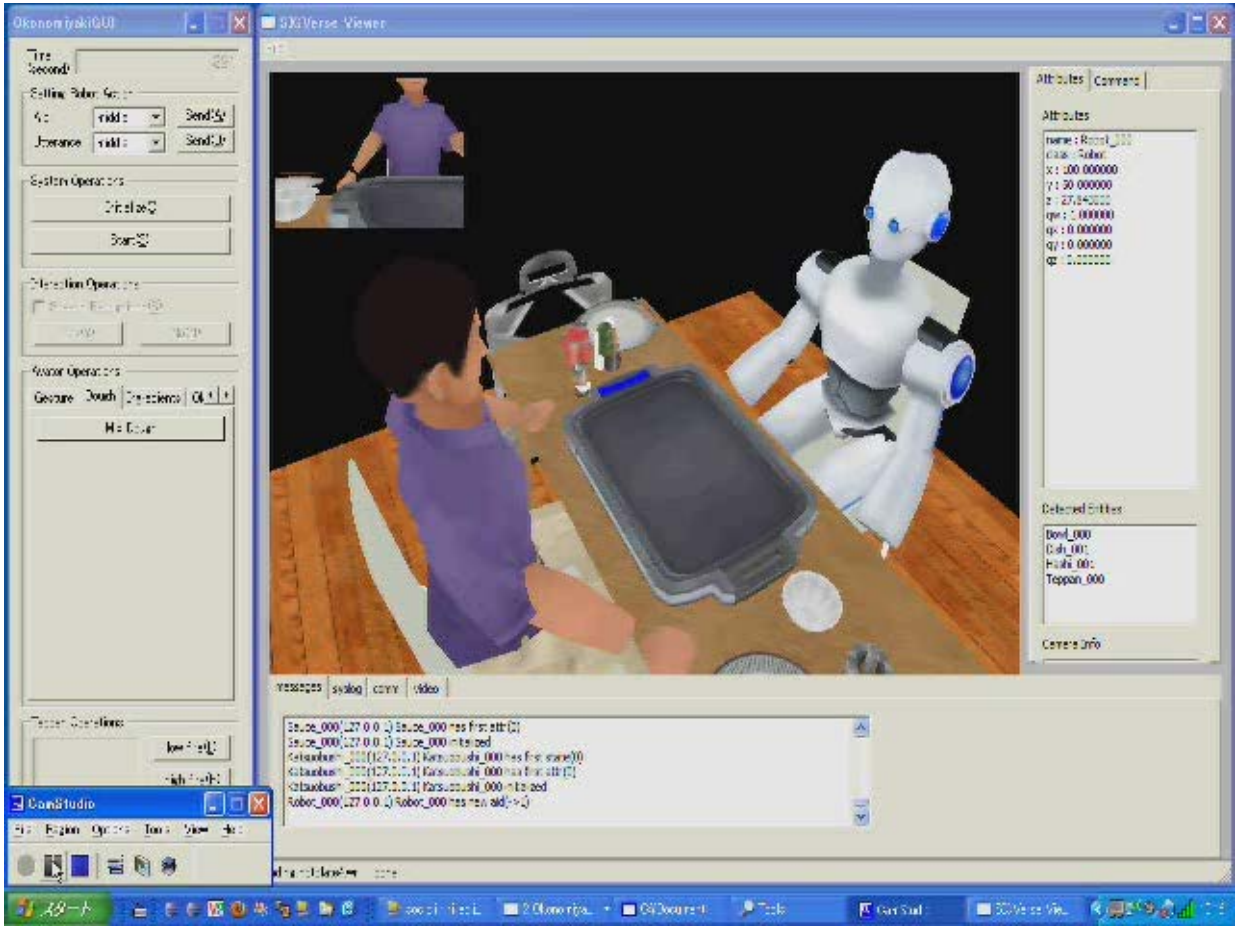

大学共同利用機関法人 情報・システム研究機構
国立情報学研究所
National Institute of Informatics

SIGVerse - A Simulation Platform for Human-Robot Interaction

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National Institute of Informatics, Japan

