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Developing Solutions to Identify and Treat Nocturnal Disorientation in Dementia Patients

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Initial state

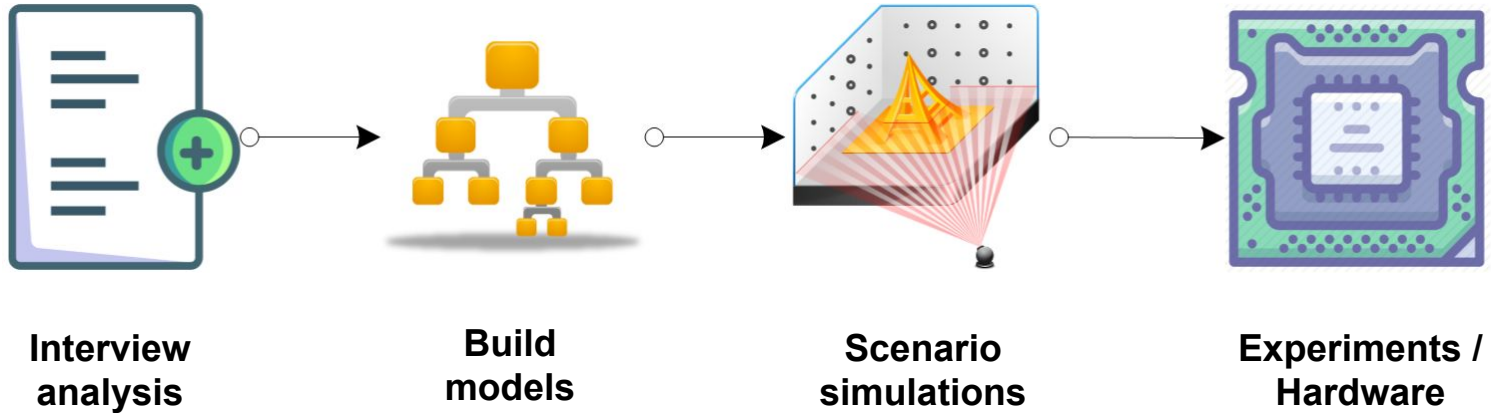
The tools for the job

- **Twenty interviews** to dementia patients:
 - Alzheimer's disease, vascular dementia, lewy bodies...
 - Various degrees of disease evolution.
 - Multiple ages and socioeconomic statuses.
- **AIDE - Ambient Intelligence Development Environment:**
 - * **Virtual Living Lab** *
 - **INGENME** ⇒ **SociAALML**: Graphical editor to model agents, environments and their behaviour.
 - **PHAT** Framework: Transforms the models of SociAALML into 3D simulations



Workflow

From interviews to solutions



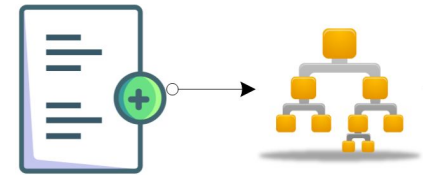
Interview Analysis

- Lots of reading, underlining and note taking.
- Key aspects of focus:
 - **Sociodemographic** data
 - Everyday **problems** and **difficulties**
 - **Technological** discussion
 - Day to day **activities** ⇒ Simulations



Build models

SociAALML Editor

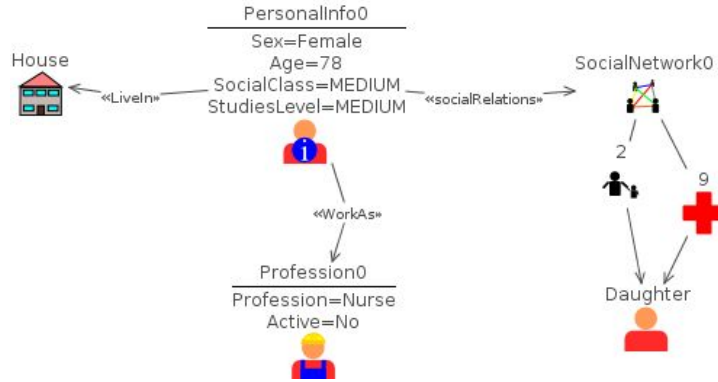


First step: Replicate the information given in the interview through the use of the SociAALML Editor's entity-relationship diagrams

