The MORSE Robotics simulation platform based on Blender

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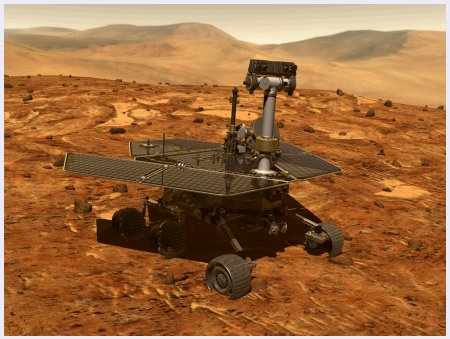
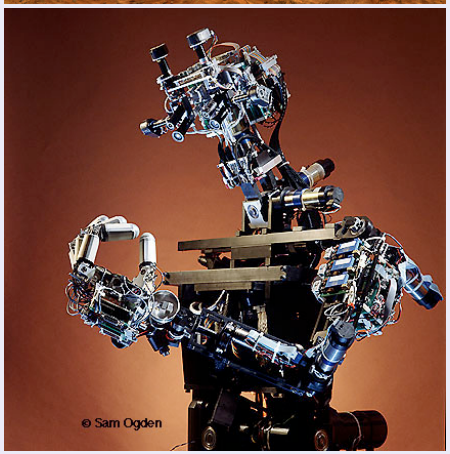
Blender Conference
October 30, 2010

What is robotics about?

- Integration of many technologies
- From automatic to autonomous machines
- Reasoning about complex tasks
- Dealing with uncertainty
- Applications in any domain

The challenge of robotics

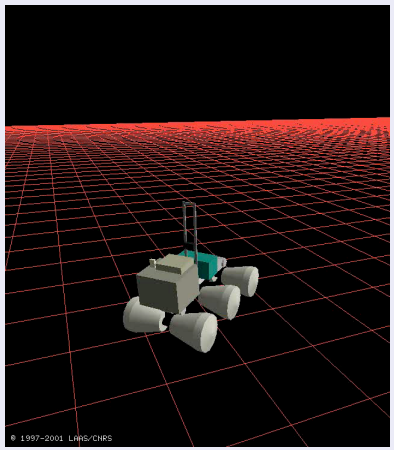


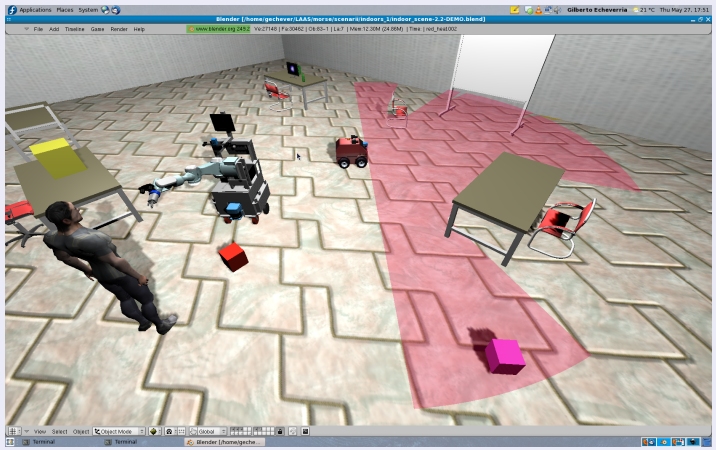


The importance of simulation

- Less expensive
- More control over the environment
- How complex?
  - Specialized simulation of components
  - System wide simulation (whole robot)

Realism levels of a simulation



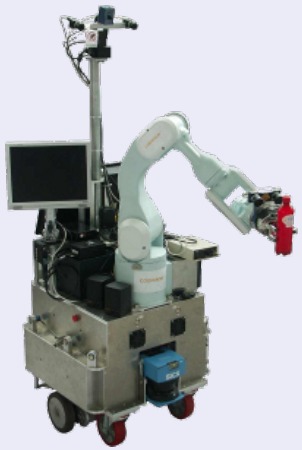


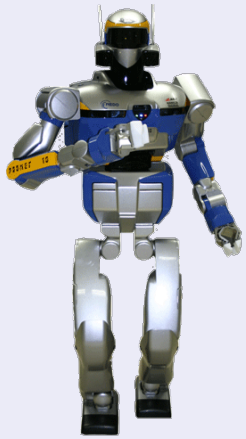
Outline

Robotics at LAAS

- No hardware development, only control software
- Research with sensors, interaction and control
- Multiple projects
  - Robot teams performing a complex task
  - Human–robot interaction

Robot platforms





Why use Blender?

Simulated scenario in Blender

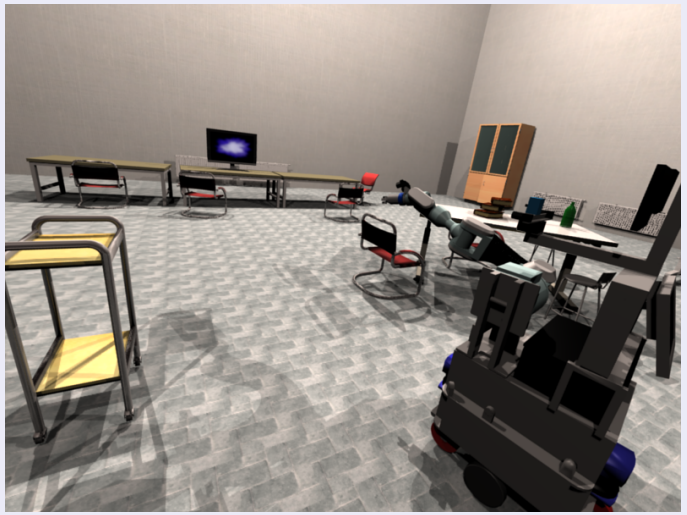
- Game Engine
- Bullet Physics simulation
- Realistic graphics
- Event oriented programming using Logic Bricks
- Python Scripts
- Modelling of robots and scenarios

Modular Open Robots Simulation Engine (MORSE)

Requirements for the simulation:

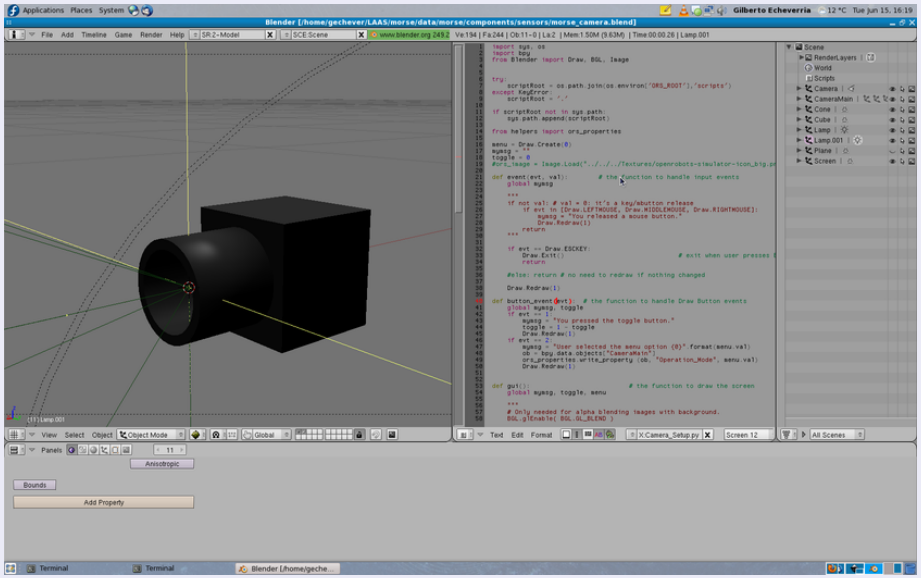
- Use Blender as the base platform
- Modular and reusable architecture
- "Software in the loop" philosophy
- Multi–robot simulation
- Adjustable levels of realism

