INSENSION

Supporting interaction of people with PIMD using advanced ICT

Michał Kosiedowski
Poznań Supercomputing and Networking Center, Poland

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 780819.

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Personalized intelligent platform enabling interaction with digital services to individuals with profound and multiple learning disabilities

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PARTNERS:

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The goal

Design and develop an ICT platform that enables persons with profound intellectual and multiple disabilities (PIMD) to use digital applications and services that:

- **can enhance the quality of their life**
- **increase their ability to self-determination**
- **and enrich their life.**

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The consortium

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Technological partners

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Future Internet,
eInclusion technologies

Jožef Stefan Institute

Artificial intelligence

CTIC

Computer vision

Domain partners

Pädagogische Hochschule HEIDELBERG University of Education

Intellectual disability, special education

Stowarzyszenie na tak

Care provision to people with intellectual disability

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Creation and distribution of assistive technologies

People with profound intellectual and mutliple disabilities

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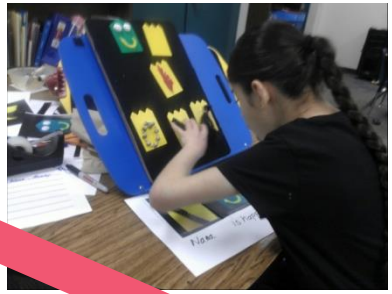
People with PIMD

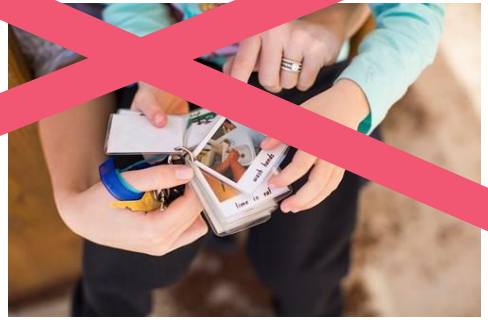
- **profound intellectual disability (IQ < 20) combined with other disabilities:** severe forms of motor disabilities, sensory disabilities (hearing or visual impairment), severe forms of epilepsy (on heavy medicamentations, frequent epileptic seizures up to grand mal)
- **communication:**
  - (usually) no verbal language
  - often on a pre-symbolic level
  - use of unconventional behavior signals
- **long-term high need for therapy, care, support (WHOLE LIFE!)**

→ **difficult social participation!**

Non-symbolic interaction (1)



Request an it... Receive the item



AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

Non-symbolic interaction (2)

- Reactions to the happenings around through:
  - gestures
  - facial expressions
  - vocalizations
  - gaze

- These signals are highly individual!

Non-symbolic interaction (3)

ACCEPT
(I WANT IT)

DISAPPROVE
(I DON'T WANT IT)

DEMAND

COMMENT

PROTEST

Physiological affective response

- *„heart rate and skin temperature can give information about the emotions of persons with severe and profound ID”* [Vos et al. 2012]
- *„frequent consistent physiological reactions”* to stimuli [Lima et al. 2013]
- *„a shallow, fast breathing pattern, used less thoracic breathing, had a higher skin conductance and had less RSA when experiencing positive emotions then when experiencing negative emotions”* [Vos et al. 2010]

