INSENSION

IT IS ENTIRELY POSSIBLE THAT BEHIND THE PERCEPTION OF OUR SENSES, WORLDS ARE HIDDEN OF WHICH WE ARE UNAWARE

Albert Einstein

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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HARPO

Using advanced ICT for supporting people with profound intellectual and mutliple disabilities to ‘speak’ to others

Michał Kosiedowski

Poznań Supercomputing and Networking Center

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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www.insension.eu

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

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

PARTNERS:

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Technological partners

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Future Internet,
eInclusion technologies

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Artificial intelligence

CTIC

Computer vision

Domain partners

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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 (1)

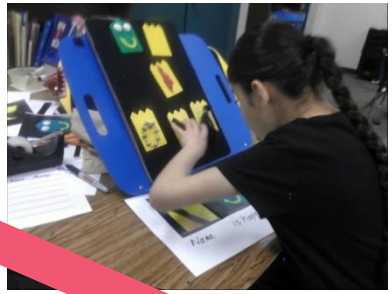
- **profound intellectual disability (IQ < 20) combined with other disabilities:** severe forms of motor disabilities, sensory disabilities (hearing or visual impairment), severe forms of epilepsy (on heavy medicamentations, frequent epileptic seizures up to grand mal)
- **communication:**
  - (usually)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

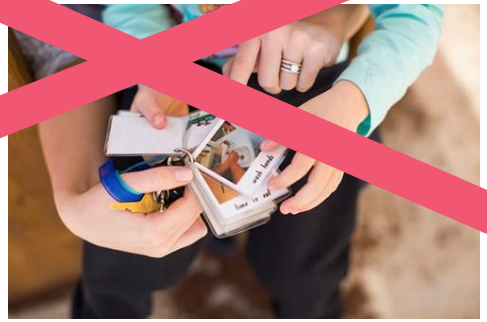
→ **difficult social participation!**

People with PIMD (2)

- **Tenedency to distinguishable etiologies:**
  - **Genetic syndroms** (e.g. Rett-Syndrome, Lejeune-Syndrome (Cri du Chat), Angelman-Syndrome …)
  - **Cerebral Palsy (CP) (Pre, peri, post natal)**
- **Problems with nutrition -> tube feeding**
- **Reorganized Brains**

Non-symbolic interaction (1)





AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

Non-symbolic interaction (2)

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

- These signals are highly individual!

Example of non-symbolic behavioral signals in a person with PIMD

- **Jeremi**: boy, 9 years old
- Signals used:
  - gestures: jerky body, floppy body (head, arms), flexed arms, raising arms, flexed legs, raising legs
  - facial expressions: closed eyes, semi-closed eyes, widened eyes, raised eyebrows, corners of mouth up, frown
  - vocalizations: 7 different types, including *loud aaa*, *special breathing*, *laugh*

Non-symbolic interaction (3)

ACCEPT
(I WANT IT)

DISAPPROVE
(I DON'T WANT IT)

Behavioral state

PLEASURE ***NEUTRAL*** ***DISPLEASURE***

Communication attempt

DEMAND ***COMMENT*** ***PROTEST***

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The goal

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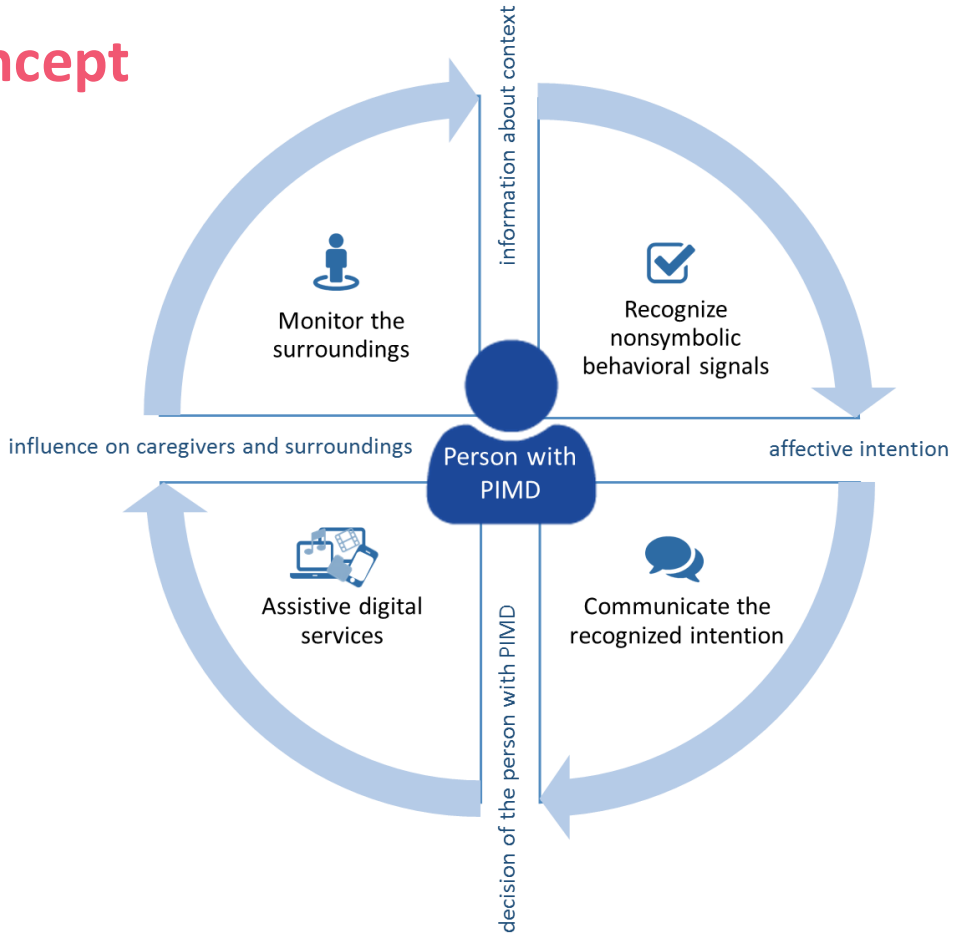
The goal

Design and develop an ICT platform that enables persons with profound intellectual and multiple disabilites (PIMD, also referred to as PMLD - profound and multiple learning disabilities) to interact with their surroundings and, as a result, increase the ability to self-determination.