Simulation environment modelled in Blender



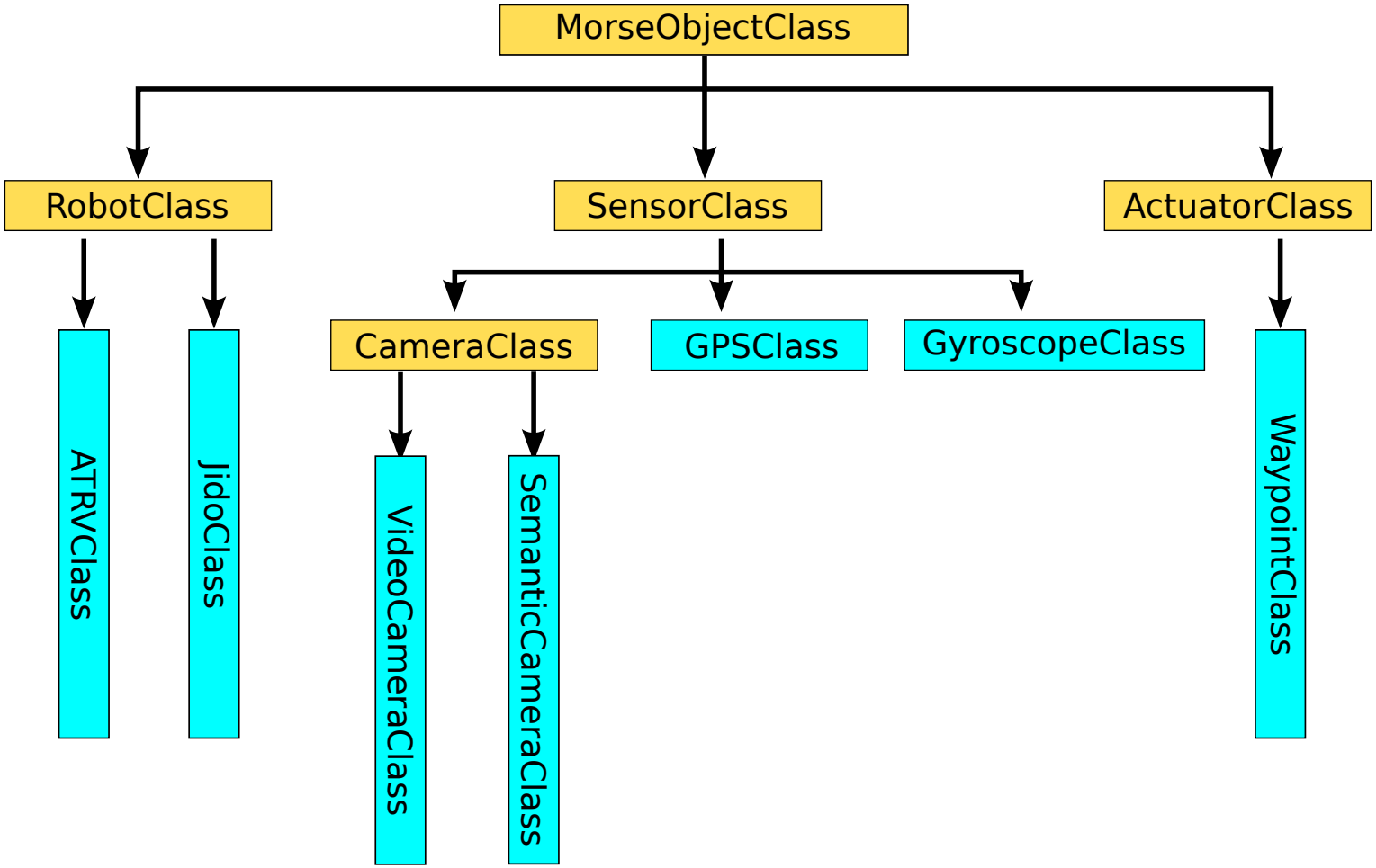
- Components in individual files
- Very simplified modules
- Middlewares add connectivity
- Modifiers change data

Blender file



Python file

Class structure



Middlewares

Definition

A Middleware is a type of software used to transfer data between individual components. Mainly used in distributed heterogeneous systems.

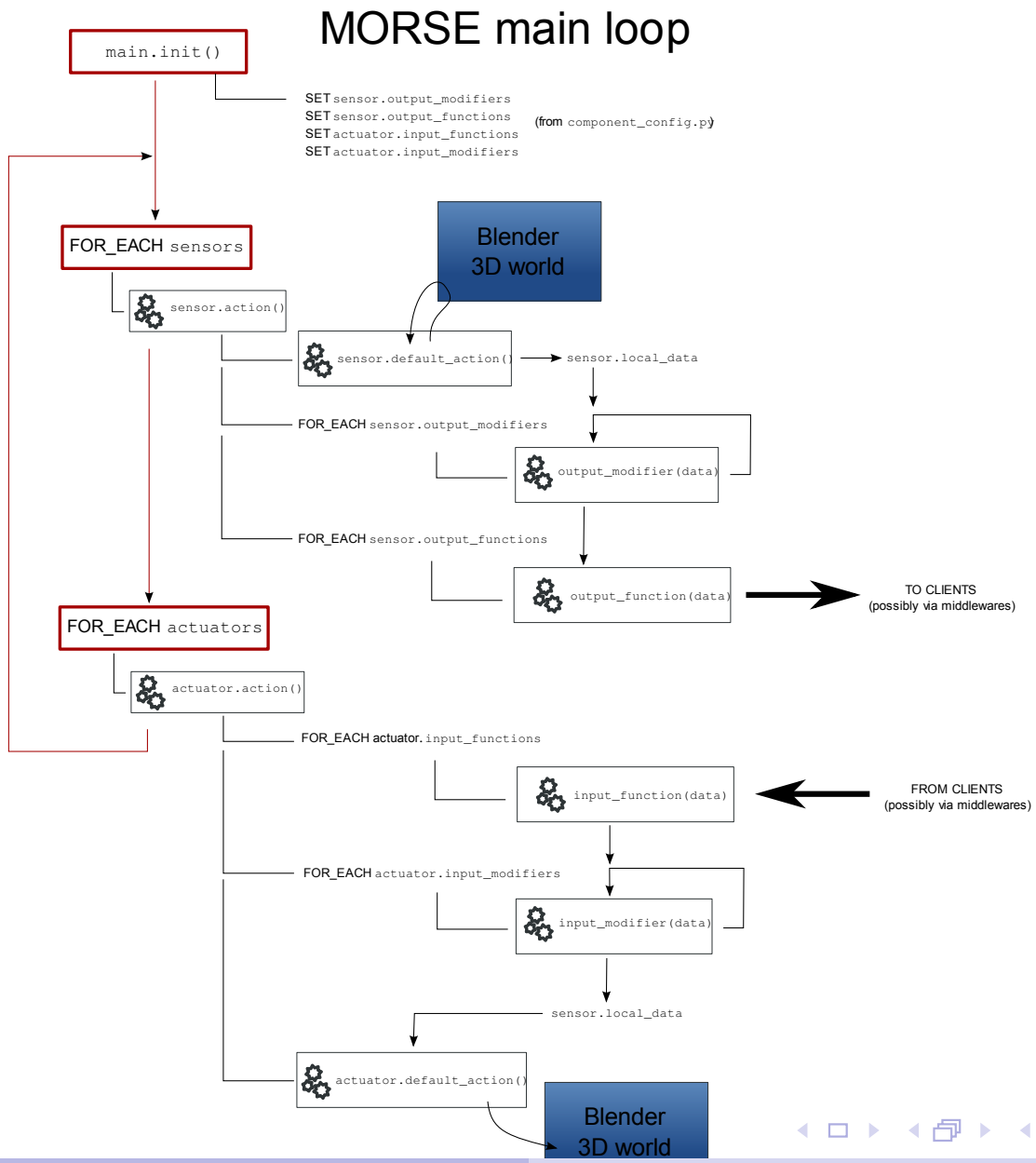
- Many middlewares are used in robotics
- They encapsulate data
- MORSE must be middleware independent
- Each component can use a different middleware

Modifications to the data

- Simulated data is "perfect"
- Data in the real world is imprecise and noisy
- Simulated data must be as close to reality as possible
- Modifications to the reference frames, scale, units, etc.