- **Social** and **Human** diagrams model age, profession and social relationships for all agents involved
- **ADL, Activity** and **Sequential Tasks** diagrams constitute the behaviour of agents. These can be associated to specific times of the day and can have different conditions applied to them
- **Disease Spec, Symptom Evolution** and **Filter** diagrams model specific problems, their evolution throughout the day and effects on the agents
- **Building, Floor, Room, Devices**, etc... make up the diagrams of the scenario in which the simulations will take place
- **Simulation** diagrams tie everything together

SociAALML Editor

Agent info and social profile

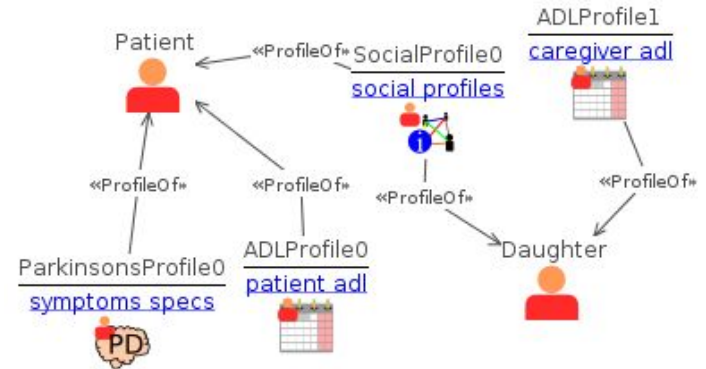


SocialSpecDiagrams:

- Personal and professional info.
- Social relationships.

HumanProfileSpecDiagrams:

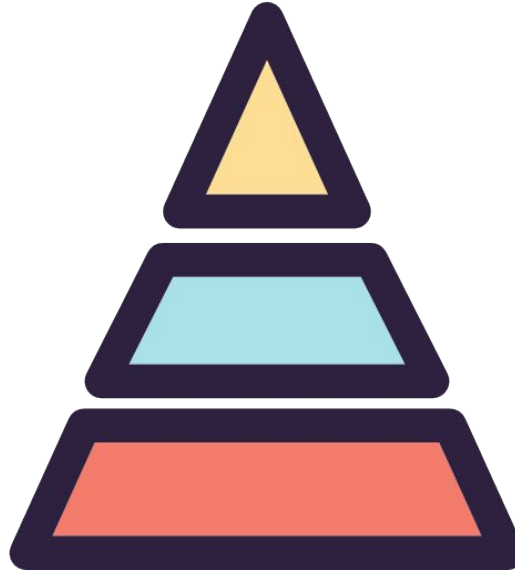
- Associate each agent to their daily activities.
- Specify symptom diagrams.



SociAALML Editor

Agent planning and environment interaction

From the more general planning to the specifics of each task.
Conditional planning can be performed.



ADLSpecDiagram



ActivityDiagram



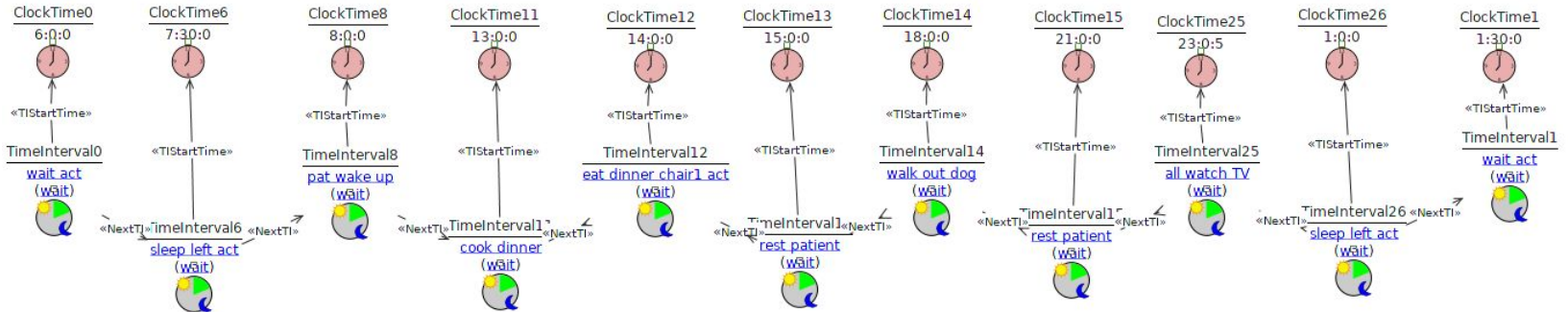
SequentialTaskDiagram

SociAALML Editor

Agent planning and environment interaction

ADLSpecDiagram:

Assign **activity sequences** to **times of the day**.