The INSENSION Platform

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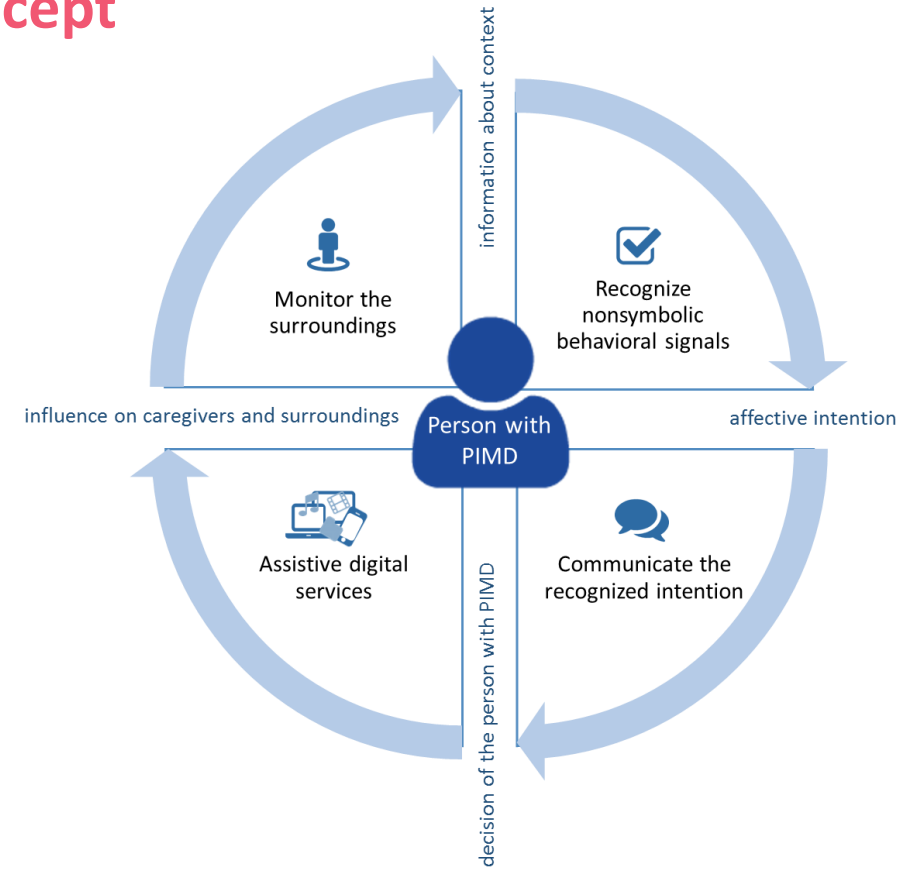
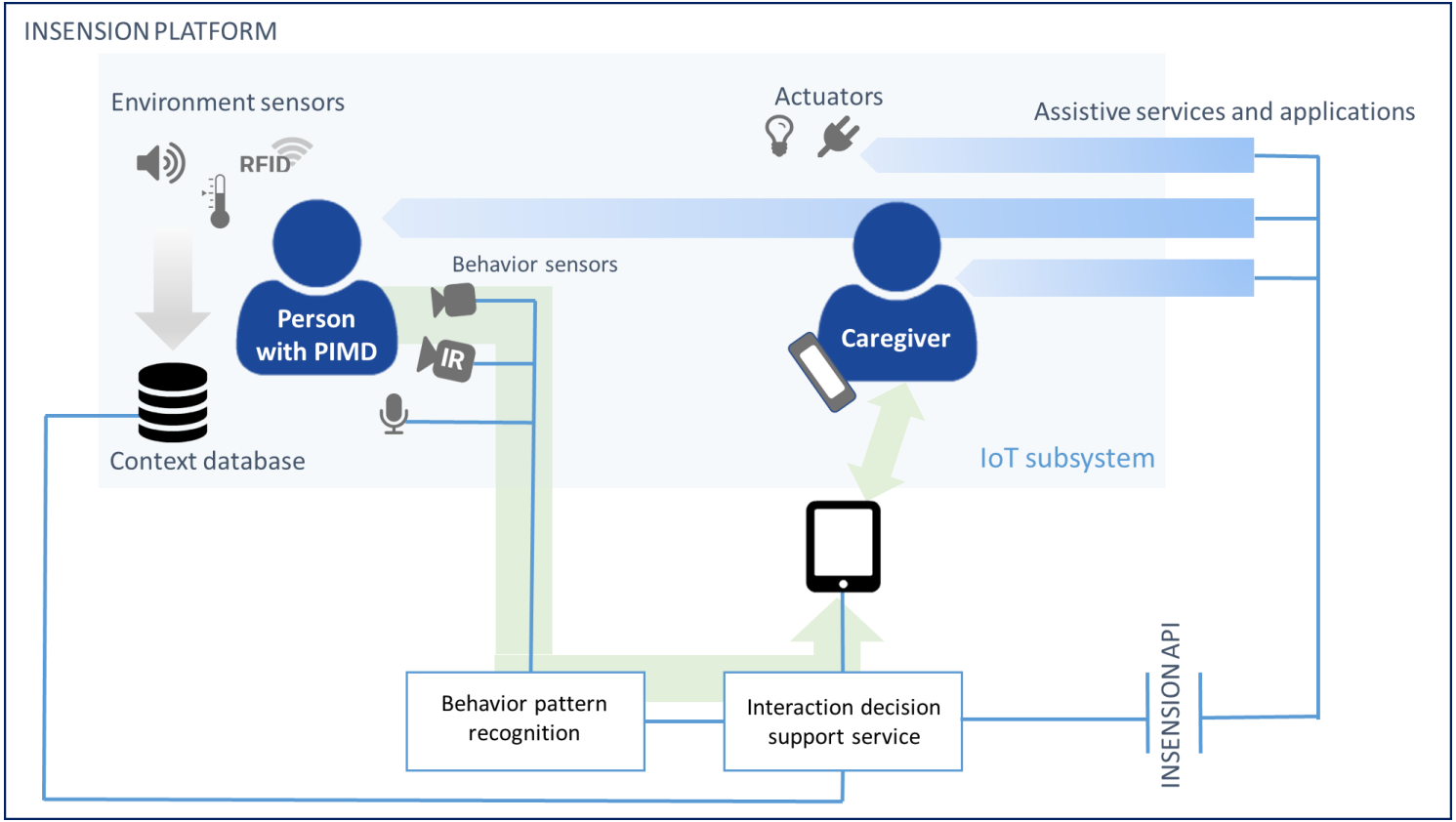
General concept