Definition

A Modifier is a program that alters the data before it is sent outside the simulator.


MORSE main loop
main.init()
SET sensor.output_modifiers
SET sensor.output_functions
SET actuator.input_functions
SET actuator.input_modifiers
(from component_config.py)
Blender 3D world
FOR_EACH sensors
sensor.action()
sensor.default_action()
sensor.local_data
FOR_EACH sensor.output_modifiers
output_modifier(data)
FOR_EACH sensor.output_functions
output_function(data)
TO CLIENTS
(possibly via middlewares)
FOR_EACH actuators
actuator.action()
FOR_EACH actuator.input_functions
input_function(data)
FROM CLIENTS
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FOR_EACH actuator.input_modifiers
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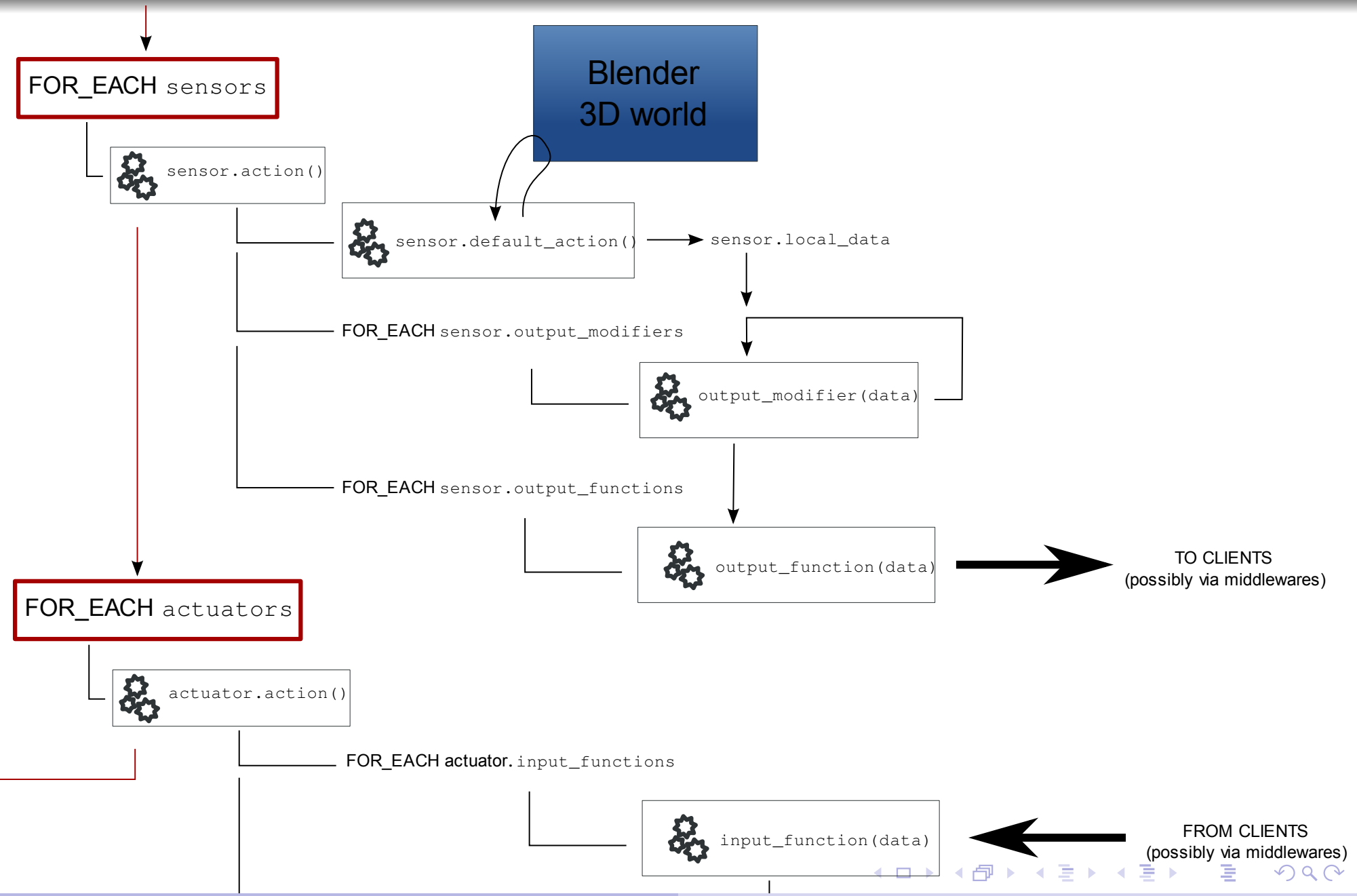
Blender 3D world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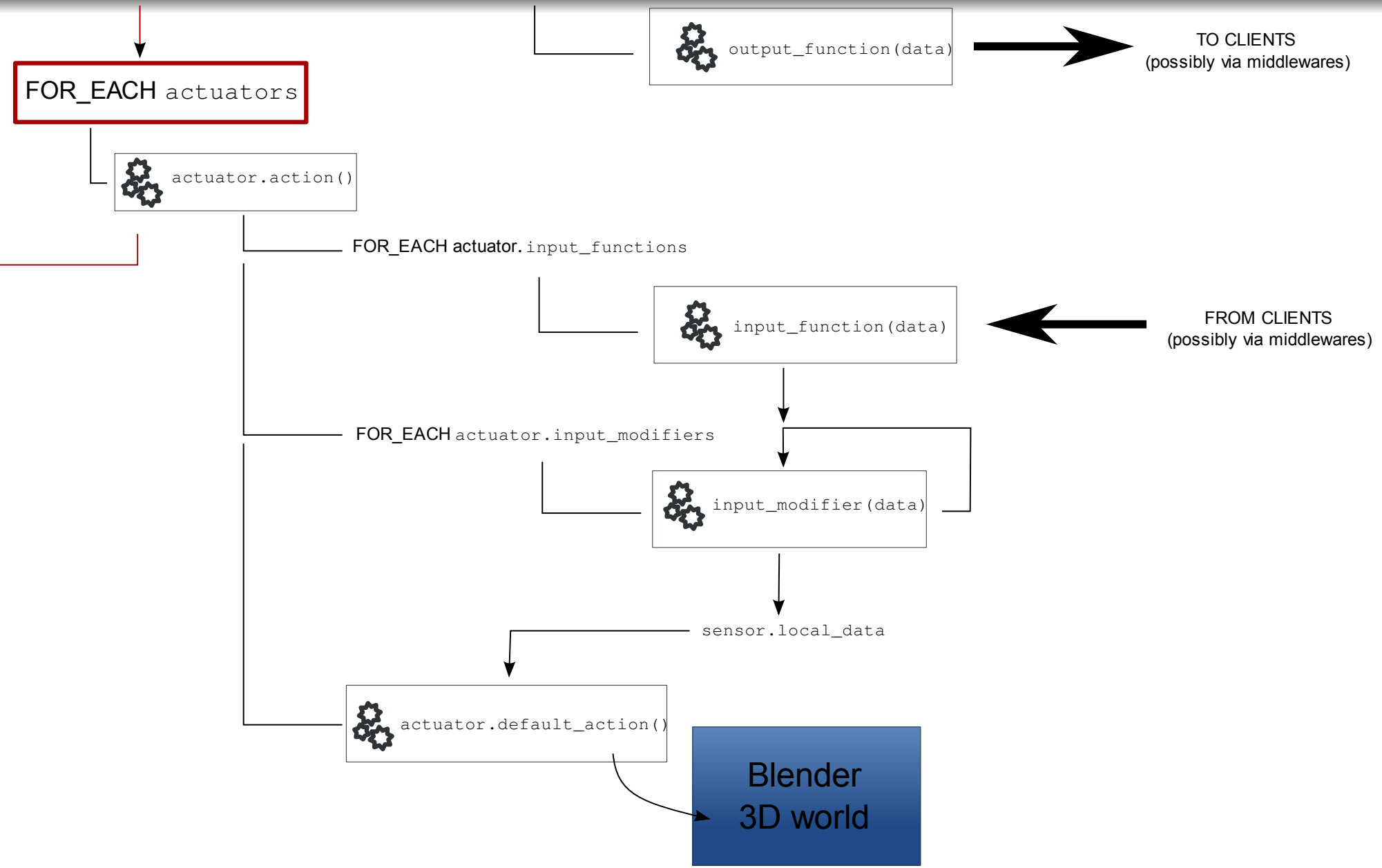
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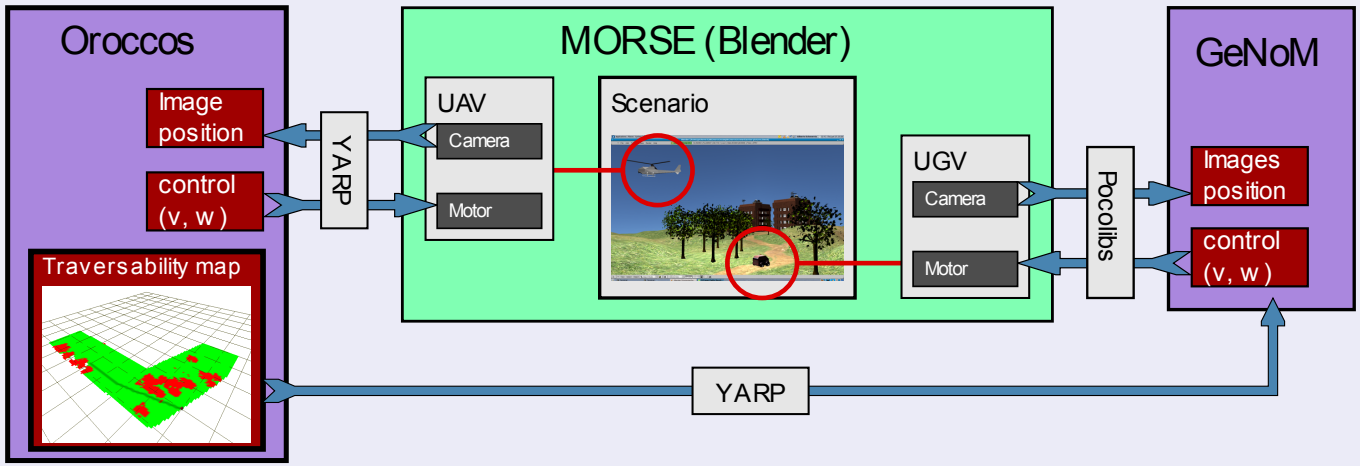
Blender
3D world