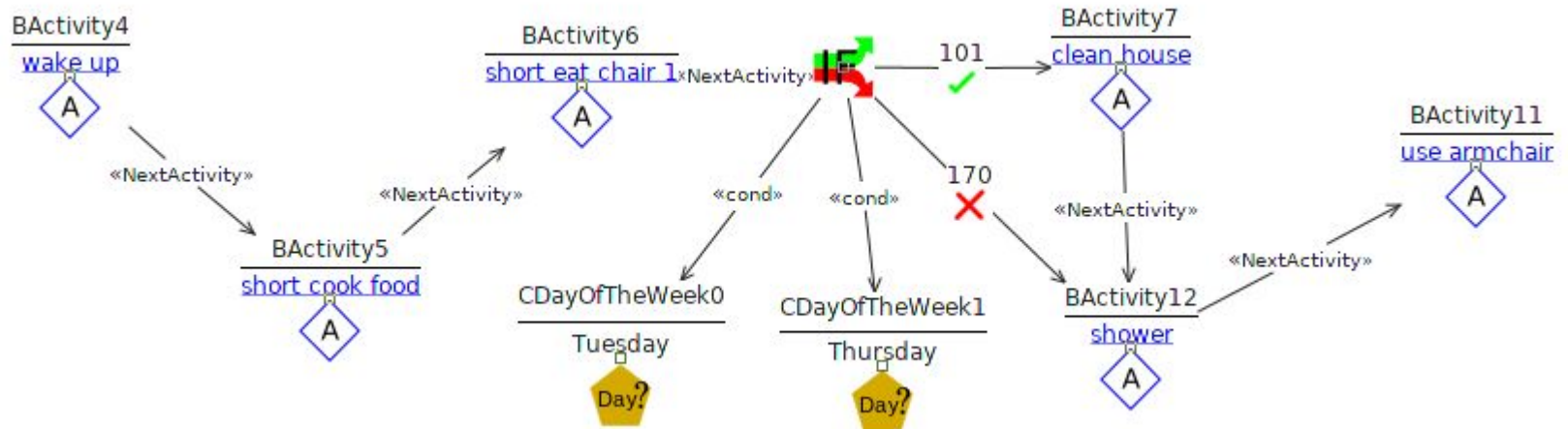


SociAALML Editor

Agent planning and environment interaction

ActivityDiagram:

They contain **sequences of tasks** which can be **conditionally executed**.