The 29th Annual Conference of The Robotics Society of Japan

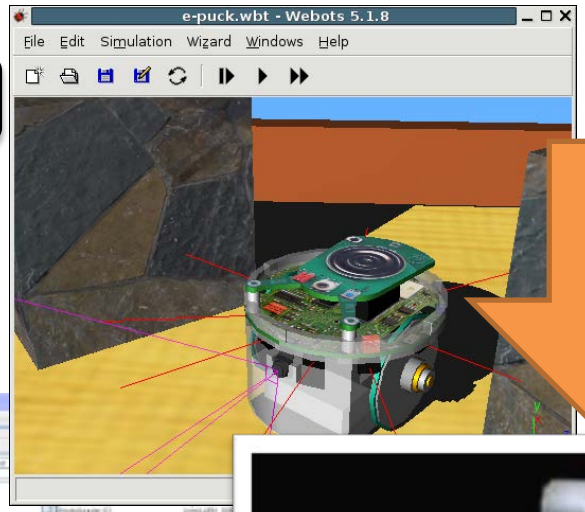
Motivation

Classical Robot Simulation

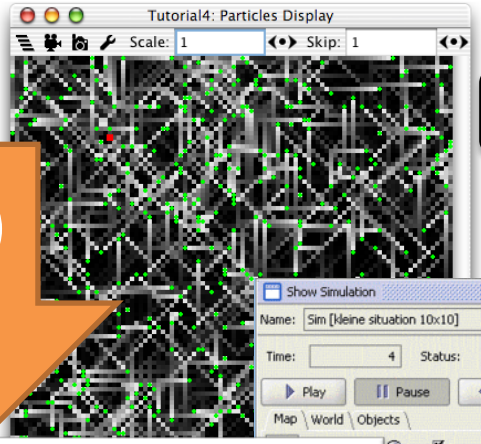
- Physical behaviors

Multi-Agent Simulation

- Collective effects



Webots



MASON

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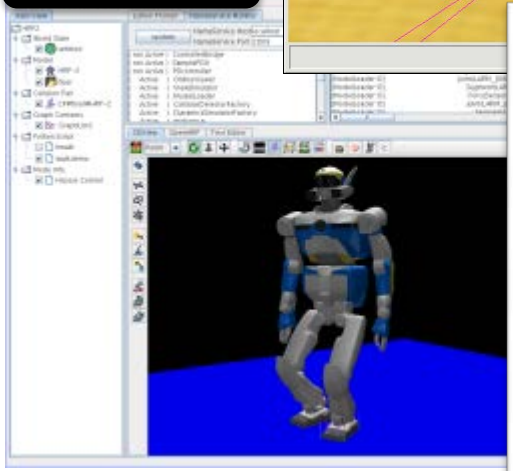
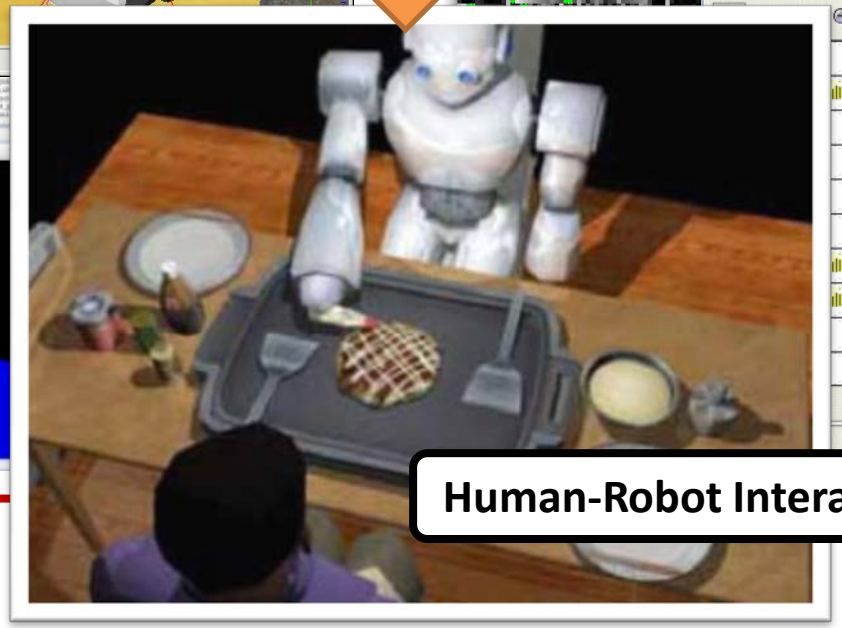
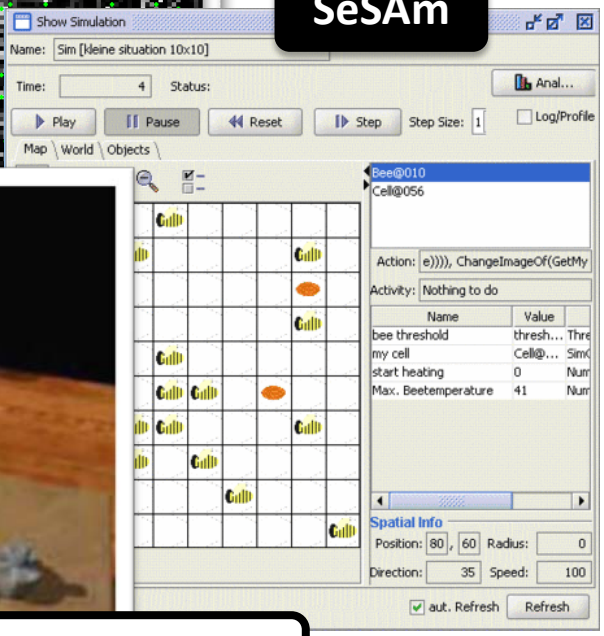
SeSAm