- Control software of each robot can run on different CPU
- Middlewares are used to communicate the computers
- A single instance of MORSE controls the simulation

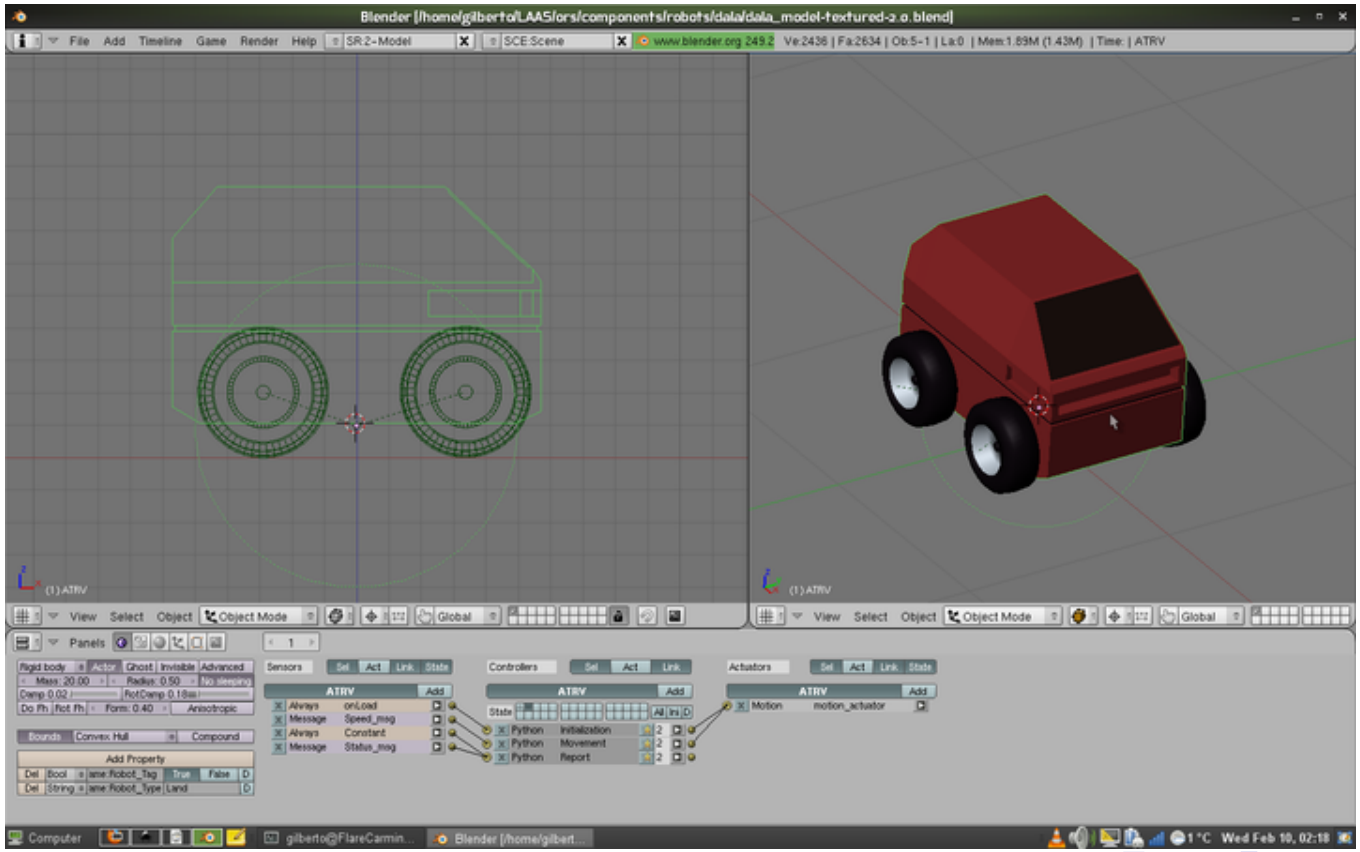
Distributed control of heterogeneous robots



