3rd International Workshop on Artificial Intelligence and Assistive Medicine (AI-AM/NetMed 2014)

Using 3D Simulators for the Ambient Assisted Living

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Outline

- Introduction
  - Ambient Assisted Living
  - Smart homes
- Related Works
  - Virtual environments for development
  - Rehabilitation
- 3D Simulator for the AAL
- Conclusions
- Future works

AAL

65+ people will triple within 2050 (becoming 16% of the World population) [WHO, 2011]:

- rise of chronical diseases
- more medical emergencies
- increase of the healthcare expenditure

The Ambient Assisted Living faces these challenges.

Smart Homes

Ambient Assisted Living

Ambient Intelligence

Safe, smart, interconnected environments around people

Smart Homes

Assessing technologies for the AAL would require tests:

- with real human inhabitants
- with different kinds of impairments
- in different environmental situations
- in diverse economical conditions

For example…

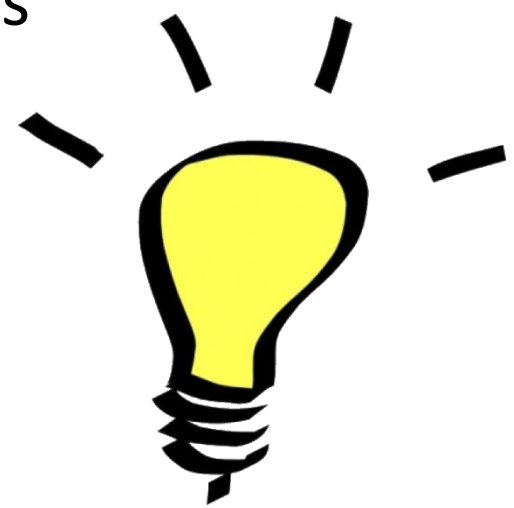
Even the development and the assessment of software prototypes is extremely expensive!

- hardware for a great number of tests
- modify or redesign software components
- test again

Solution

A virtual 3D environment…

- simulating an interface to sensors and actuators
- to develop and test intelligent systems
- with economical sustainability!



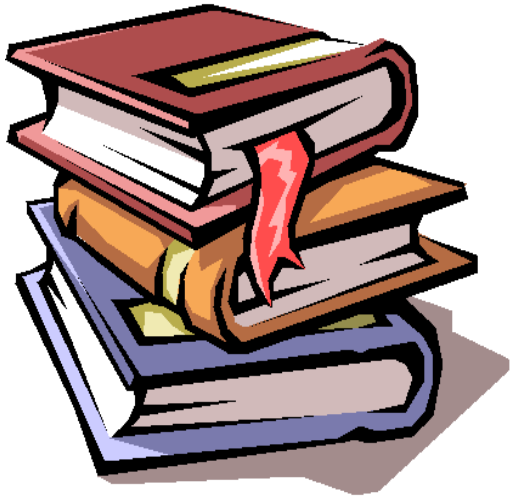
From…

Open source simulators [edit]

- ARS: physically-accurate robotics simulator written in Python.
- breve 3d simulator using Python
- EZPhysics: Combination of Ogre3D and ODE physics, GUI exposes all of ODE's objects data, network closed loop remote control optionally via Matlab/Simulink.
- Gazebo: Probably the most complete open source simulator to this writing. Unless the deb precompiled package is used, it is notoriously difficult to install. It started as part of the Player project but is also used in ROS.
- Khepera Simulator Apparently before Webots became commercial it was open source and called Khepera Simulator
- Klamp't: a simulator introduced in 2013 specializing in stable trimesh-trimesh contact. Supports legged locomotion and manipulation.
- LpzRobots: Another rich simulator with good material support.
- miniBloq: This robot programing software for Arduino boards has a new simulator.
- Moby is a robust robotic dynamics simulator
- MORSE project provides a simulation tools based on the Blender 3D modeling software.
- OpenHRP3: (Open Architecture Human-centered Robotics Platform version 3) is an integrated software platform for robot simulations and software developments.
- OpenSim Simulator for articulated and wheeled robots with a wide range of characteristics. Further development stopped in the year 2006.
- ORCA-Sim: a simulator for robotics: is a (Windows) 3D robot simulator which incorporates the Newton Game Dynamics physics engine. A good alternative for Win32 platforms and the Gazebo project, with fast response and good performance. (Currently not open source. Last update in 2007)
- Robotics Toolbox for MATLAB is Free Software that provides functionality for representing pose (homogeneous transformations, Euler and RPY angles, quaternions), arm robots (forward/inverse kinematics, dynamics, simulation, animation) and mobile robots (control, localisation, planning and animation).
- Simbad 3d Robot Simulator Java based simulator
- SimRobot: A robot simulator software package developed at the Universität Bremen and the German Research Center for Artificial Intelligence.
- Stage: 2.5D simulator often used with Player to form the Player/Stage system. Part of the Player Project
- STDR Simulator A simple, flexible and scalable 2D multi-robot simulator for use within Robot Operating System.
- UCHILSIM: A physics based simulator for AIBO Robots introduced in RoboCup 2004.
- v-rep (Virtual Robot Experimentation Platform): "the Swiss army knife among robot simulators". Note: v-rep has an open-source license (GNU GPL) but v-rep pro as well as some plugins do not.
- UWSim : an UnderWater SIMulator for marine robotics research and development which incorporates sensor, dynamic and physics simulation.