General concept



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The technology

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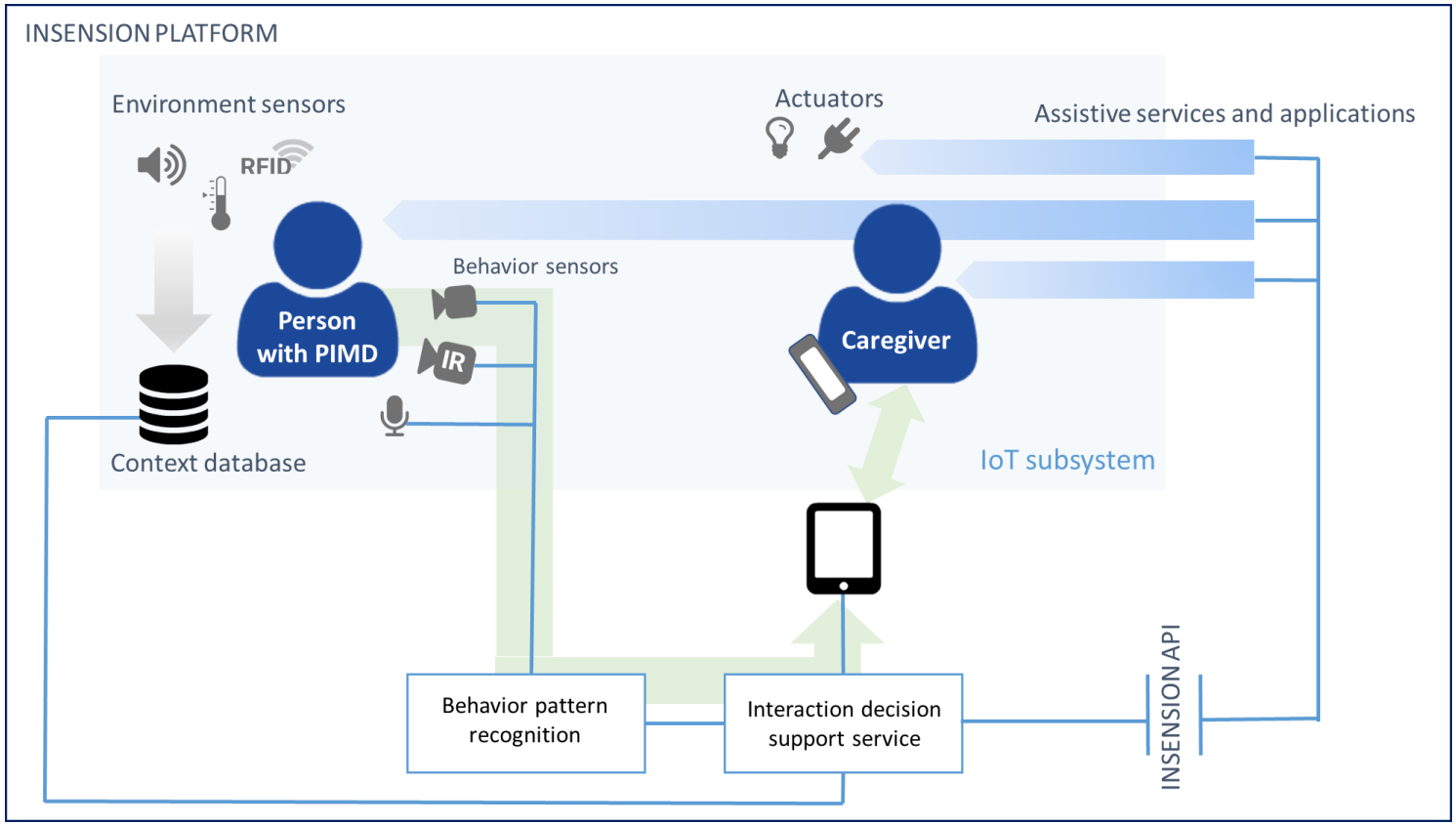
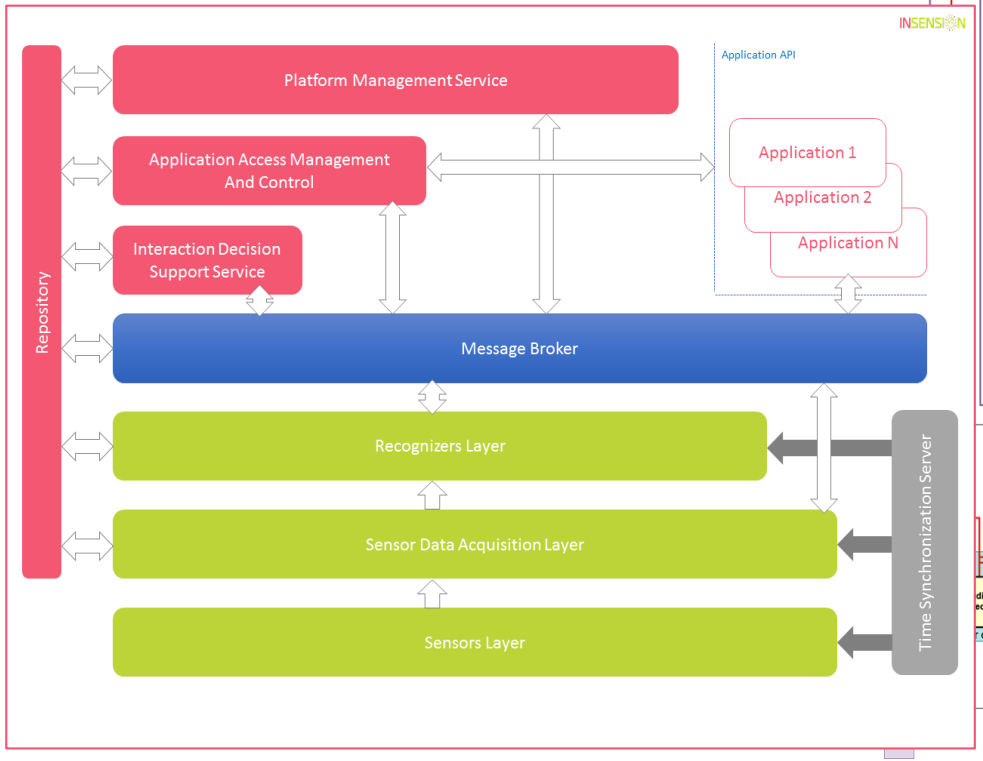
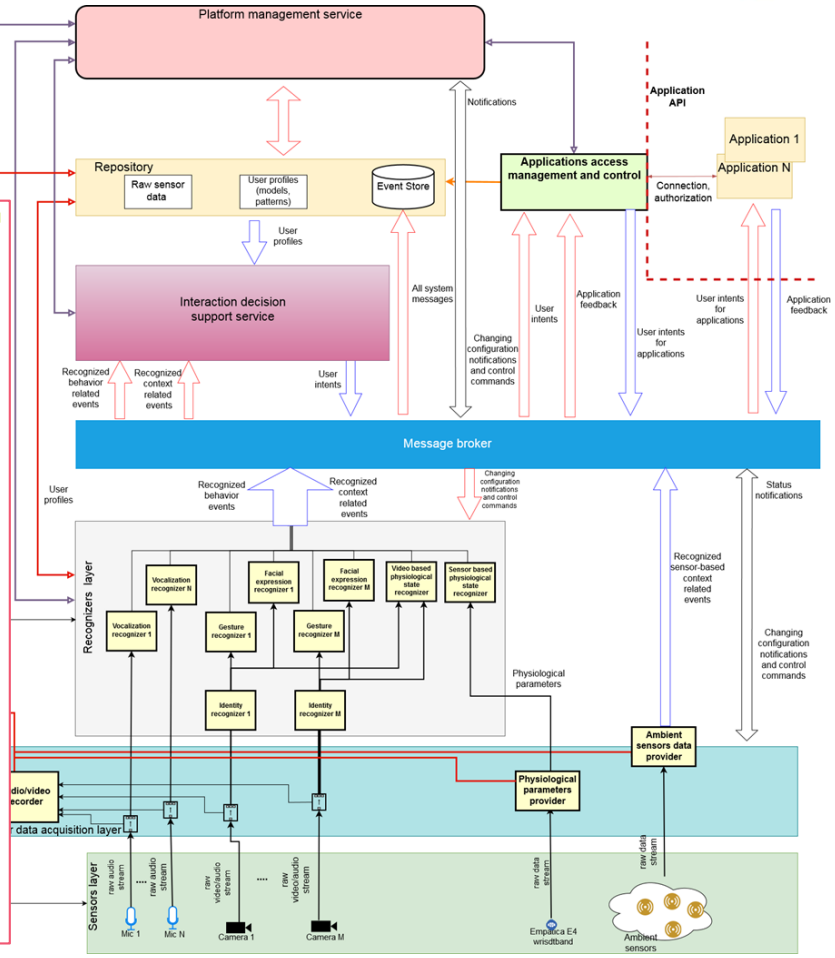
Insension platform