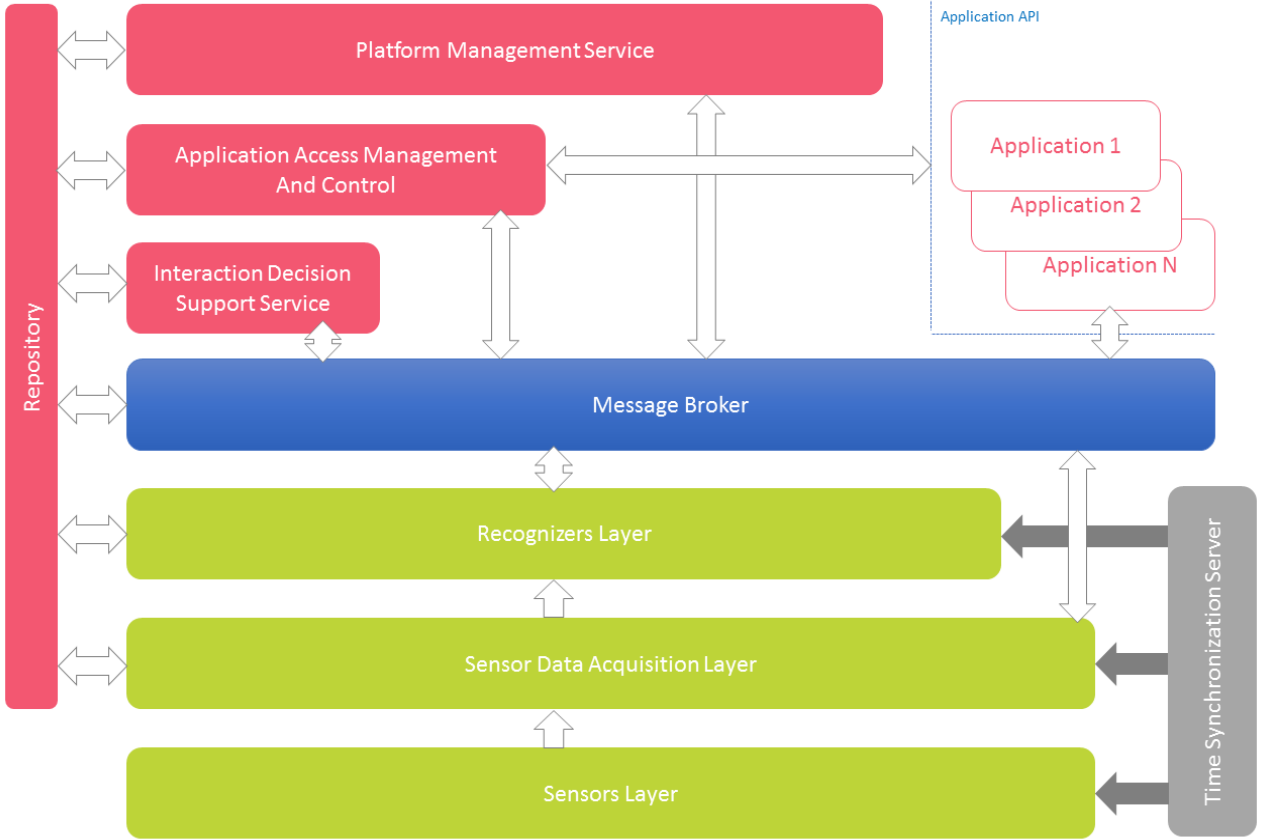


Insension platform



System architecture

Event-driven



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Artificial Intelligence