Outline

Robots

- All terrain ground robot (DALA)
- Mobile platform with robotic arm (JIDO)
- Robotic helicopter (RESSAC)



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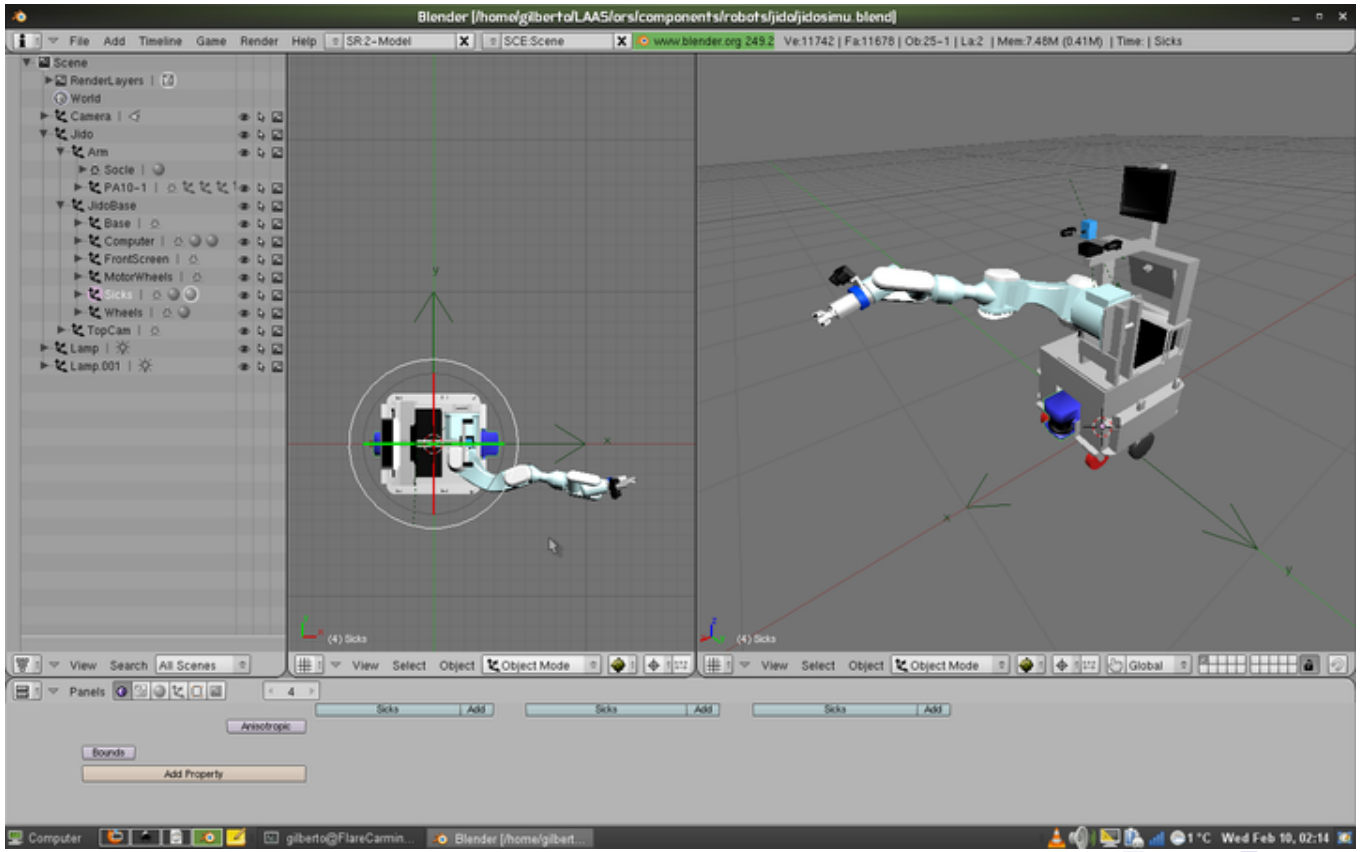