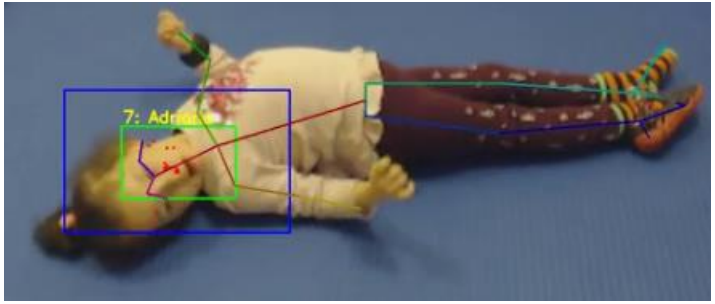
Platform complexity





Recognizers of behavioral signals

Facial expression recognizer



Gesture recognizer

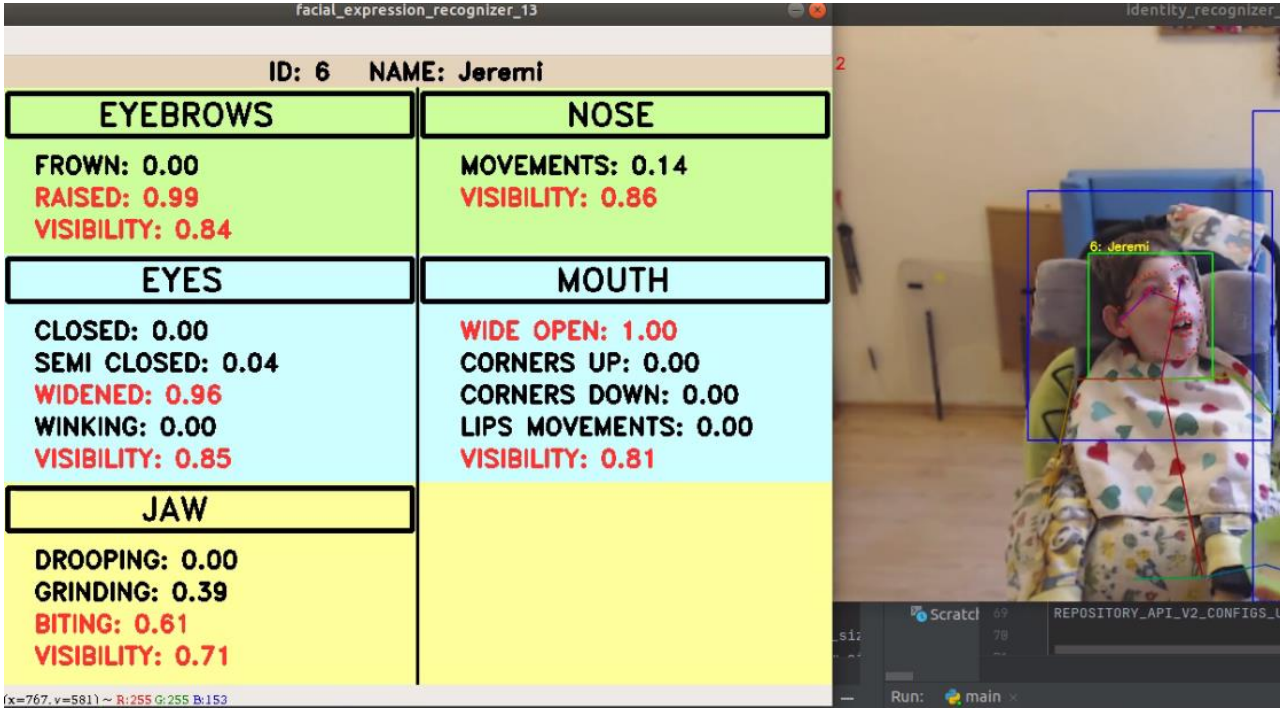
Vocalization recognizer

Facial expression recognizer (1)

Recognition by face regions

- Appearance of eyes:
  - Widened eyes
  - Closed eyes
  - Semi-closed eyes
  - Winking
  - Raised eyebrow(s)
  - Frown
- Appearance of nose:
  - Nose movements
- Appearance of mouth:
  - Lip movements
  - Corners of mouth up
  - Corners of mouth down
  - Mouth wide open
- Appearance of jaw:
  - Dropping
  - Grinding
  - Biting

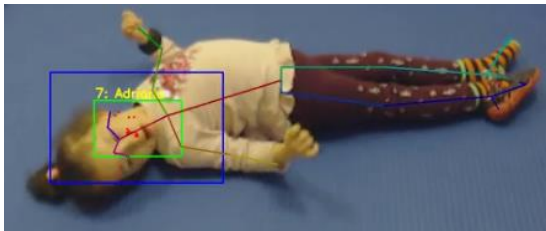
Facial expression recognizer (2)



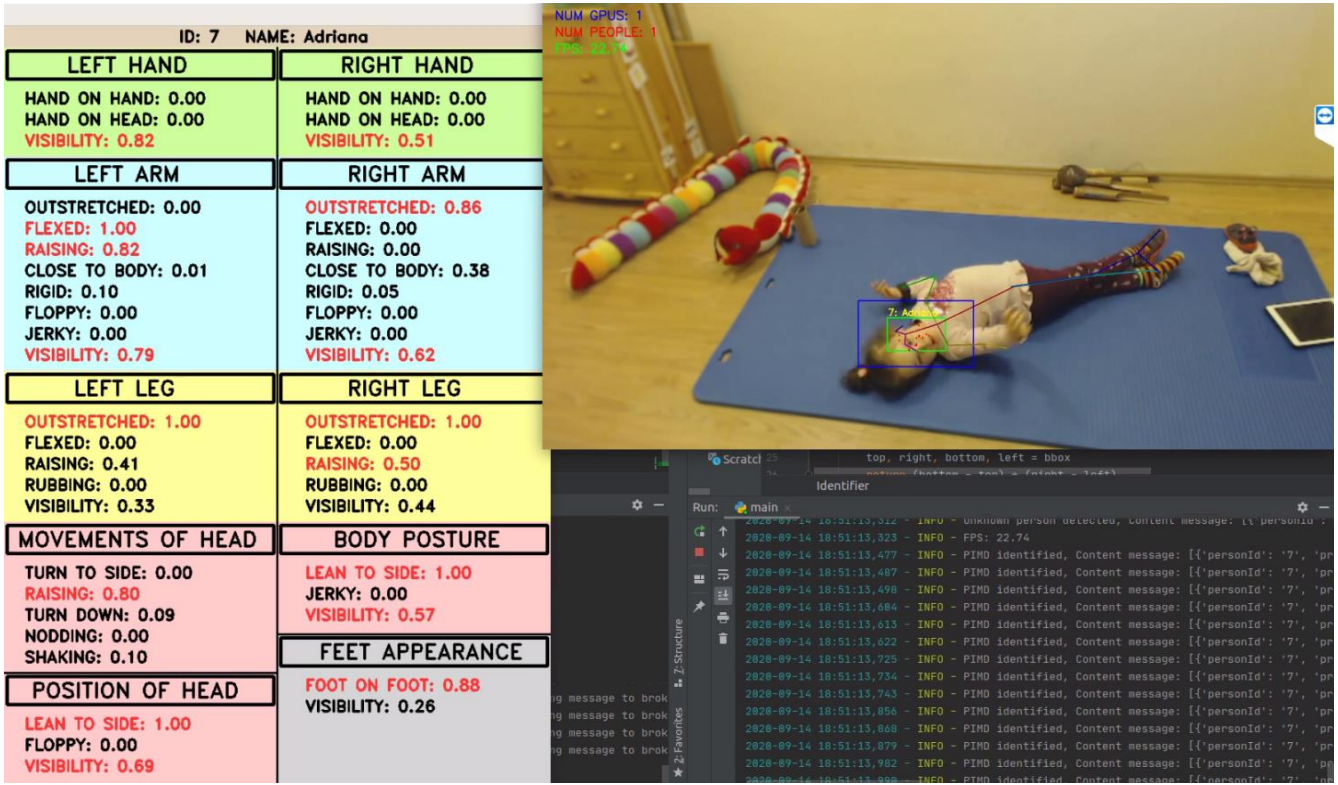
Gesture recognizer (1)