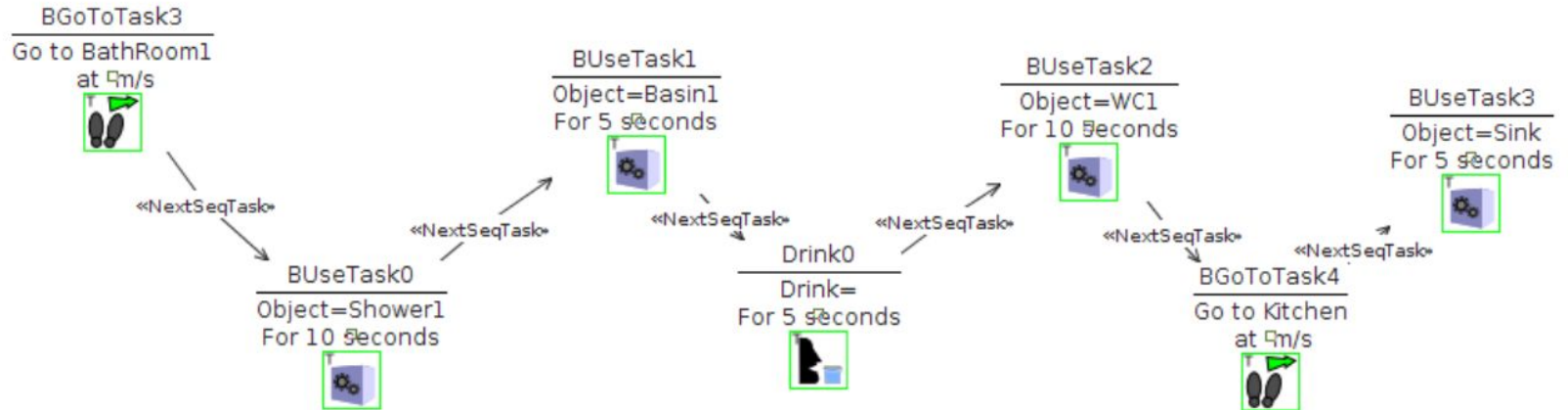


SociAALML Editor

Agent planning and environment interaction

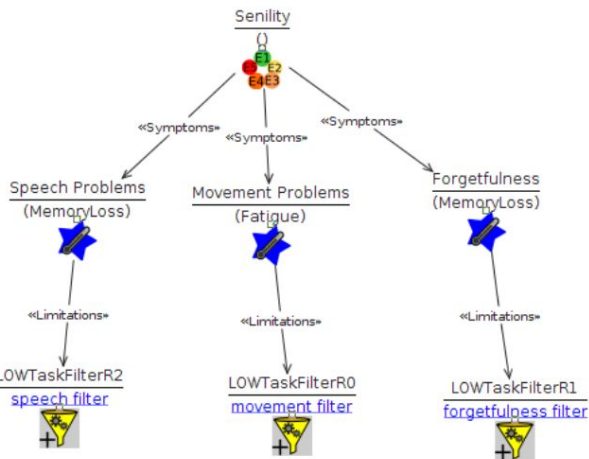
SequentialTaskDiagram:

Specifics of every activity. They contain info on **duration** and **object** of interaction.



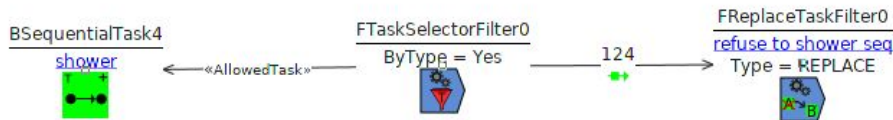
SociAALML Editor

Illness specifics



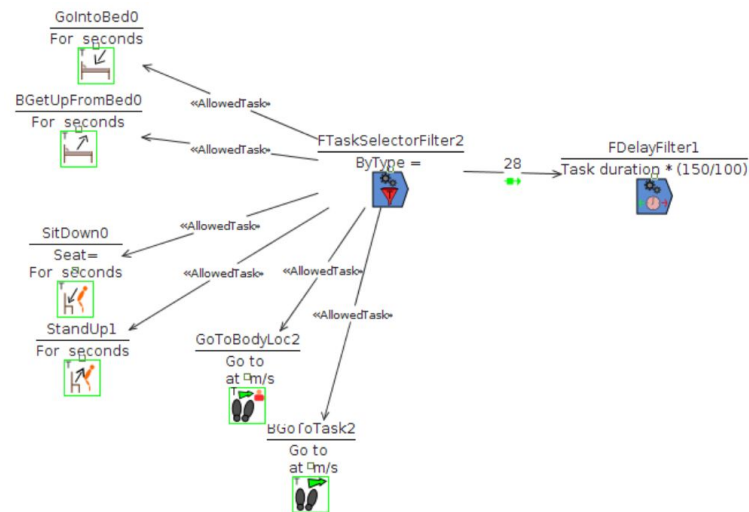
FilterDiagram:

Model the way in which **planning is modified** when under a symptom. Can also contain **conditionals**.



DiseaseSpecDiagram:

Tree of **symptoms** with **filters** applied to them. Can also contain the **symptom evolution** across time or while taking/not taking medication.

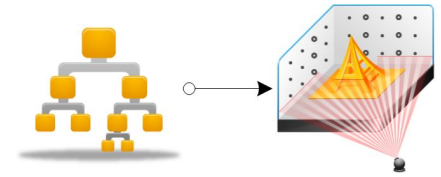


Symptoms can be isolated or combined, **environment** can be changed. **Starting time** and date can vary along with **camera position** and other various features.