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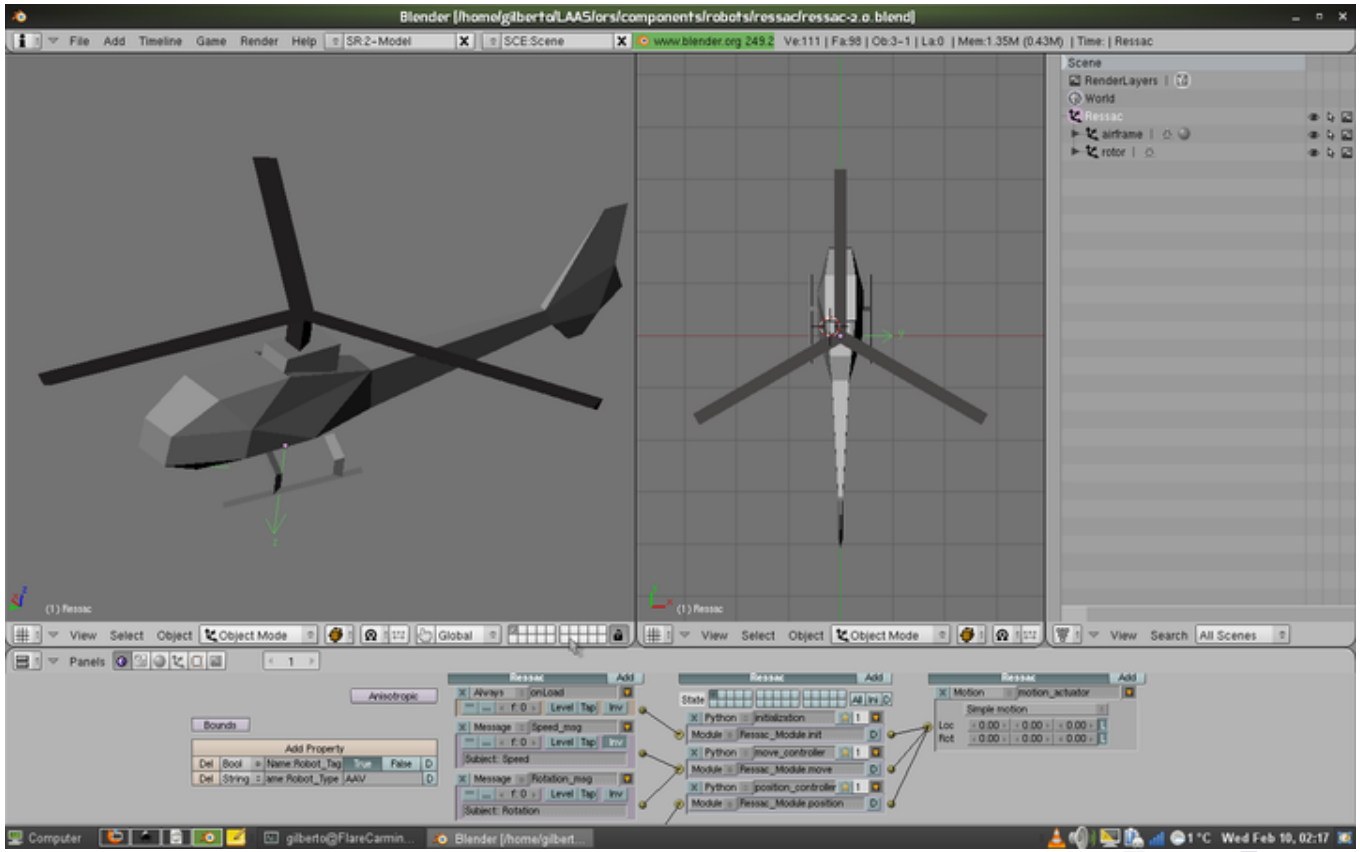
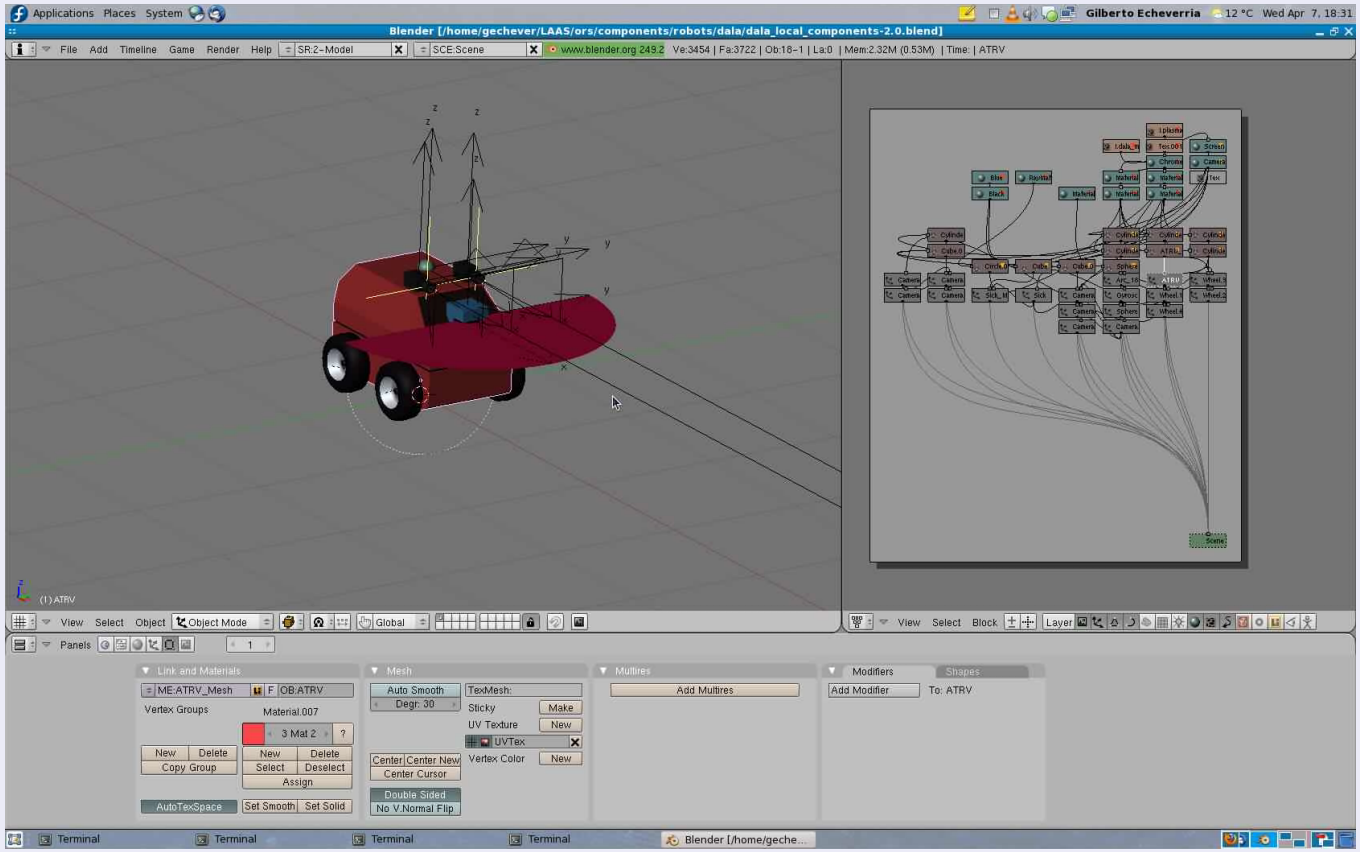


Programming of components

- The behaviour of sensors and actuators is scripted in Python
- Using the predefined functions in Blender
- Cameras use the VideoTexture module
- SICK sensor uses vertex editing
- Other sensors use rayCastTo function

Building a robot in MORSE

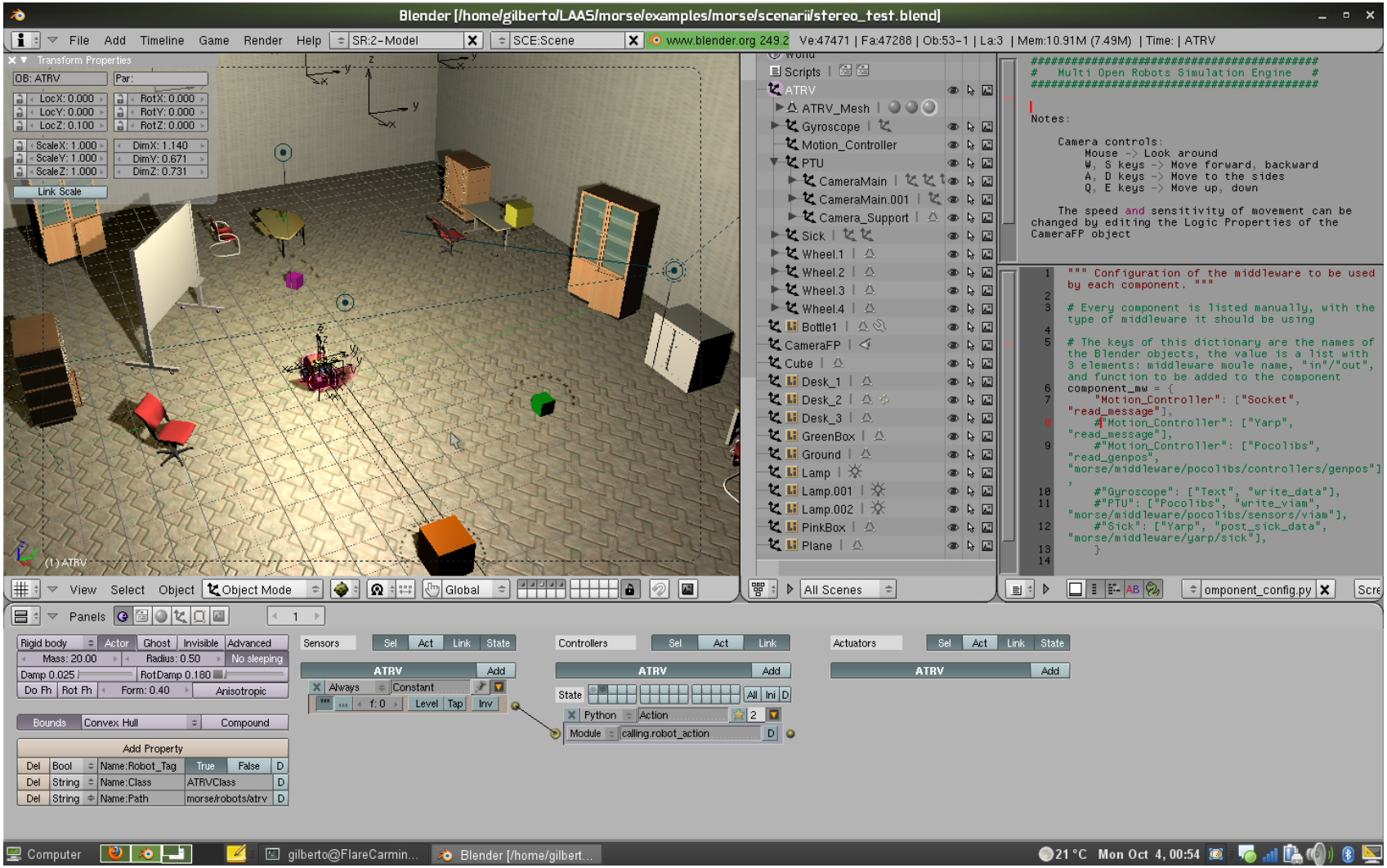
Linking of components in different files