Recognition by body parts/regions

- Body posture:
  - Jerky
  - Leans to side
- Appearance of head:
  - Floppy
  - Shaking
  - Nodding
  - Raising
  - Turns to side
  - Leans to side
- Appearance of arm:
  - Rigid
  - Floppy
  - Jerky
  - Outstretched
  - Flexed
  - Raising
  - Close to the body
- Appearance of hand:
  - Hand on hand
  - Hand on head
- Appearance of leg:
  - Outstretched
  - Flexed
  - Raising
  - Rubbing
- Appearance of feet:
  - Foot on foot



Gesture recognizer (2)



Vocalization recognizer

Adriana

Vocalization name
eee
aaa
grunt
moan
eeh
laugh

Jeremi

Vocalization name
specific_breathing
aaa
crying
aeaeae
eee
cough
nge

Context of behaviors (1)

Reaction	Person A	Person B	Person C	Person D	Person E
Positive	Swinging	Singing	Massager	Music/musical instrument sounds	Music/playing with instruments
	Listening to music	Listening to music	Music	Swinging	Listening to singing and other people talking
	Massager (vibrations)	Playing with favorite toy - the pig makes noises/sounds	Movies	Backyard (she calms down when she looks through the window and when the caretaker says they'll go outside)	Playing with beads
	Special sympathies:: -A. N. (caretaker) -mother -father -grandfather	Sounds of vehicles and animals	Smelling flowers	Special sympathies: - M. (group coordinator) -K. (person from Kamyk group)	Special sympathies: -A.J.(caretaker from the group) -mother -father -sister
		"Talking" to others - people making funny sounds	Favorite toy - rabbit		
		Swinging	Lights		
		Special sympathies: -mother -grandmother -S. (caretaker at school) -therapists:M., K., K., A., B., M., R.	Other people's voices		

Context of behaviors (2)

Reaction	Person A	Person B	Person C	Person D	Person E
Negative	Cold objects	Crowded places	When it's cold		Large group of people when there's noise
	Change of position to sitting down	Sounds of violin, ambulance, fire brigade siren	Being alone		Change of position
			Sudden, loud noises		Eating and drinking
			Unknown people (he ignores them)		

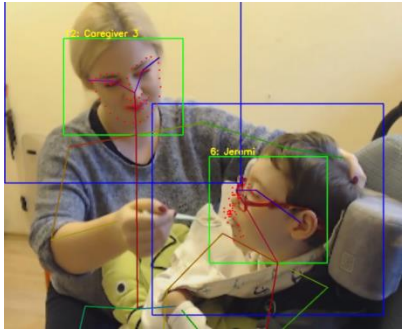
Example likes/dislikes of a person with PIMD

- Jeremi likes:
  - cars (sounds of cars, e.g. racing)
  - lights
  - music (jazz music)
  - swinging
  - people, with several special sympathies (family, teachers at kindergarten)

- Jeremi dislikes:
  - cold
  - no attention

Context recognizers

Ambient sounds recognizer



Identity recognizer

Ambient sensors

Feedback from assistive applications

Object recognizer

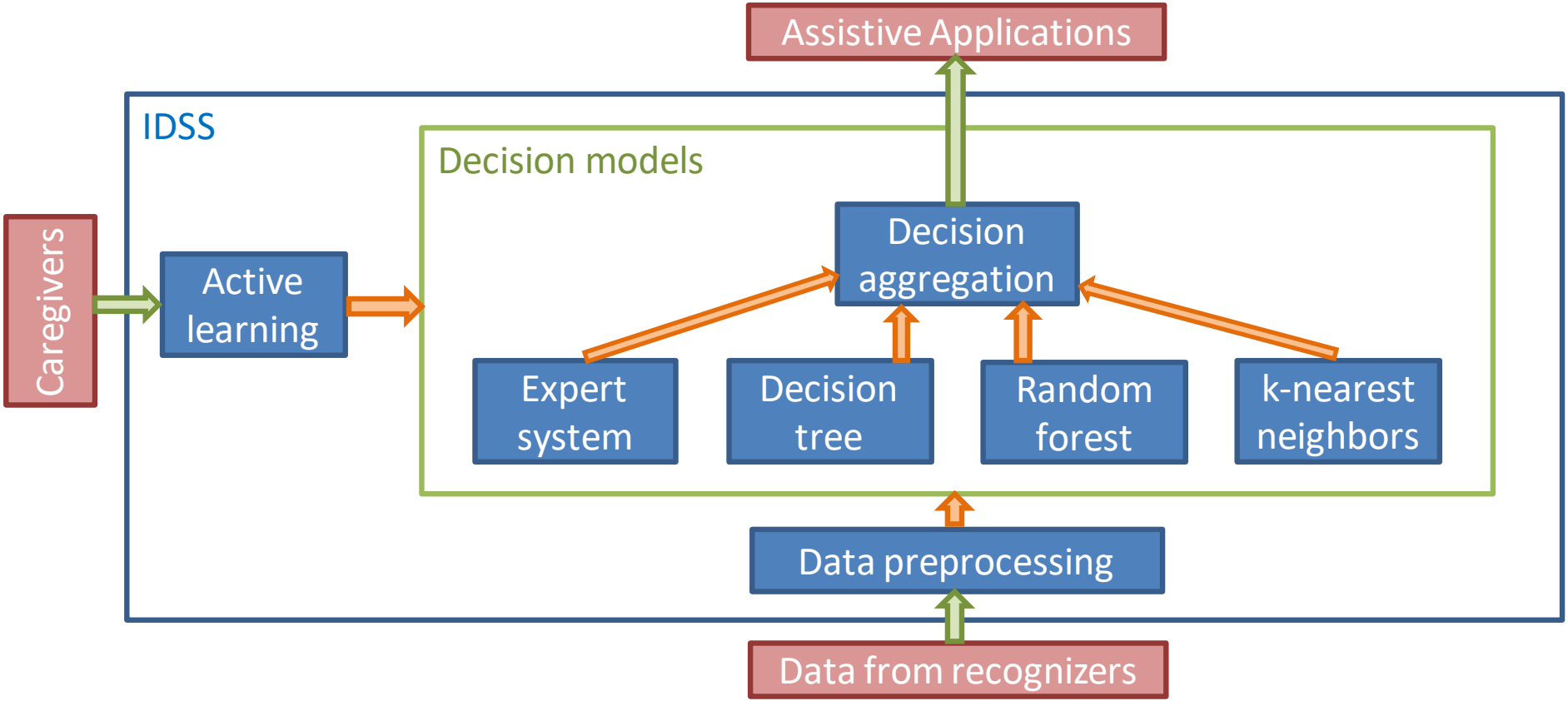
Interaction decision support (1)