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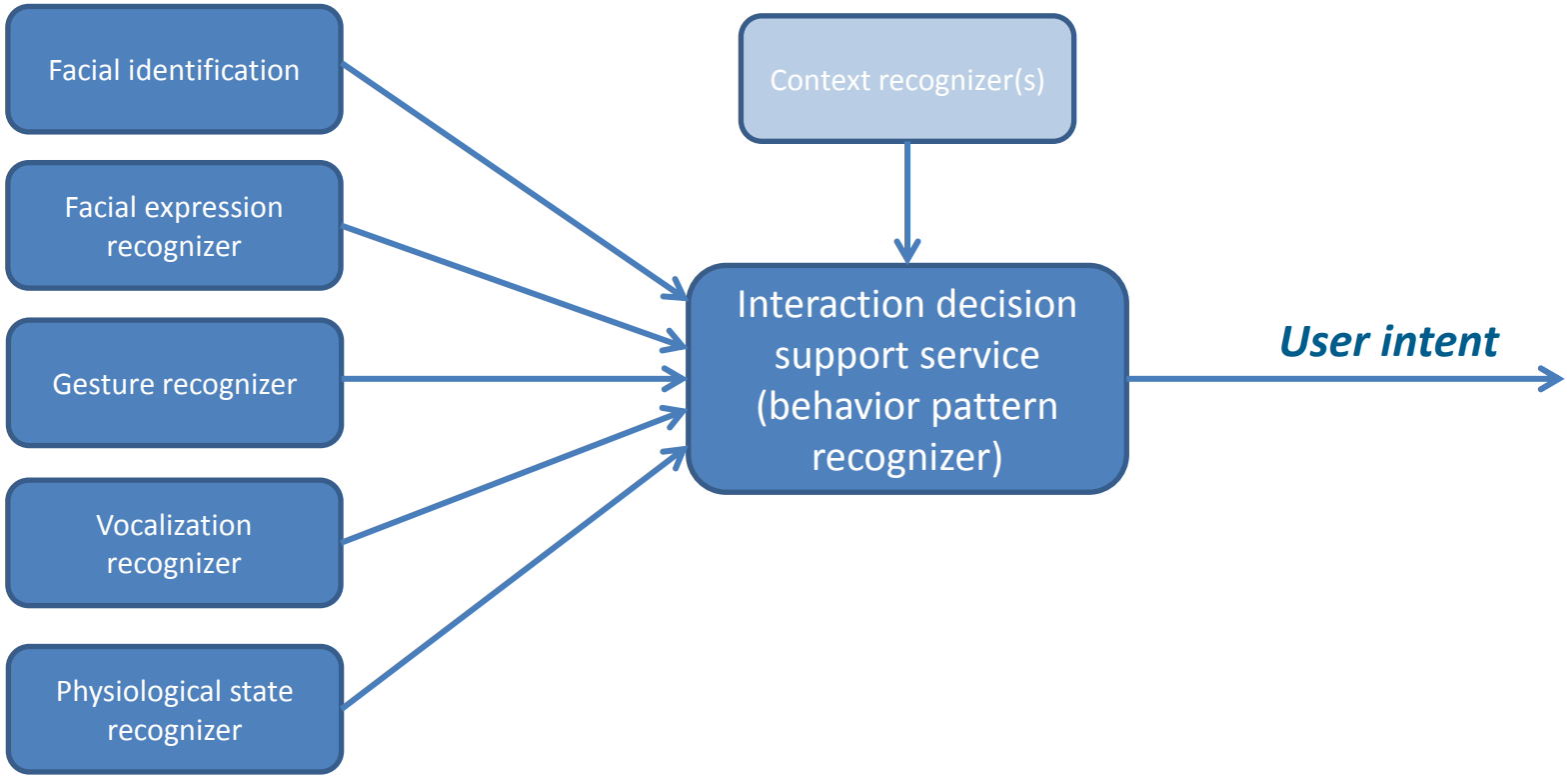
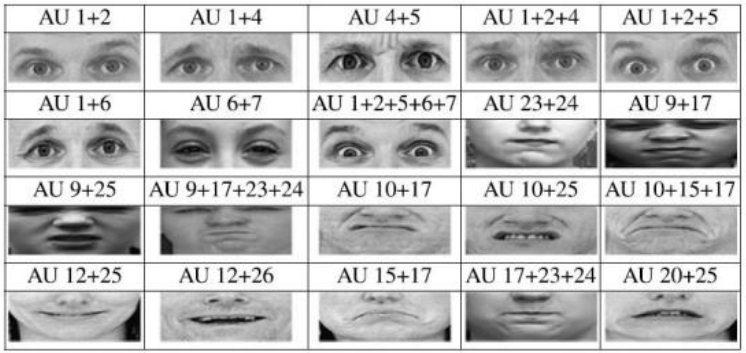
AI in INSENSION



