14:00	User action: reposo	Duration: 2 hours
29	2019-03-17 19:14:33	User action: reposo	Duration: 20 minutos
30	2019-03-17 19:45:03	User action: ejercicio fisico	Duration: 1 hora 10 minutos

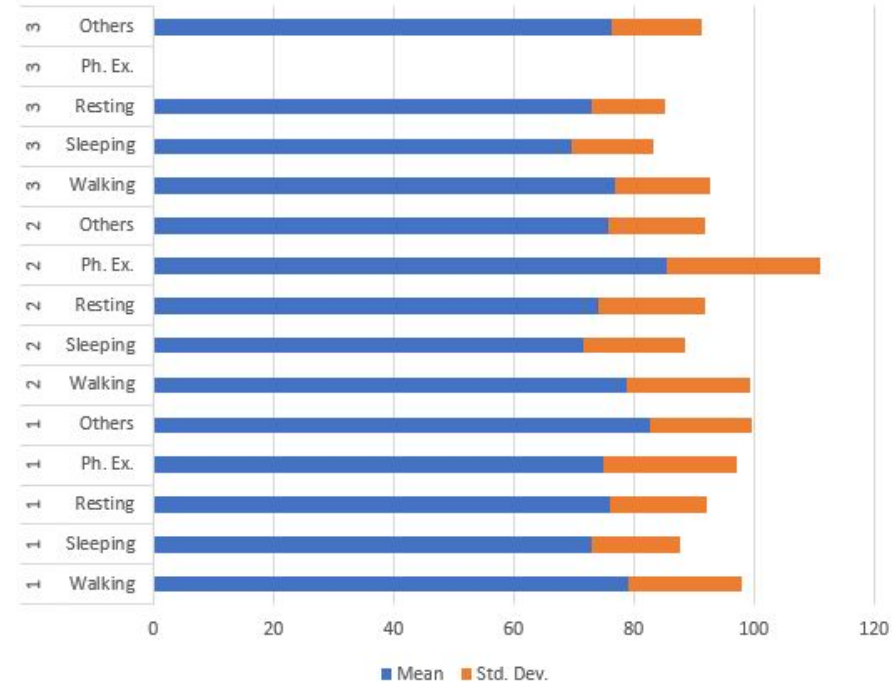# Statistical Analysis

Experimental Setup:

- 24 users
- 3 days per user
- 30.622 of samples in dataset
- Frequency of devices: 1 measurement per minute

Statistical Analysis

Gender-Based Categorical Data
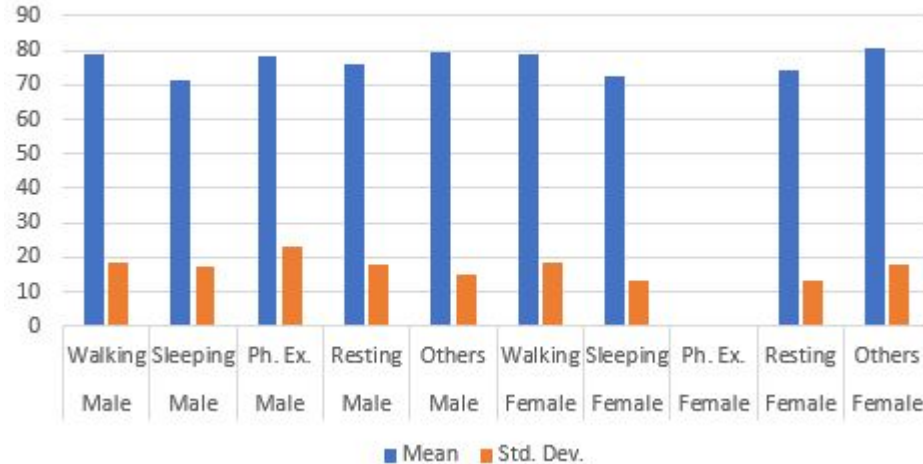
Categorical Data for all age groups (1,2,3)