OpenHRP







Human-Robot Interaction?

The HRI Problem

The HRI Problem by Goodrich and Schultz [10]:

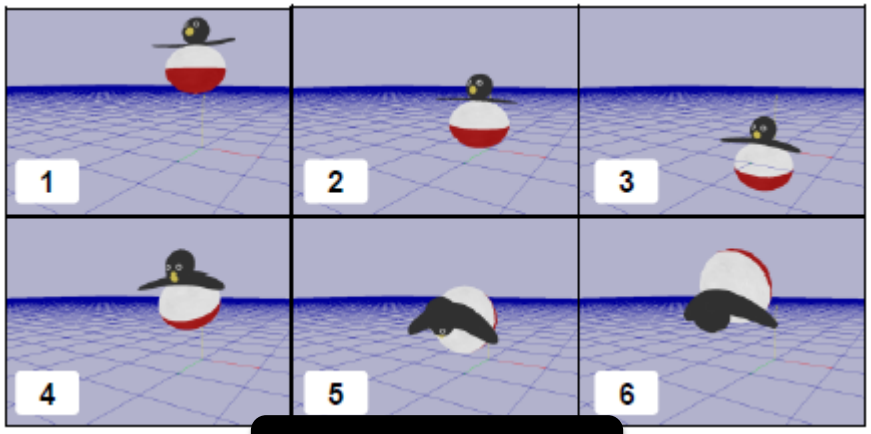
1. Level and behavior of **autonomy**
2. Nature of **information exchange**
3. Structure of the **team**
4. **Adaptation, learning, and training** of people and the robot
5. **Shape** of the **task**

SIGVerse

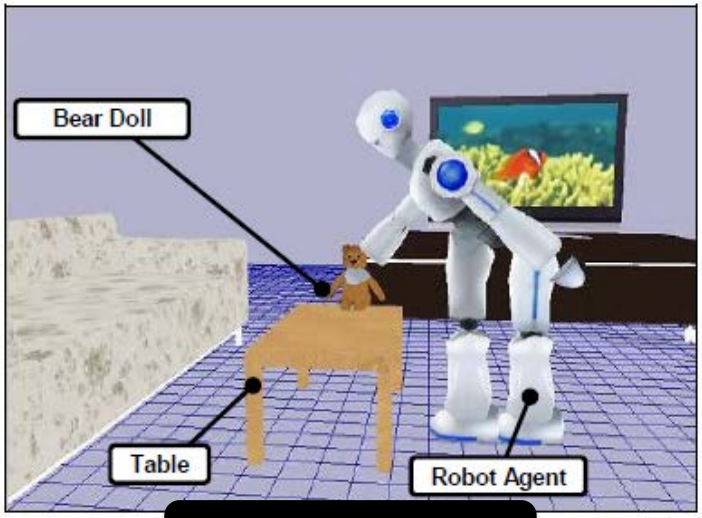
1. General development platform to model and simulate a wide range of **robot design**
2. **Communication** between agents and human-robot is a main focus
3. Not just **multi-agent** but **multi-user** is targeted to simulate a whole social interaction
4. Support application based customized **human-agent interface**
5. **Human-robot task** planning and evaluation