- Objective: interpret the data collected by recognizers as *user intents*
- A *user intent* contains:
  - behavioral state of the user (PLEASURE/DISPLEASURE/NEUTRAL)

  and/or
  - communication attempt of the user (DEMAND/PROTEST/COMMENT)

  plus
  - potential causes of the behavior related to the current user intent

Interaction decision support (2)



Application of the Insension platform

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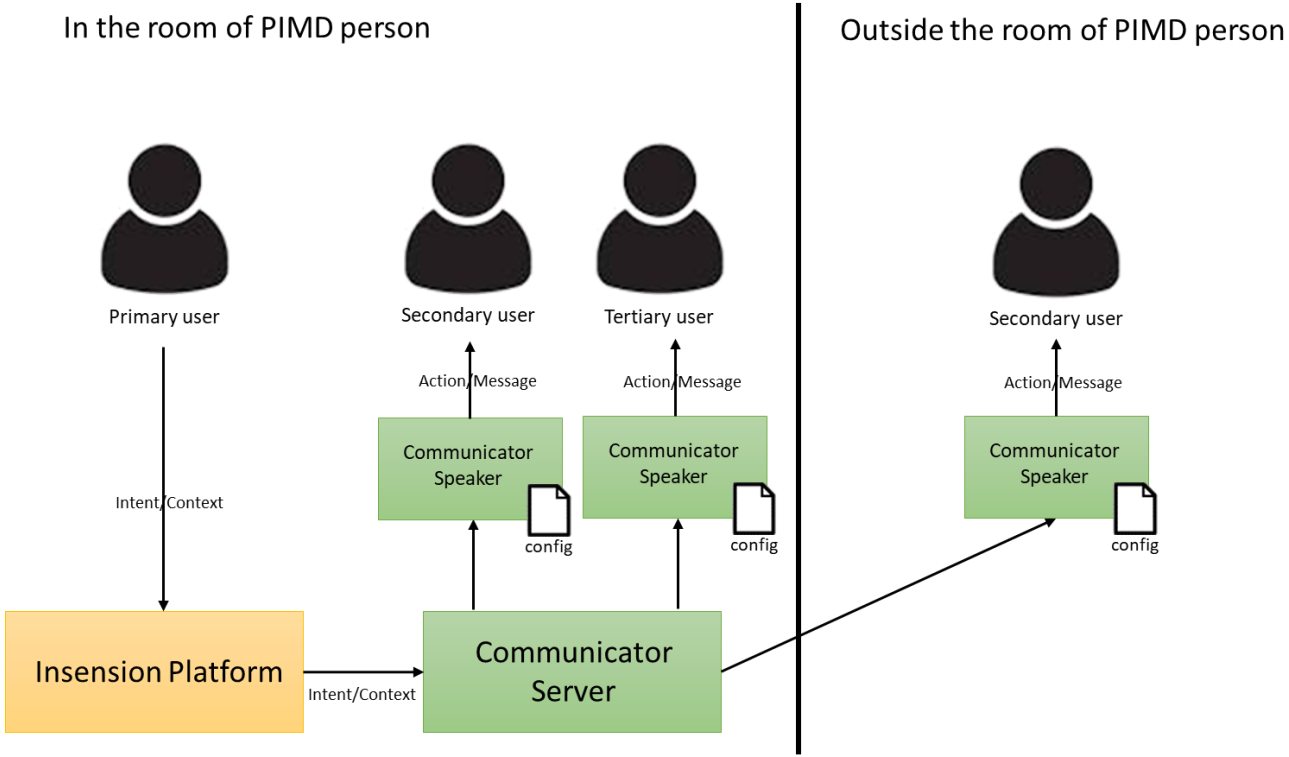
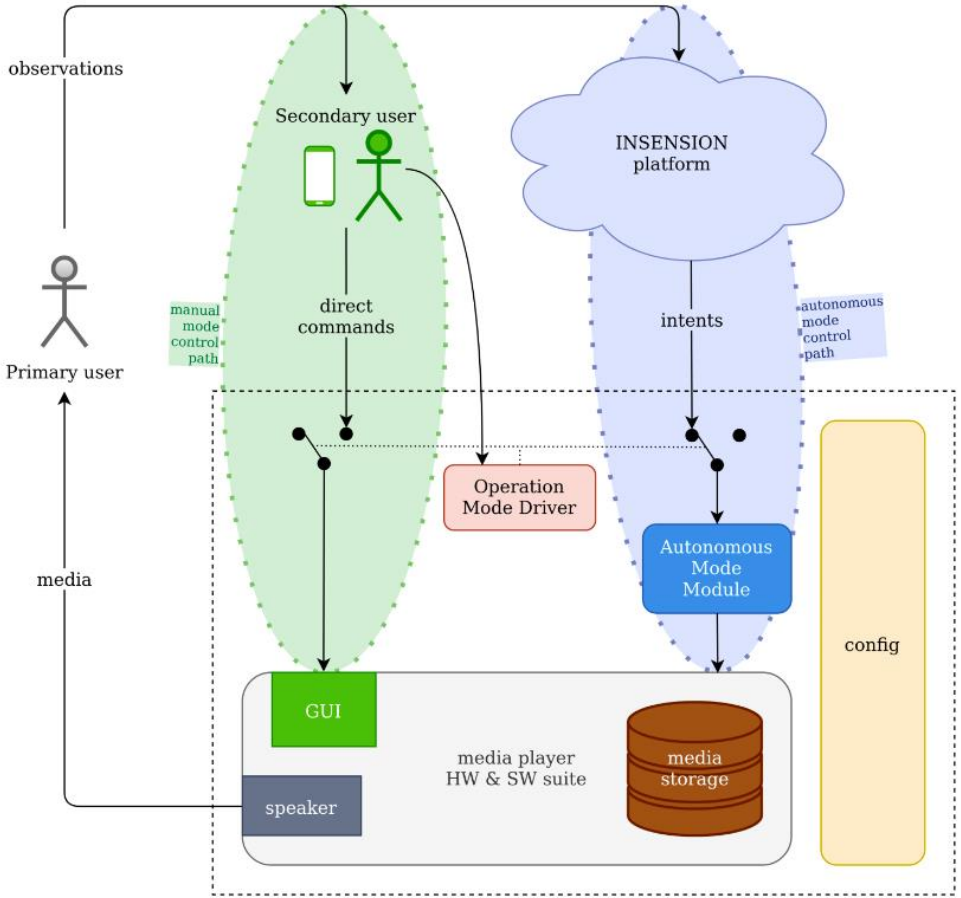
Assistive applications