- High standard deviation from measurements: Xiaomi Mi Band 2

- Data used in robotic application: static thresholds for anomaly detection

Robotic Application

- Real-time data acquisition
    - Bluetooth (BLE) connection with Xiaomi Mi Band 2
- Cryptographic handshake + requests
- Machine learning real-time prediction
- Real-time monitoring
    - Danger level
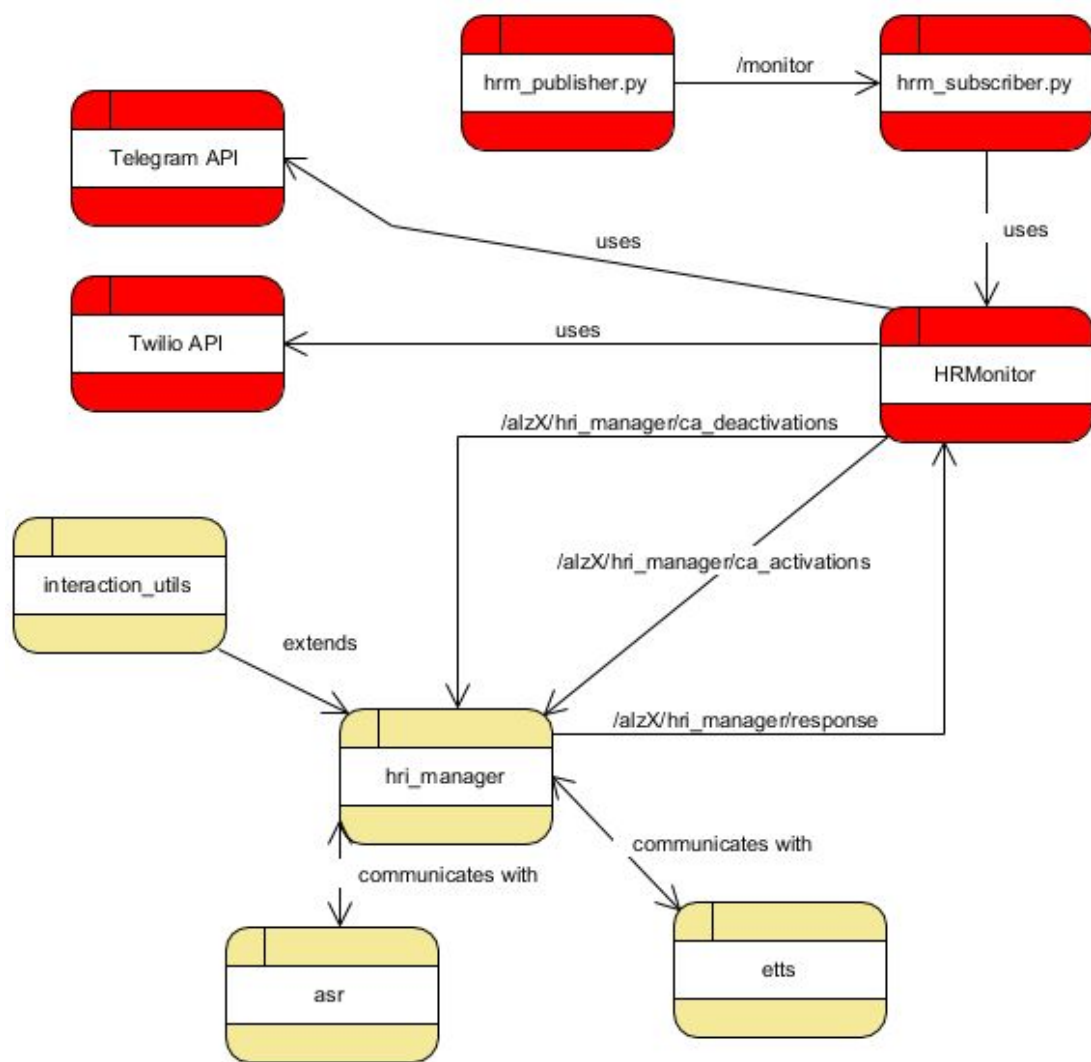- Telegram, SMS, telephone call