1. Robot Design [1/3]

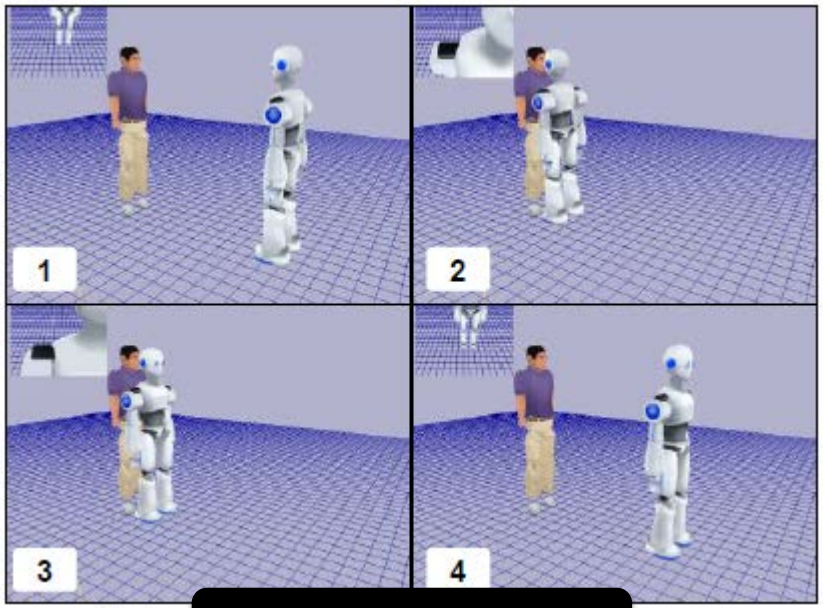
- **Physics and Dynamics Behaviors**
  - Fundamental Physics and Dynamics
  - Collision Detection
  - Object Grasping and Manipulation