- Goal of the INSENSION platform: provide information on the current need of the end user to external applications which are capable of acting on behalf of the end user
- Example (pilot) applications:

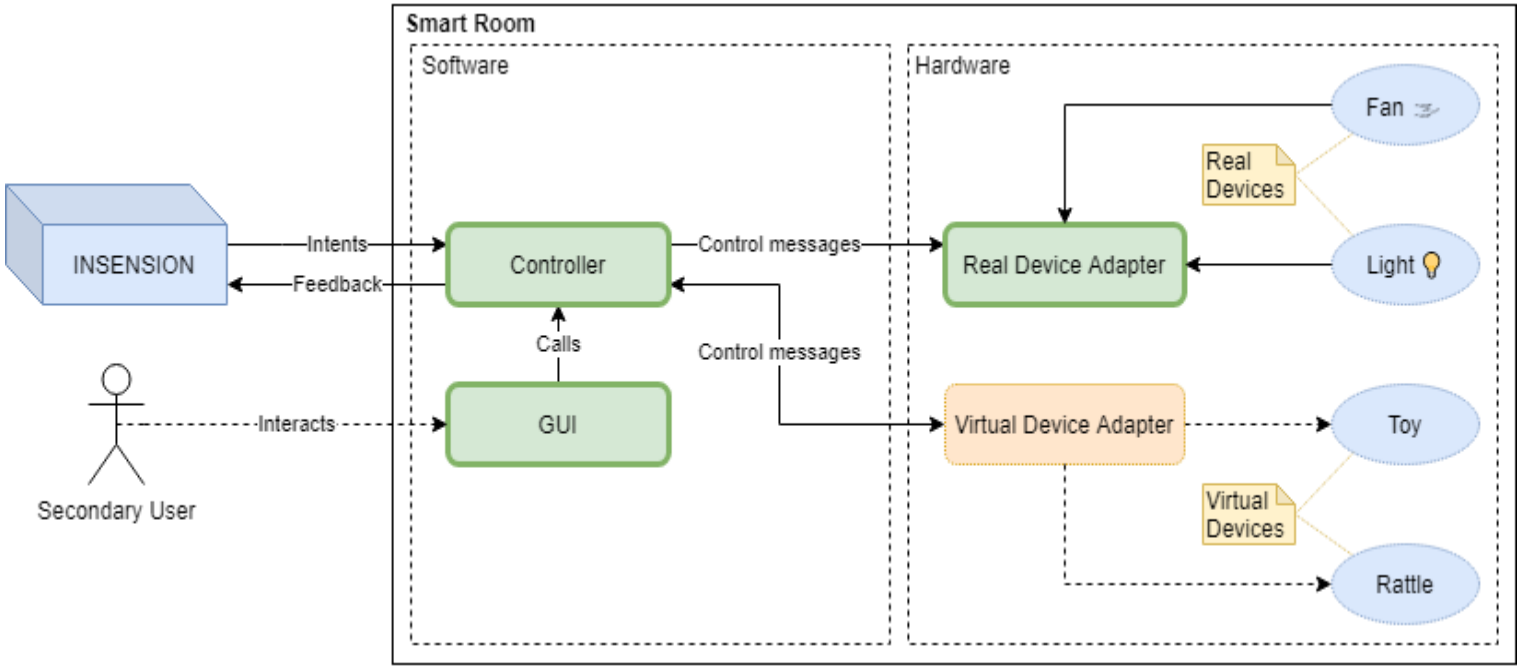
Communicator



Media player



Smart room

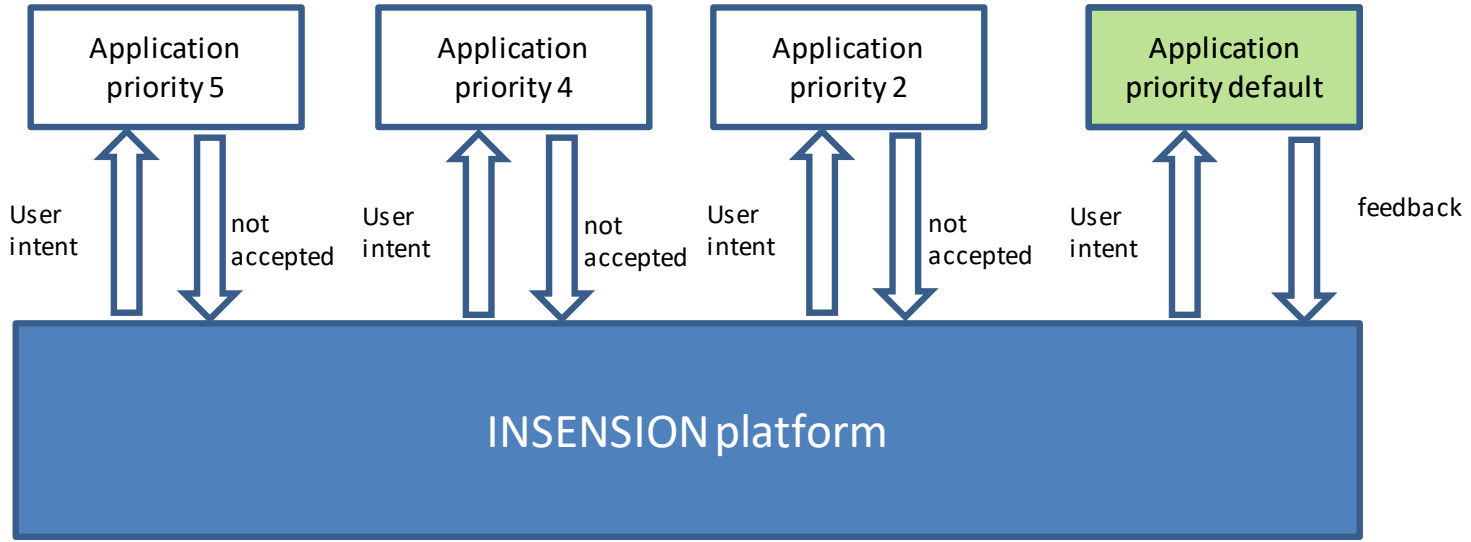

Smart Room
Software
Hardware
INSENSION
Intents
Feedback
Controller
Control messages
Real Device Adapter
Fan
Real Devices
Light
Calls
Control messages
Secondary User
Interacts
GUI
Virtual Device Adapter
Toy
Virtual Devices
Rattle

Applications prioritization (1)

- Applications receive primary user intents in order of priority until the one wishing to process the intent informs the platform it will do so
- Many applications can have the same priority which allows them to process the same primary user intent
- A selected application acts as *default* (default application has the lowest priority)
  - If no application with higher priority decides to process a given primary user intent, the default application must process it
  - Modes
    - Mode 1 - the default application receives the intent only when it is not handled by any other application
    - Mode 2 - the default application receives the intent regardless of whether any other application handles it too