Simulate Scenarios

PHAT Simulator



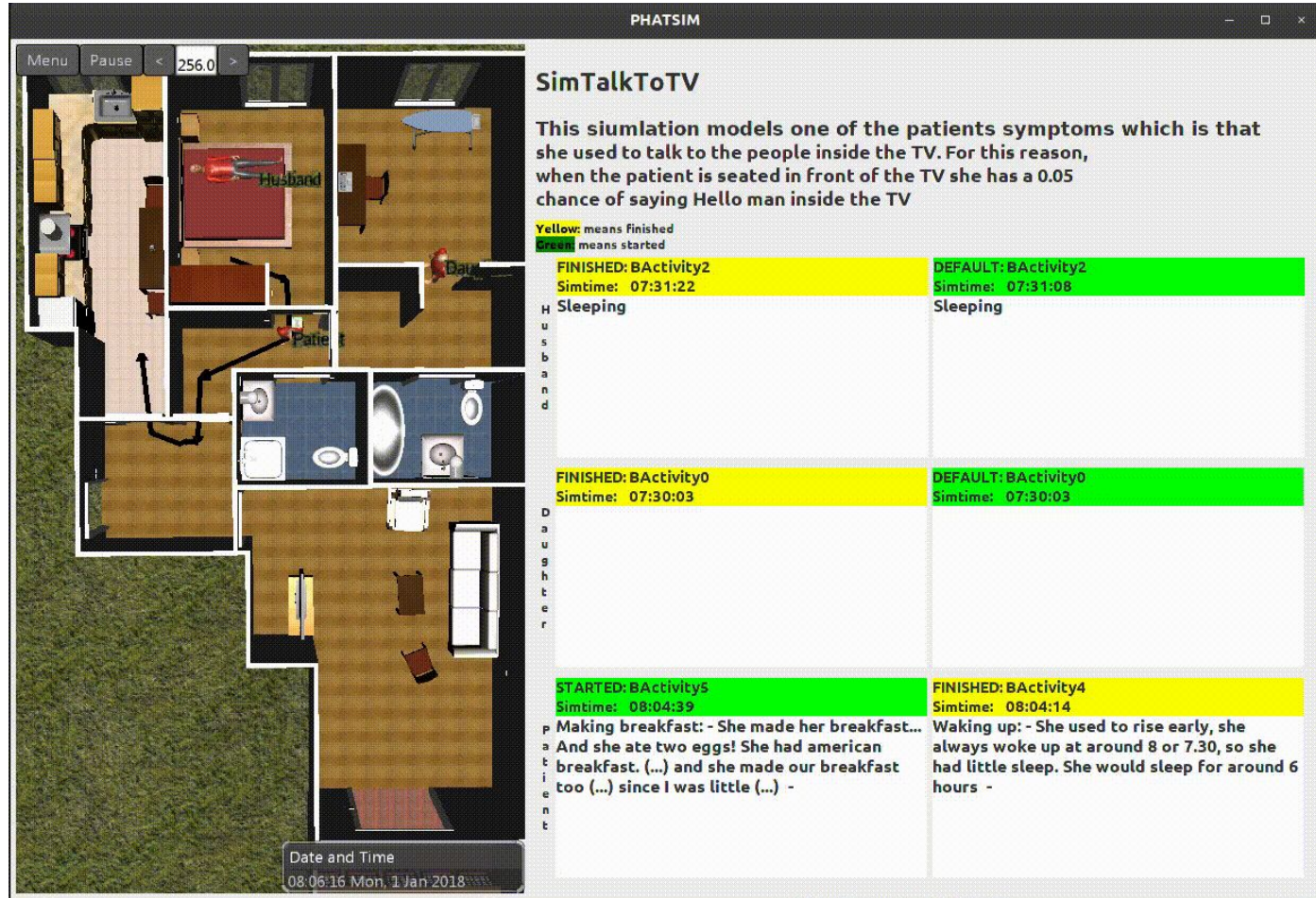
Once we have modeled the interview within the tool, we can **run simulations**:

- Enable, disable or mix **symptoms**
- Attach **virtual sensors** to gather data

For this project we made complete **24-hour simulations** of a patient's day with varying symptoms.