Falling Behavior



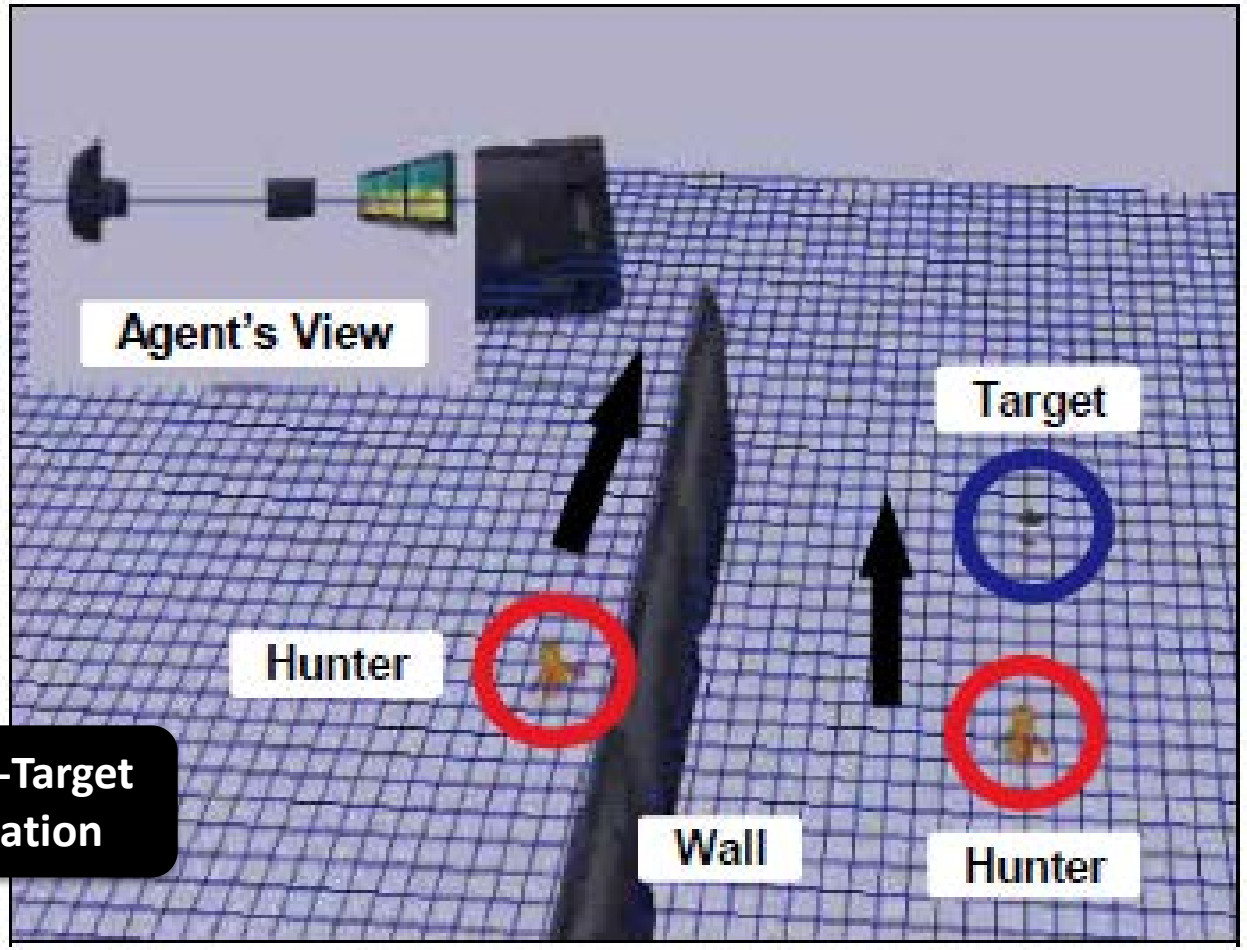
Object Grasping



Collision Detection

1. Robot Design [2/3]

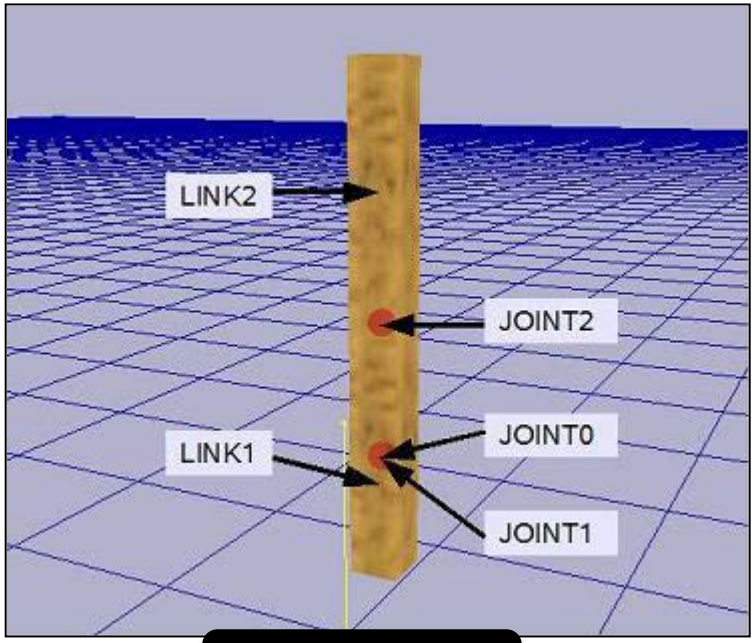
- **Perception with Physical Constrains**
  - Visual and Audio