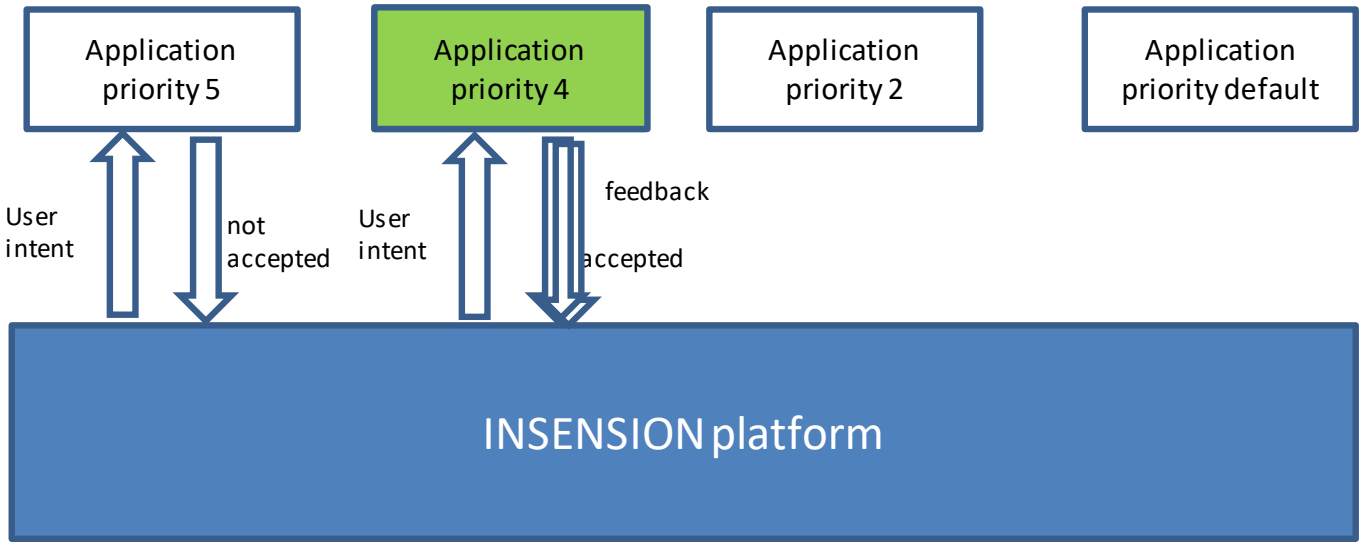
Processing user intents by applications (2)

Mode 1 – the default application receives the intent only when it is not handled by any other application



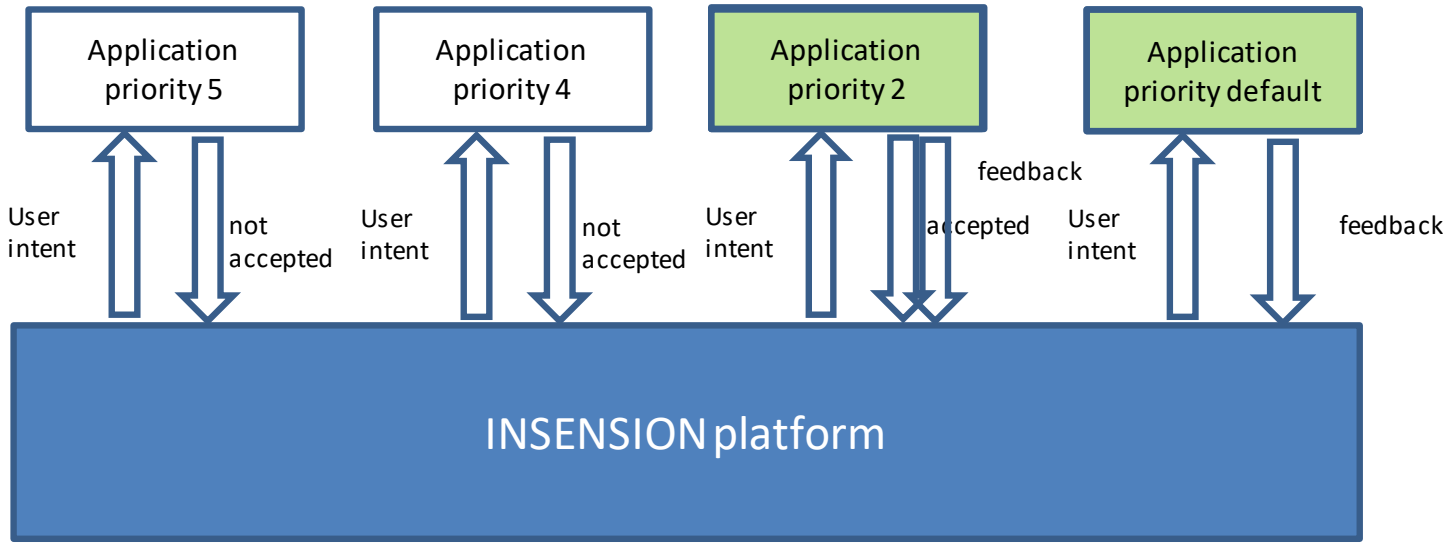
Processing user intents by applications (3)

Mode 1 – the default application receives the intent only when it is not handled by any other application (intent consumed by application with priority 4)

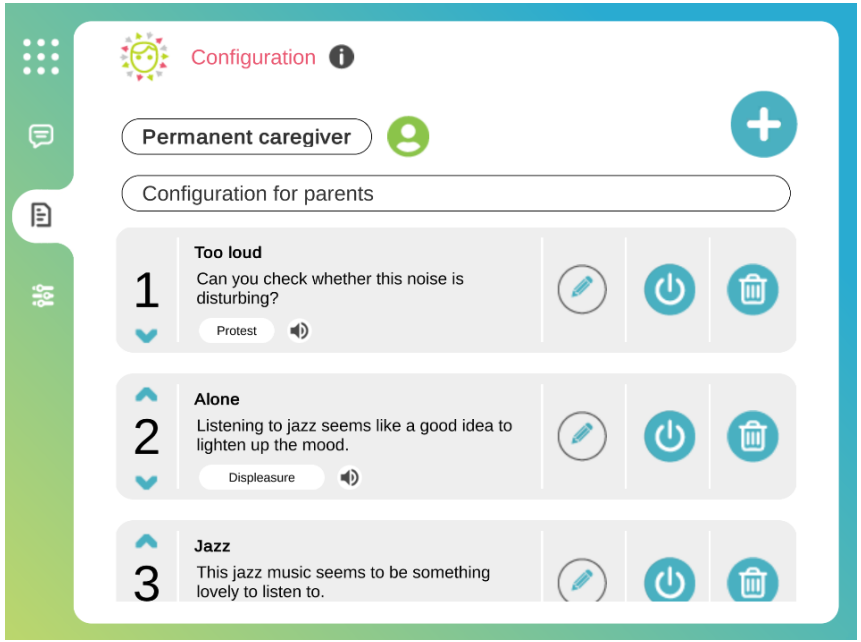


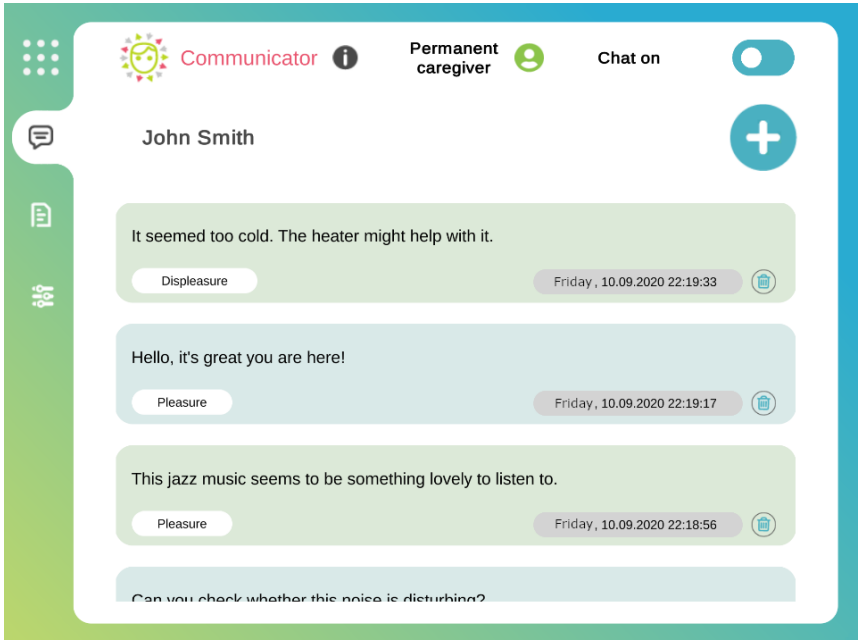
Processing user intents by applications (4)