Facial expression recognition

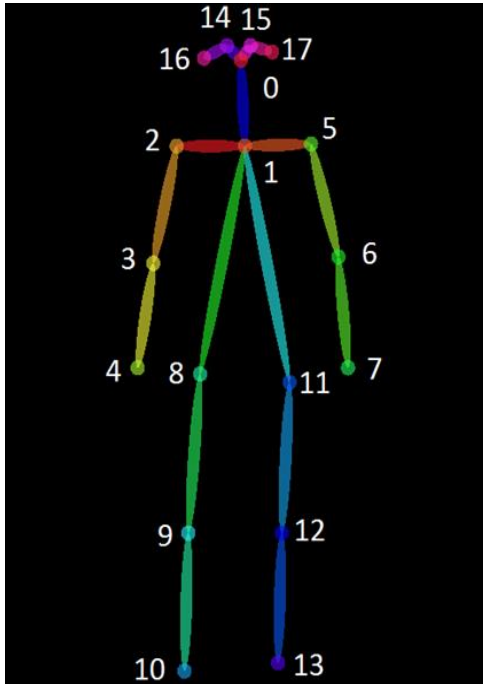
- We identify facial changes as facial action units (AUs) and facial expressions can be defined as the combination of these AUs
- Methodology
  - Extracting facial landmarks.
  - Characterizing the AUs using (relative) distances/positions between landmarks.
  - Collecting the database.
  - Implementing the algorithm for recognizing each facial expression
- We use public facial expression databases:
  - THE BOSPHORUS DATABASE (150 subjects, 4666 samples, 25 AUs)
  - The Cohn-Kanade AU-Coded Database (210 subjects, 593 samples, 30 AUs)
  - The ChildrenFacialExpression Database (12 subjects, 208 videos)



OpenPose

Gesture recognition

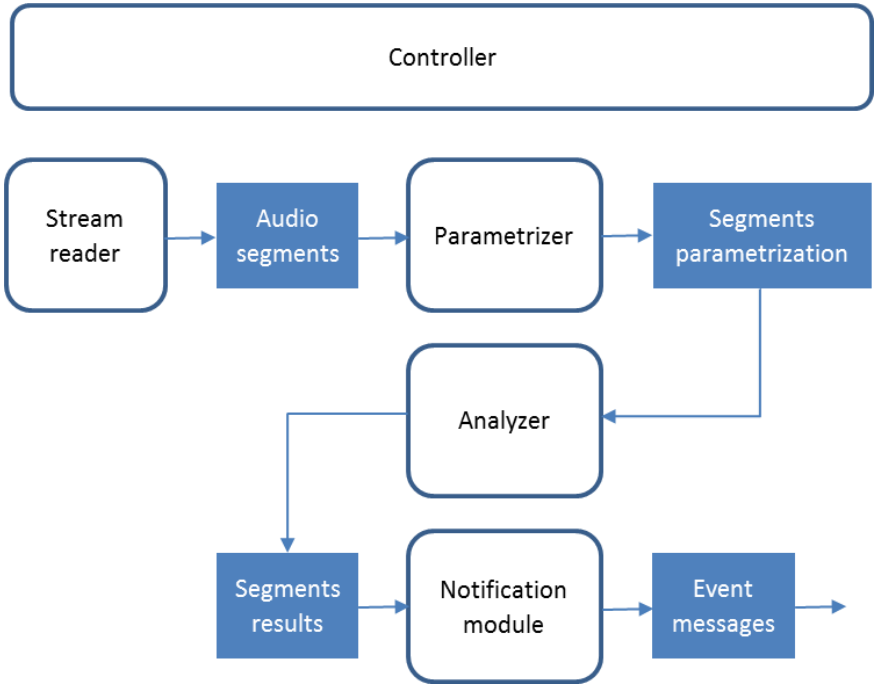
- Methodology:
  - Extracting body keypoints
  - Characterizing poses/movements using (relative) distances, angles, positions between keypoints
  - Collecting the database
  - Implementing the algorithm for recognizing each gesture