External Python files

- Python scripts inside the .blend files are difficult to handle using version control systems
- Use of external Python modules
- Blender files reference the Python modules and classes
- Modules are dynamically loaded
- Initialization scripts allow better control of components in the scene

Logic brick programming for modules



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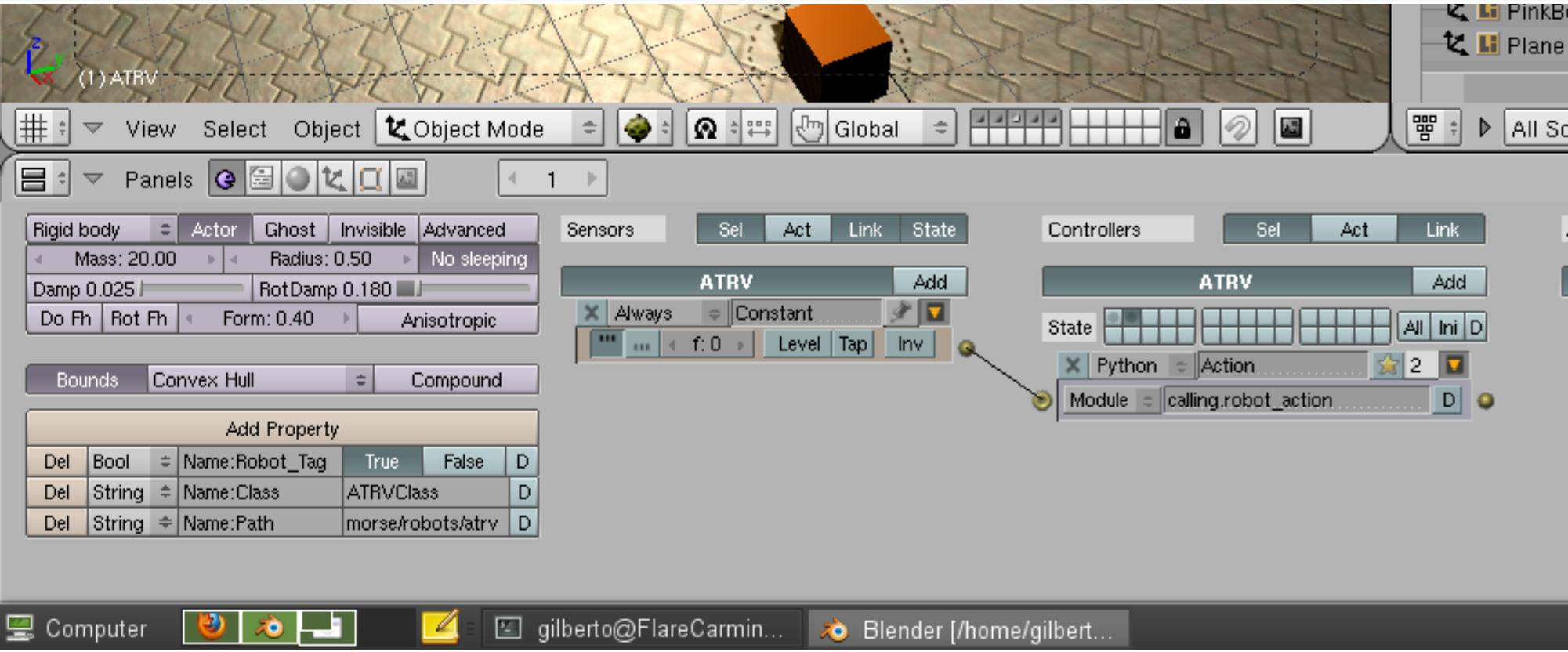
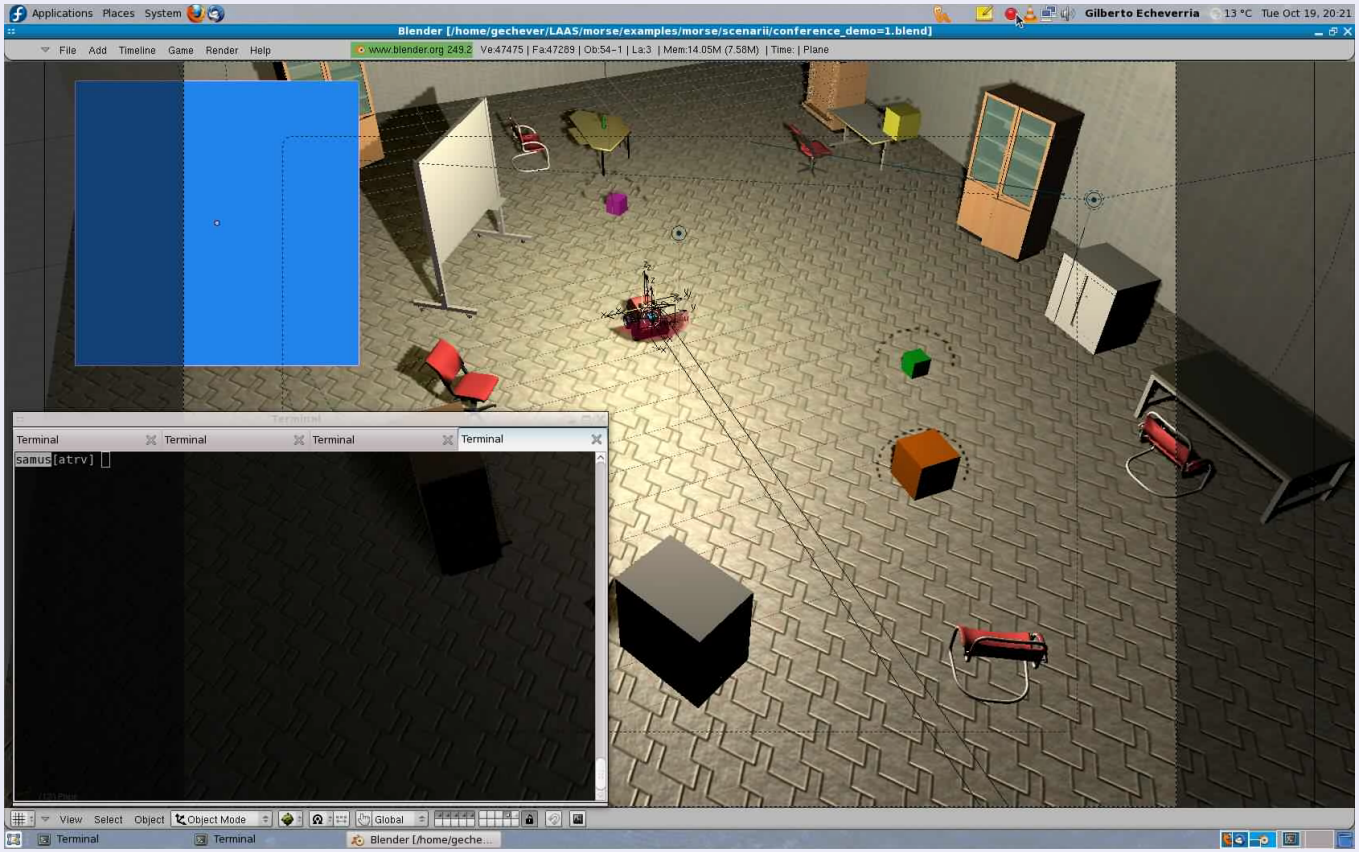