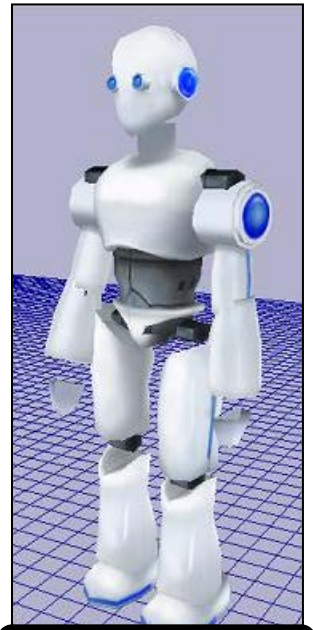
Hunter-Target Simulation

1. Robot Design [3/3]

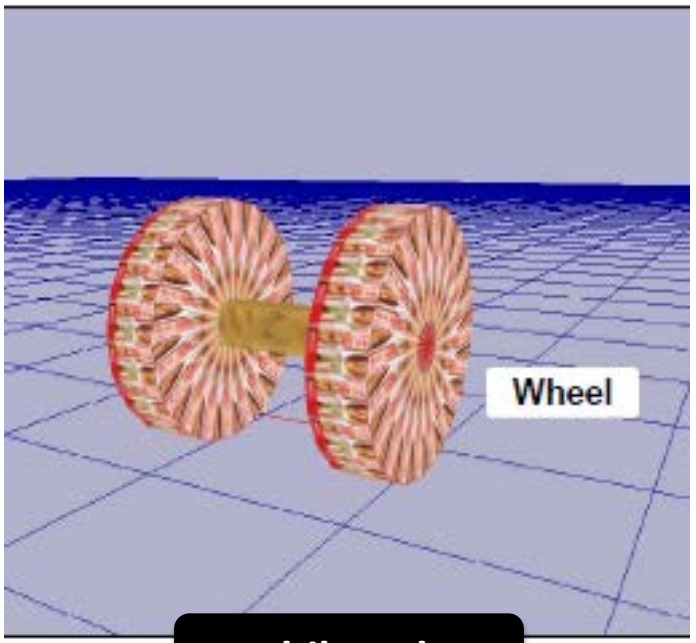
- **Robot Modeling**
  - Humanoid
  - Mobile Robot