OpenPose

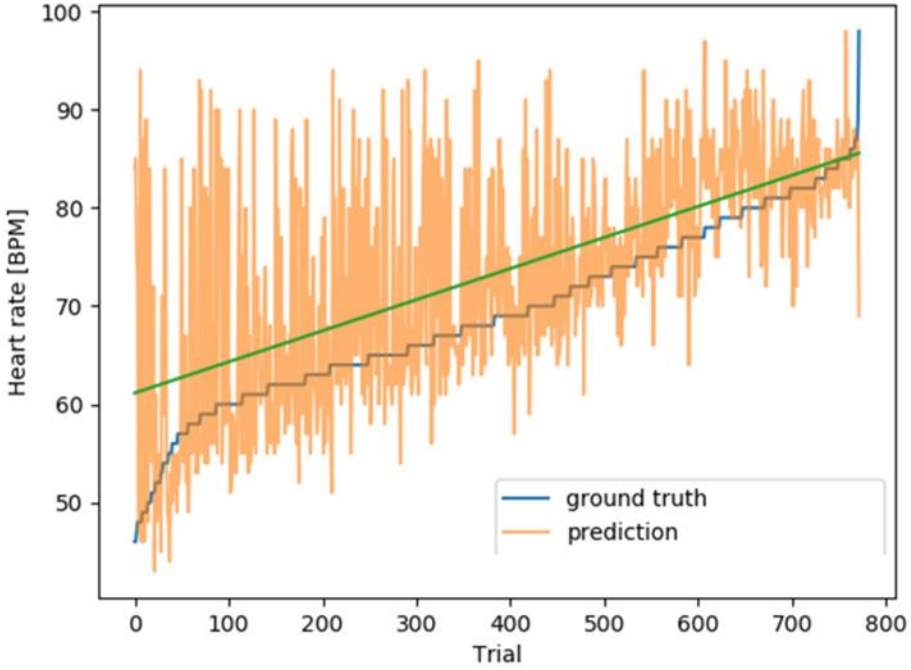
Vocalization recognition

- A separate model constructed for each vocalization type
- Model training
  - Signal parametrization = mel-frequency cepstral coefficients (MFCC)
  - Training
    - Phase 1. Unsupervised audio frame clustering (Gaussian Mixture Model)
    - Phase 2. Reestimation (Baum-Welch-based, several iterations)
- Detection algorithm
  - Signal parametrization (MFCC)
  - Event detection using statistical process modeling (HMM)



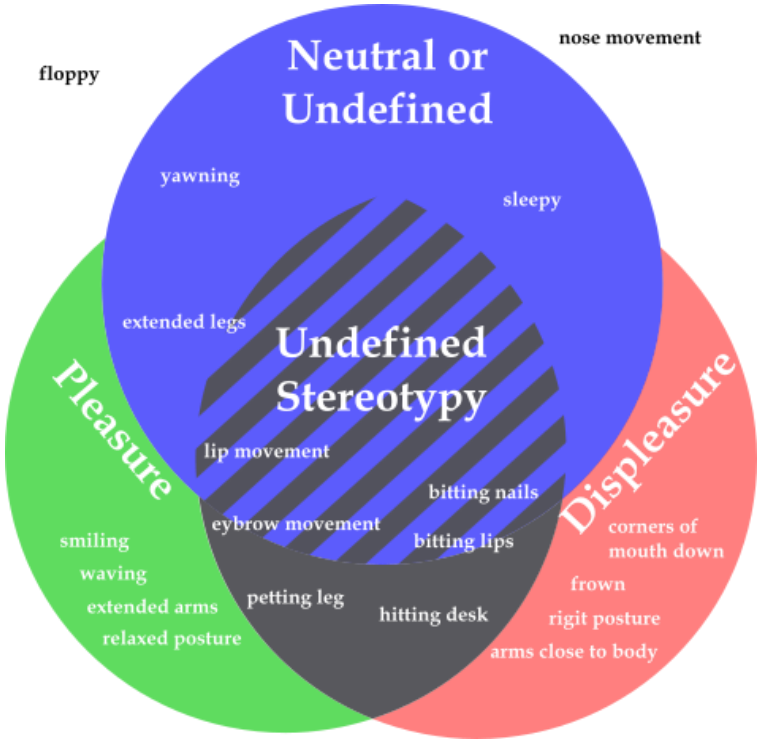
Video-based recognition of physiological state