Mode 2 - The default application receives the intent regardless of whether any other application handles it too



Configuration of applications (1)

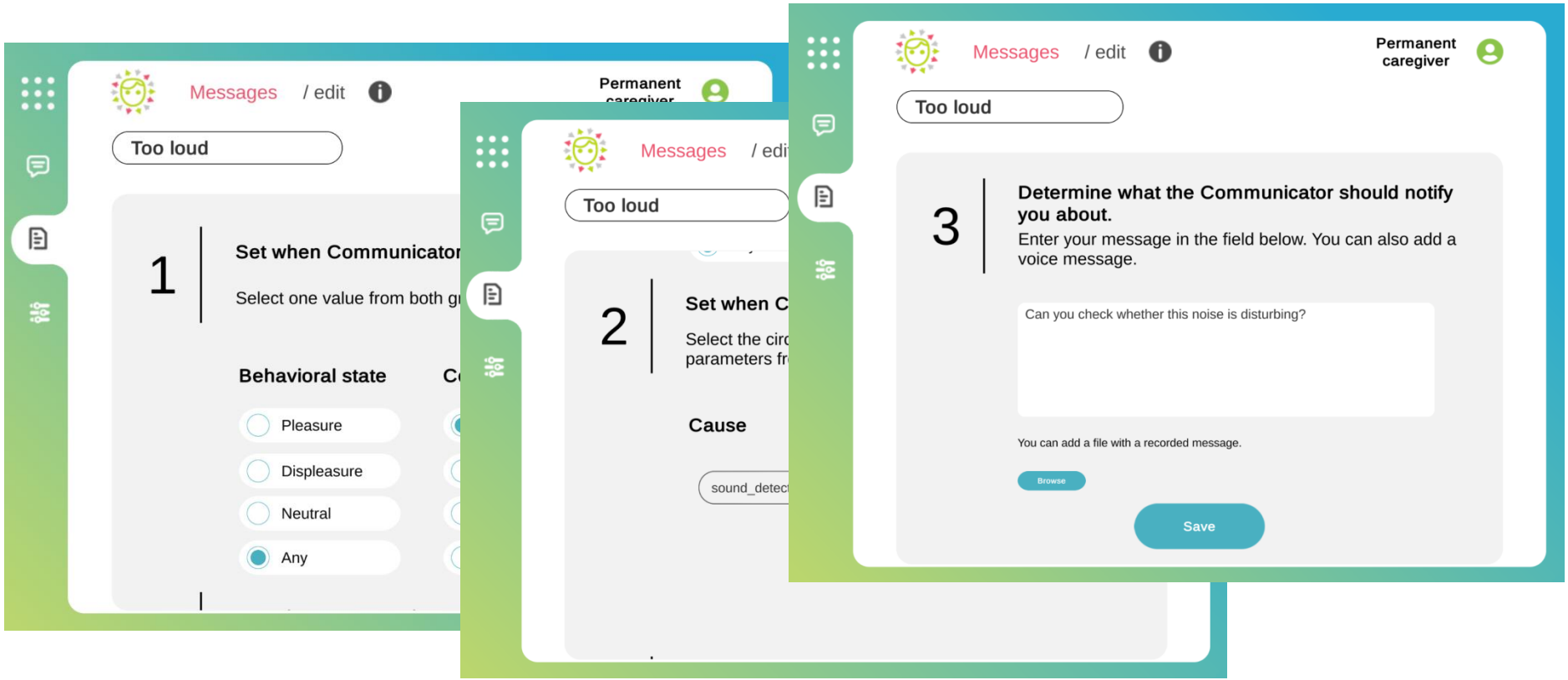




Rules

Actions

Configuration of applications (2)



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Potential enhancement of interpretion results

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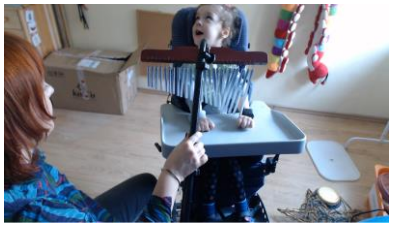
Additional study: influence of monitoring physiological response on the platform accuracy

Literature has suggested that including information on physiological response of people with PIMD might help to interpret their behaviors:

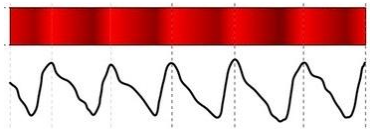
- ***„heart rate and skin temperature can give information about the emotions of persons with severe and profound ID"*** **[Vos et al. 2012]**
- ***„frequent consistent physiological reactions"*** **to stimuli [Lima et al. 2013]**
- ***„a shallow, fast breathing pattern, used less thoracic breathing,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

Physiological parameters monitoring

- Contact-free monitoring:



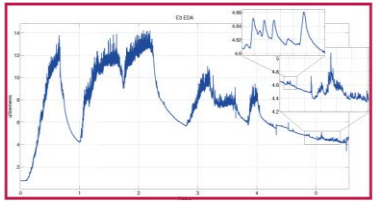
rPPG



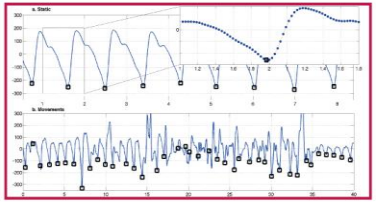
Heart rate (HR) +
Heart rate variability (HRV) +
…
→ Mental state

- Contact monitoring:

EDA



PPG



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Important questions

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Important research (and design) questions

- Is building the INSENSION system possible from the technical point of view?
- Is the INSENSION system *smart* enough to accurately act on behalf of the primary end user?
- Does the INSENSION system actually support people with PIMD?
- To what extent should the INSENSION system act on its own once it is able to recognize the meaning of the given behavior of the person with profound disability?

Should we use AI for supporting people with PIMD?

- *(We believe)* **AI can empower people with profound intellectual and multiple disabilities to take actions themselves, especially when no direct support person is around**
- **AI system such as INSENSION is sort of a prosthesis of verbal communication for a person who is biologically unable to use verbal communication**
- **Such a system is similar to:**
  - **wheelchair that allows people with motor impairment to move around**
  - **white cane that allows people with visual impairment to scan surroundings**
  - **…**

The answer

Not applying Artificial Intelligence on people with PIMD

due to their incapability of consenting to it

would refuse them the possibility to benefit from the potential of achieving a level of independence

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Thank you for your attention!

Further information on insension.eu

Find us on Facebook: www.insension.eu/fb

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