Related Works

- Interactive Scenario Visualization for user-centered development [11]



- Serious Games:
  - rehabilation & pain management [4, 9]
  - improve social inclusion [9]
  - acceptance of technologies [10]

3D Simulator for the AAL

Goals:

- To expose interfaces to simulated sensors and actuators
- To test intelligent software systems
- To face unexpected events
- Transparent migration

Why 3D?

Not only the involvement typical of graphical effects!

- Direct interaction with the simulation environment:
  - moving objects “on the fly”
  - simulating unexpected events
  - …

Related Topics (1)

For a complete simulator also human behaviour should be taken into account:

- Selection of the suitable AI approach
- Influence of AI techniques in the simulator design
- Metrics to test it?

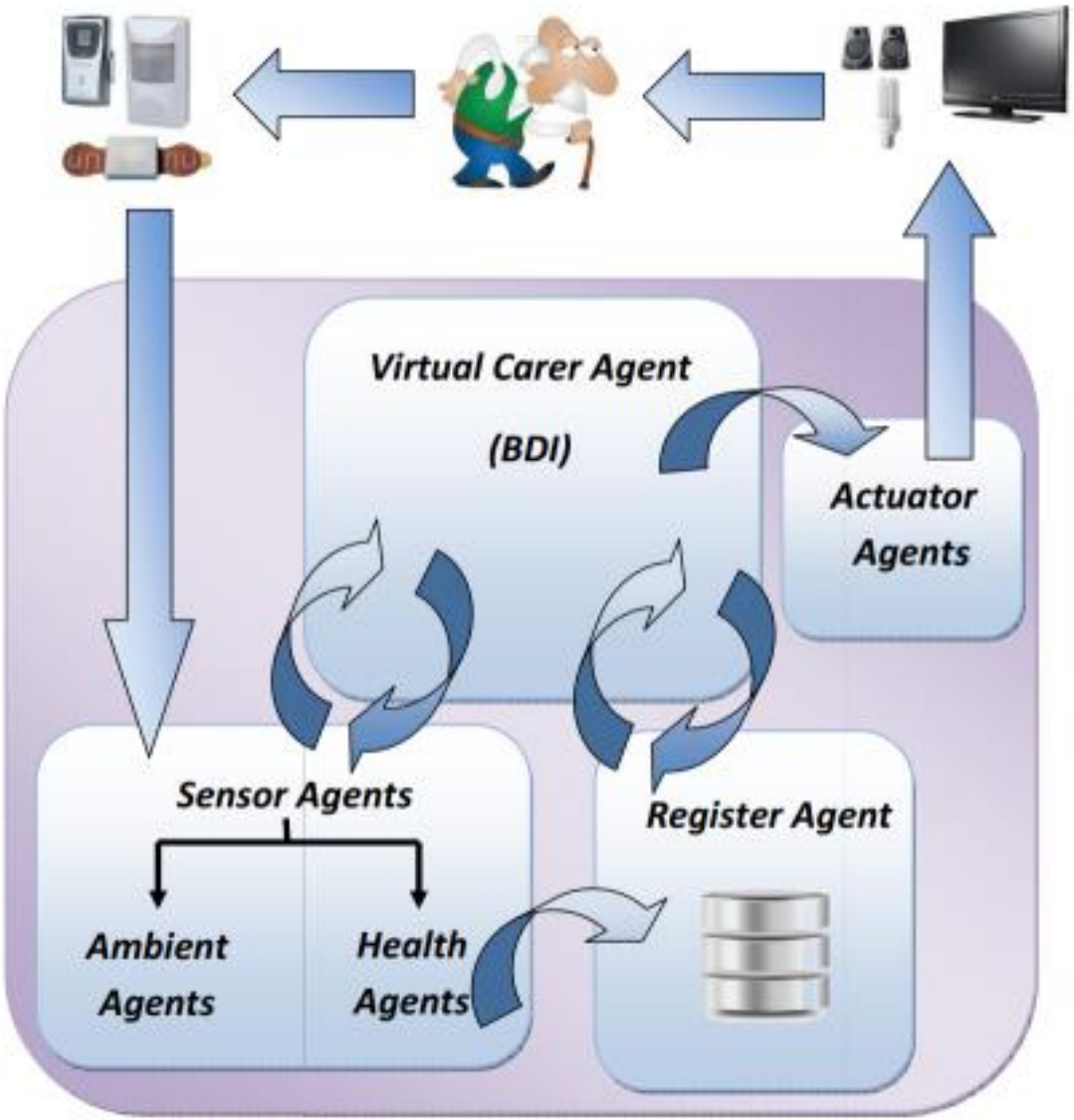
Example

Related Topics (2)