PHAT Simulator



The PHATSIM interface displays a 3D simulation of a house with rooms including a kitchen, living area, and bedrooms. A 'Menu' bar at the top left shows 'Pause' and a time value of '256.0'. A 'Date and Time' box at the bottom left indicates '08:06:16 Mon, 1 Jan 2018'. The 'SimTalkToTV' window on the right provides a detailed log of activities for 'Husband' and 'Daughter'.

SimTalkToTV

This simulation models one of the patients symptoms which is that she used to talk to the people inside the TV. For this reason, when the patient is seated in front of the TV she has a 0.05 chance of saying Hello man inside the TV

Legend:
 Yellow: means Finished
 Green: means started

Activity	Status	Simtime
FINISHED: BActivity2	Finished (Yellow)	07:31:22
Simtime: 07:31:22	Finished (Yellow)	07:31:22
Sleeping	Finished (Yellow)	07:31:22
DEFAULT: BActivity2	Started (Green)	07:31:08
Simtime: 07:31:08	Started (Green)	07:31:08
Sleeping	Started (Green)	07:31:08
FINISHED: BActivity0	Finished (Yellow)	07:30:03
Simtime: 07:30:03	Finished (Yellow)	07:30:03
DEFAULT: BActivity0	Started (Green)	07:30:03
Simtime: 07:30:03	Started (Green)	07:30:03
STARTED: BActivity3	Started (Green)	08:04:39
Simtime: 08:04:39	Started (Green)	08:04:39
FINISHED: BActivity4	Finished (Yellow)	08:04:14
Simtime: 08:04:14	Finished (Yellow)	08:04:14

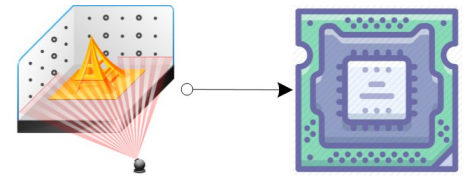
Activity Log:

- H u s b a n d**
 Making breakfast: - She made her breakfast... And she ate two eggs! She had american breakfast. (...) and she made our breakfast too (...) since I was little (...) -
- D a u g h t e r**
 Waking up: - She used to rise early, she always woke up at around 8 or 7.30, so she had little sleep. She would sleep for around 6 hours -

Date and Time
 08:06:16 Mon, 1 Jan 2018

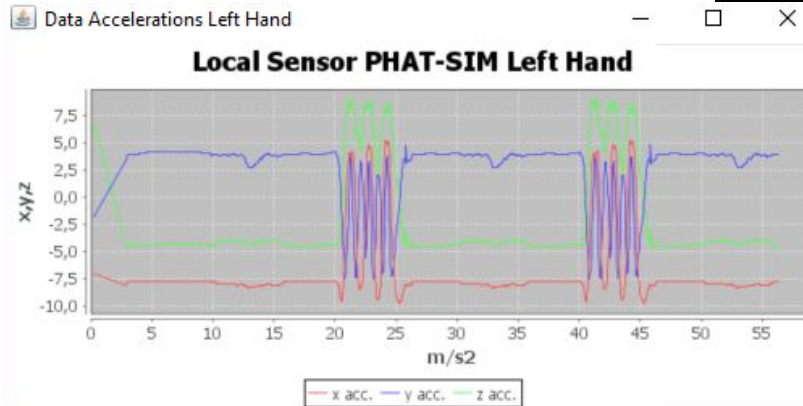
Experimenting

Gathering data from virtual sensors



We can attach **virtual hardware** to the scene, **view** and **collect** its data.

- Door sensors (Hall-effect)
- Presence sensors
- Accelerometers
- Cameras
- Even Android phones!



```
127.0.0.1 - PuTTY
sim
sensorevent;0;TYPE_ACCELEROMETER;30;-7.269268;6.442955;-1.2984961
sim
sensorevent;0;TYPE_ACCELEROMETER;29;-7.802751;5.912181;-0.4507785
sim
sensorevent;0;TYPE_ACCELEROMETER;29;-7.9960017;5.662624;-0.19668841
sim
sensorevent;0;TYPE_ACCELEROMETER;30;-7.7037888;5.9877224;-0.9158656
sim
sensorevent;0;TYPE_ACCELEROMETER;29;-7.3654814;6.25211;-1.6434166
sim
sensorevent;0;TYPE_ACCELEROMETER;29;-6.9947886;6.4315786;-2.397442
sim
sensorevent;0;TYPE_ACCELEROMETER;29;-7.32052;6.1887913;-2.036875
sim
sensorevent;0;TYPE_ACCELEROMETER;29;-7.9070582;5.667595;-1.1818664
sim
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sim
sensorevent;0;TYPE_ACCELEROMETER;29;-8.781941;4.333909;0.36712438
sim
sensorevent;0;TYPE_ACCELEROMETER;29;-8.4710294;-0.31367403
sim
sensorevent;0;TYPE_ACCELEROMETER;29;-8.348017;-1.0118593
```