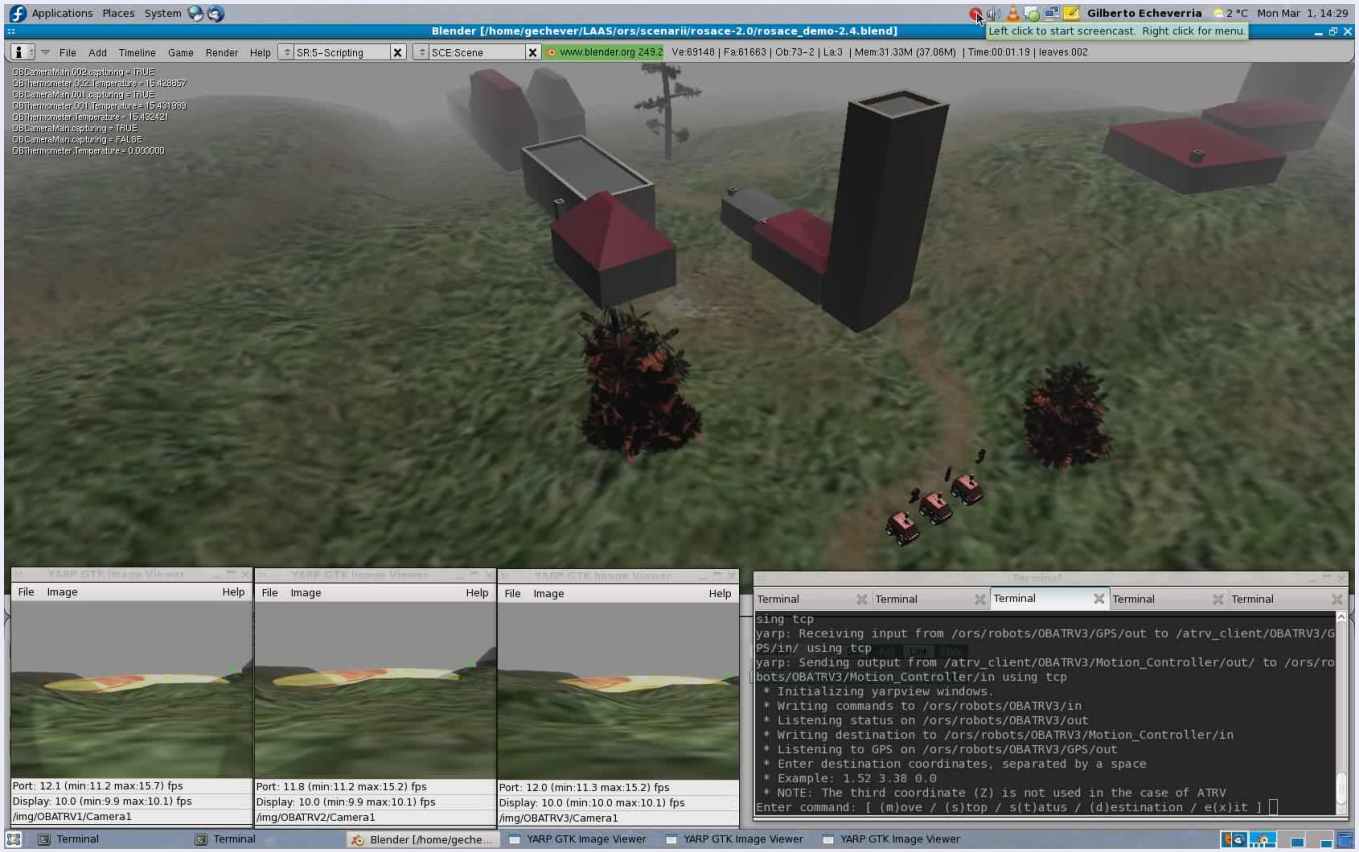
Simulation examples

Single robot simulation



Simulation examples

Team of terrestrial robots following a path



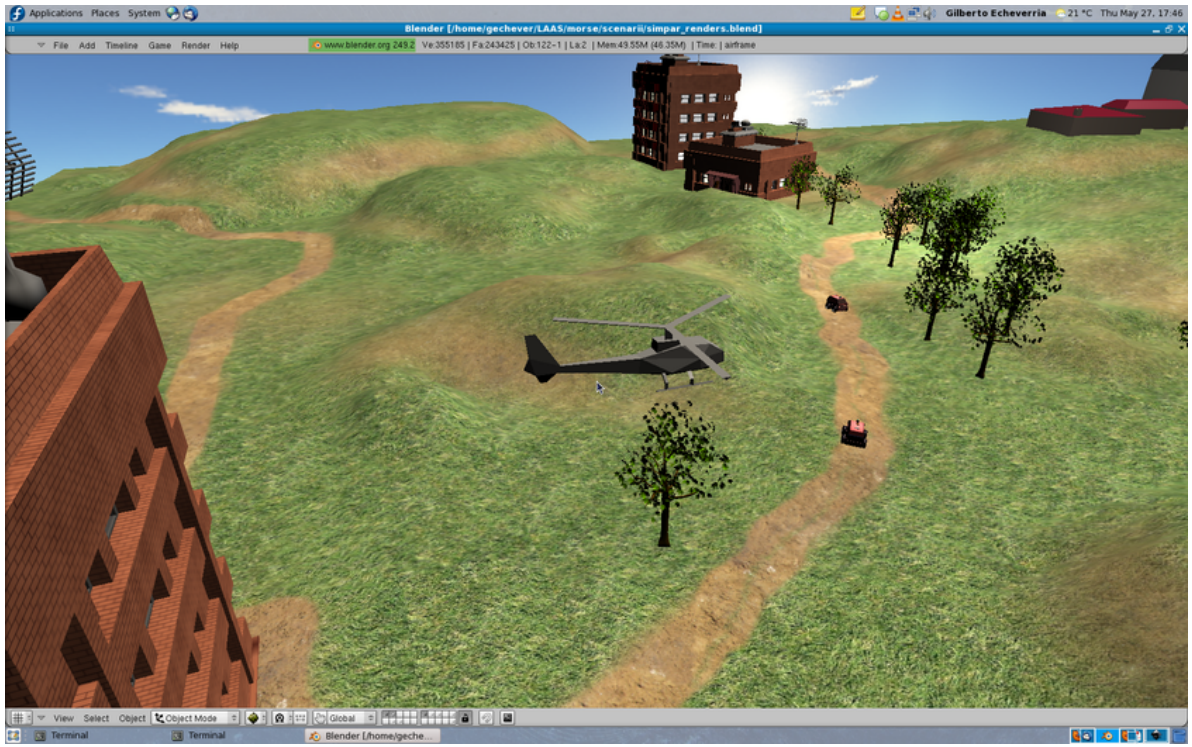
Things to improve in MORSE

- Current limitations of Blender
  - Entirely dependant on Blender's predefined functions to interact with the simulated world
  - Game Engine does not have access to all of Blender's functionality
  - Linking multiple files is not easy
  - Management of time inside the GE
- Future plans
  - Switch to Blender 2.5 and Python 3
  - Armatures in GE (including IK)
  - Configurable GUI
  - Synchronisation of multiple MORSE simulators

Outline

Summary

- Blender's Game Engine provides an interactive platform
- Great graphic detail and physics simulation
- Python offers dynamic module programming
- The MORSE project can be used in various conditions thanks to a modular structure and middleware compatibility



Contact, questions, more information:

- E-mail: gechever@laas.fr
- Developers list: morse-dev@laas.fr
- Website: http://www.laas.fr/morse

THANKS FOR YOUR ATTENTION!!!