Need a clear requirement analysis (complexity of the AAL domain), including several stakeholders:

- system developers
- patients and their relatives
- physicians
- health operators

Implementation



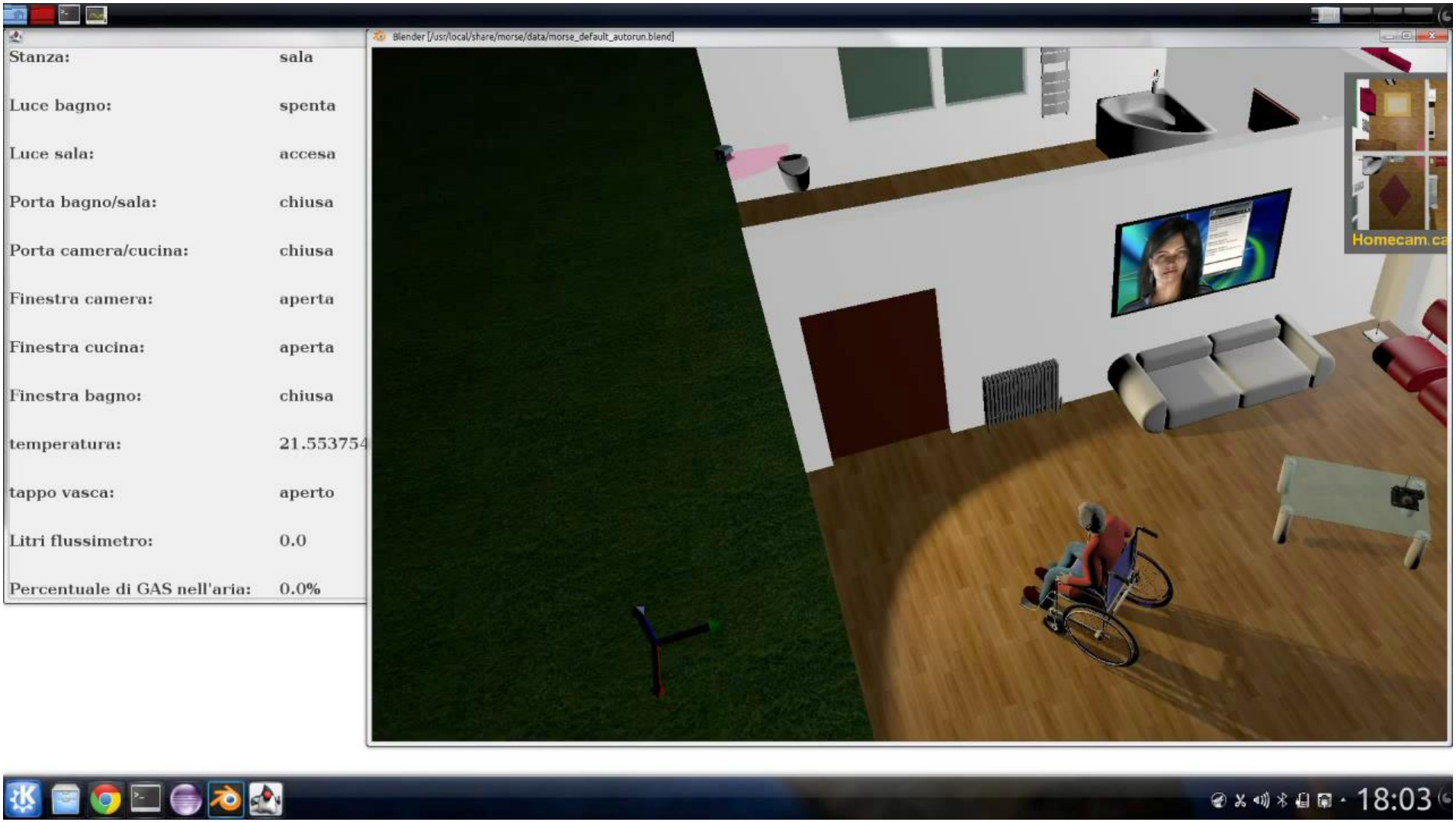
Implementation

TCP/IP communication:

- socket channel to send commands to the sensors
- easy migration, if the simulated sensors offer the same interface of *off-the-shelf* sensor

Even at runtime with *software agents*!

Implementation



Implementation

Implementation

Videos available at:

- https://www.youtube.com/user/AIRTLab
  - https://www.youtube.com/watch?v=IBuYZFoKmy8
  - https://www.youtube.com/watch?v=zXEpShRNGuo

Conclusions

Such a 3D simulator could…

- speed up the development of prototypes
- facilitate the maintenance (software decoupled from hardware)
- facilitate the updating of existing systems

But it should not completely replace user trials!

Future Works

- Dedicated simulator
- Serious game
- Testing with human participation
- Platform for AAL developers?

References

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Thank you for your attention

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