Application Flow

Bluetooth gateway

HRMonitor

Human-Robot Interaction

(HRI) Manager

- TTS

- ASR

Case Study 1

Large heart rate increment

Mini Maggie listens to user input through the microphone
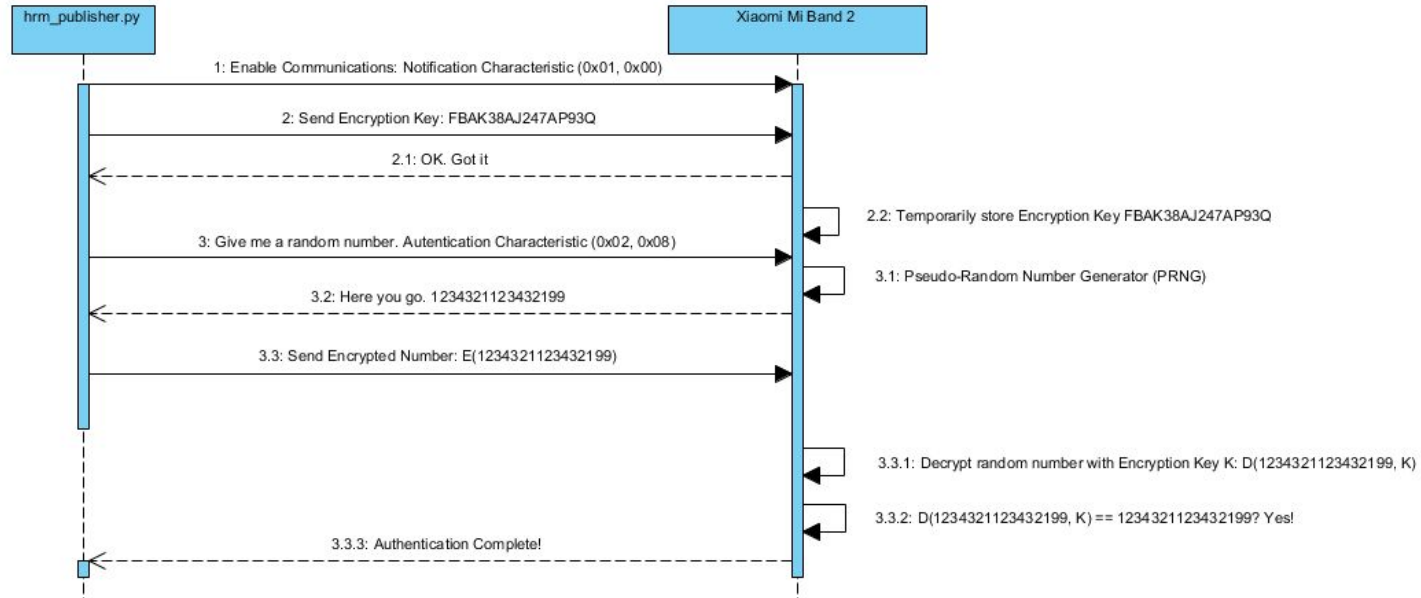
Case Study 2

Heart attack

Case Study 3

Machine Learning Detection

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We are working on a journal paper

We need to improve the quality of the data collection process -> Improve ML

Better communication with Xiaomi Mi Band 2

Conclusions

- Implement real-time alert application for a social robot using a smartband

- We have developed two applications

    - Data collection from a low-cost device

    - Real-time monitoring (integrated in a real social robot: Mini)

- Low accuracy of the Machine Learning model

Future Work

- Repeat study with more users

- Try different wearable devices

- Finish and submit a journal paper