- Two main approaches for PPG reconstruction using RGB cameras reported in literature:
  - analysis of changes in skin-color
  - analysis of small head movements induced by pumping of blood into head
- Our approach: deep neural network
  - Step 1: plane orthogonal to skin (POS) algorithm -> rough PPG reconstruction
  - Step 2: long short-term memory (LSTM) network -> improved reconstruction



Behavior pattern recognition

- The goal is to understand the inner state of the user (person with PIMD):
  - behavioral state: *pleasure, displeasure, neutral*
  - communication attempt: *demand, protest, comment*
- Decision support system based on expert knowledge



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Secondary users

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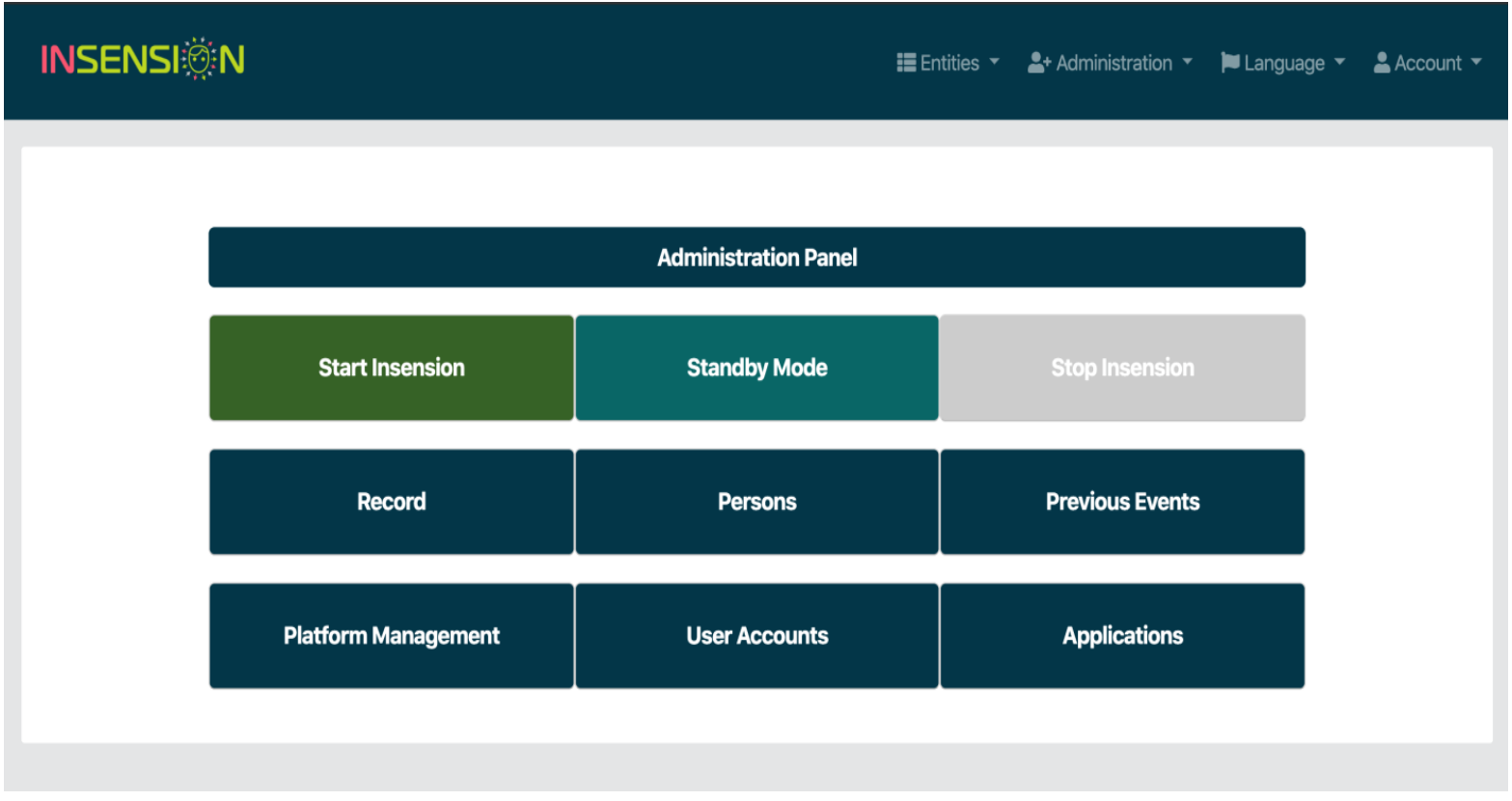
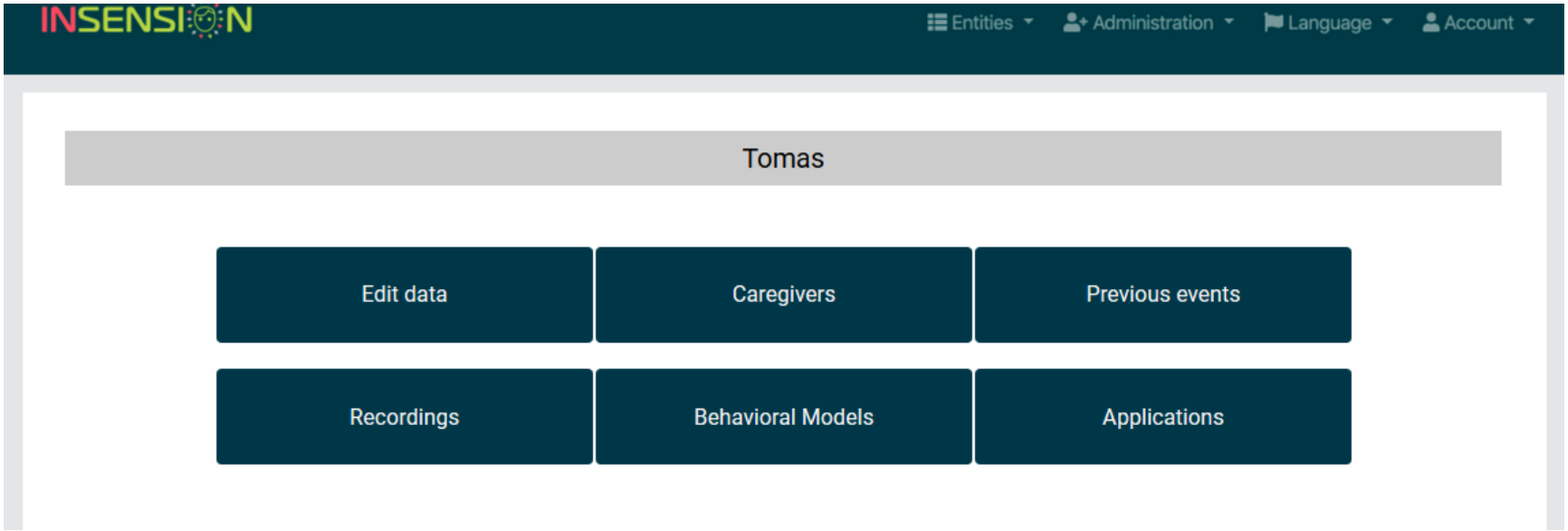
User interface for secondary users (1)



User interface for secondary users (1)



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Assistive applications

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Assistive applications

- **Goal of the INSENSION system: provide information on the current need of the end user to external applications:**
  - **Communication app, allowing the person with PIMD to communicate with other people, e.g. informing them about their current need (‘I need to relax’) or attitude (‘I don’t feel well today, this is probably because of the bad weather’);**
  - **Multimedia player, allowing the person with PIMD to decide if and what music or video is to be played in their room, based for example on feeling ‘pleasure’ or ‘displeasure’ when no song is played, or on ‘demanding’ or ‘protesting’ when a particular song or type of music is played;**
  - **Control of room devices, enabling the person with PIMD to switch particular devices on or off, for example switch on the heating device when they feel ‘displeasure’ caused by low temperature.**

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Summary

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Thank you for your attention!

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