Link & Joint



Humanoid

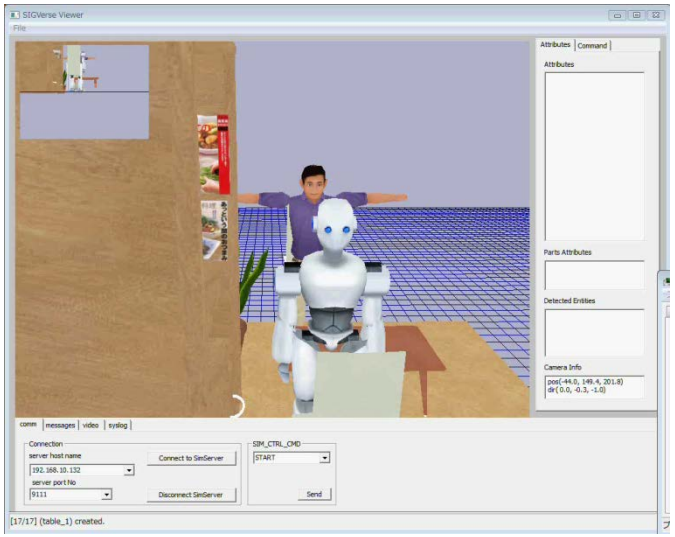


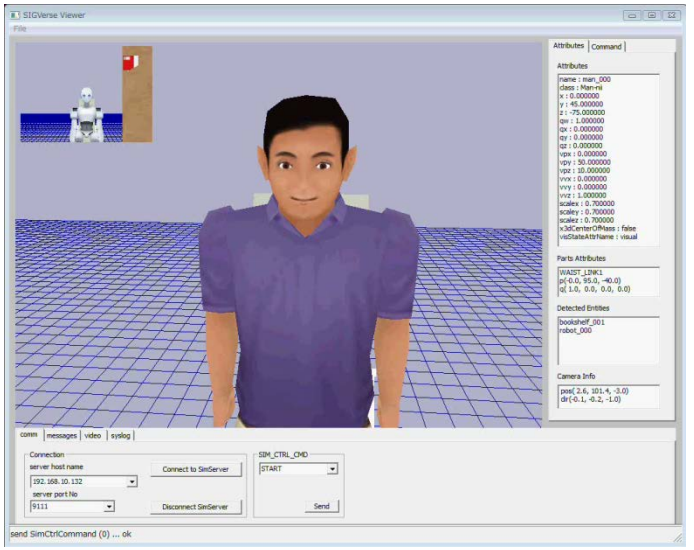
Mobile Robot

2. Communication [1/2]

- **Verbal and Non-Verbal Communication**

Communication by Messaging

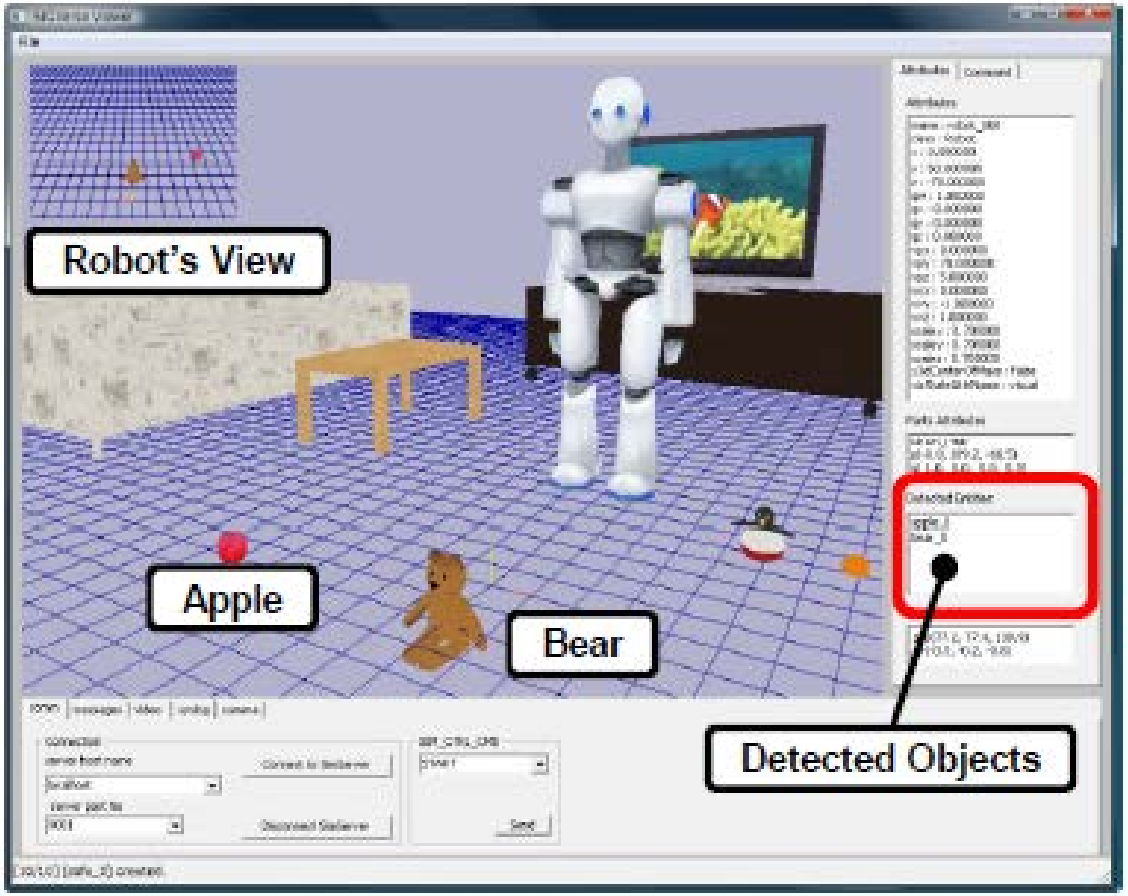