PoC Hardware Development

Helping caregivers rest at night

Problem:

- It is reported by many caregivers that they have **trouble resting at night** because they have to be **aware of the patients** waking up to **go to the bathroom**.
- These patients **disorient** rather frequently and may be **unable to turn on the light** or **find their destination**.
- Adding to these they are usually elderly people with **mobility problems** who are **prone to falling**.

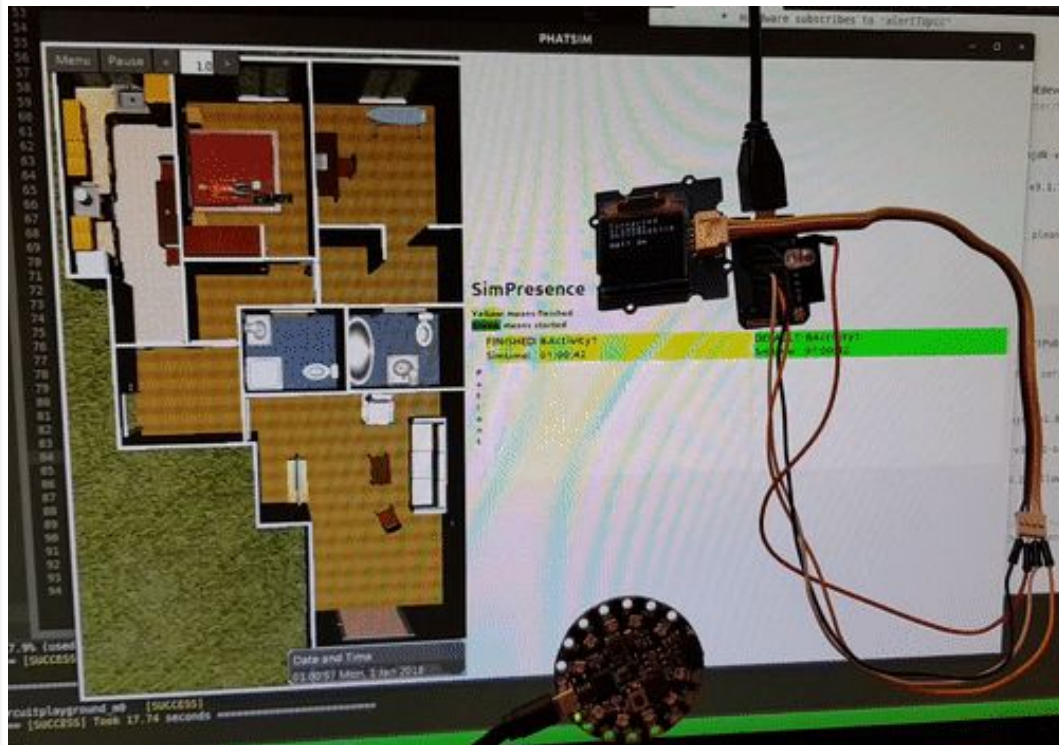
This could be **solved** with various **technological solutions** depending on the **level of the symptoms**.

- Presence-activated lights.
- Presence detection which lights the path to the bathroom.
- Caregiver warning system ⇒



PoC Hardware Development

Caregiver warning system



The system **detects** when the patient wakes up at night and **alerts** the caregiver.

- One **movement sensor** is located in the patient's room. In this case it's a virtual sensor.
- One device is used to warn the caregiver by the use of **lights** and a **speaking voice**.
- Other device is located outside the house to warn of an emergency which the caregiver did not attend.

Thank you!

Main project page

<http://grasiagroup.fdi.ucm.es/aidendd>

Github projects

<https://github.com/Melkoroth/AIDevelopment>

<https://github.com/Melkoroth/AIDevelopmentHardware>

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