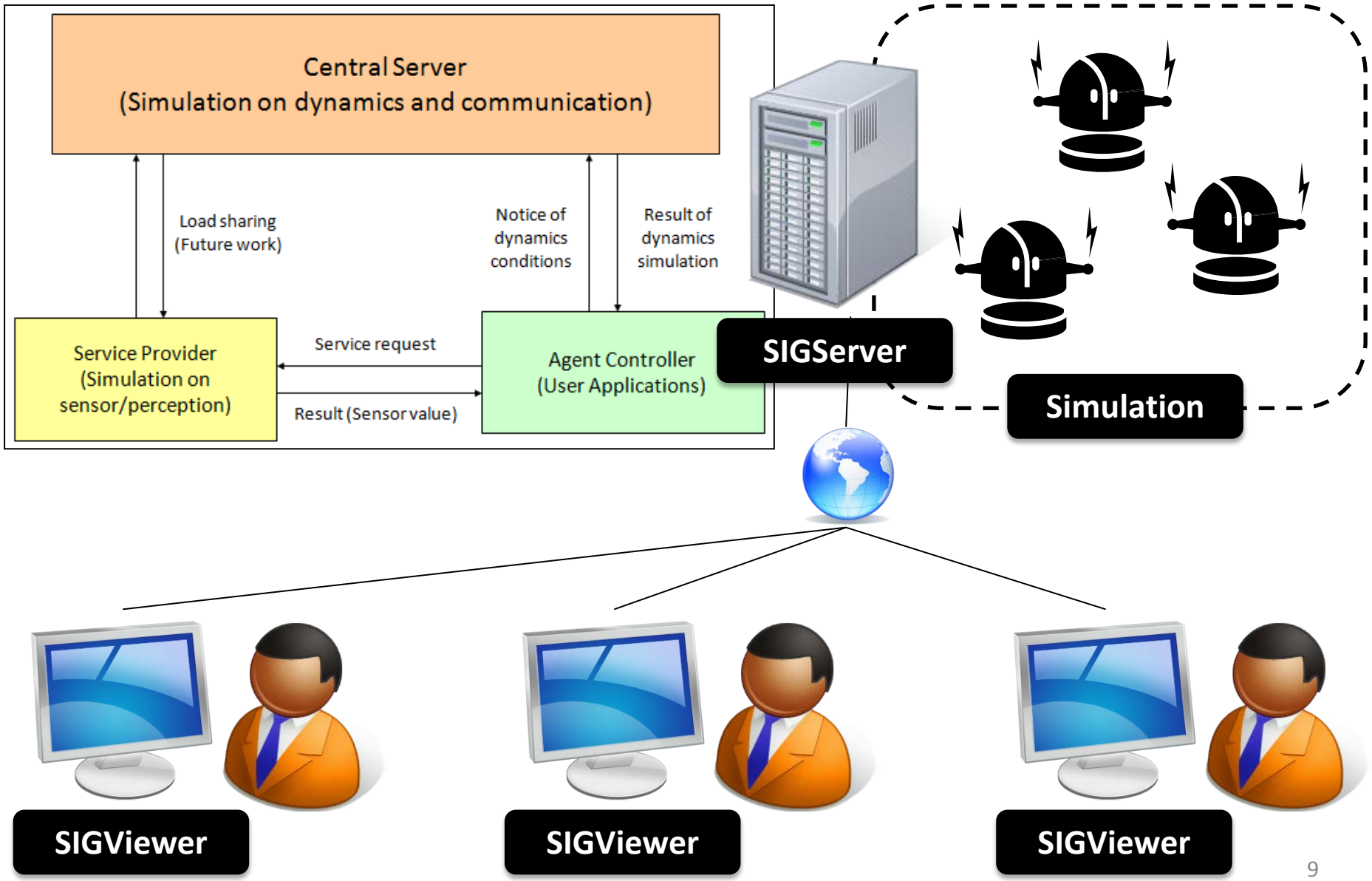
Joint Attention

2. Communication [2/2]

- **Level of Perception Data**
  - High abstract level (viewpoint, objects' metadata)
  - Raw data (raw visual data in pixel map, wave file)

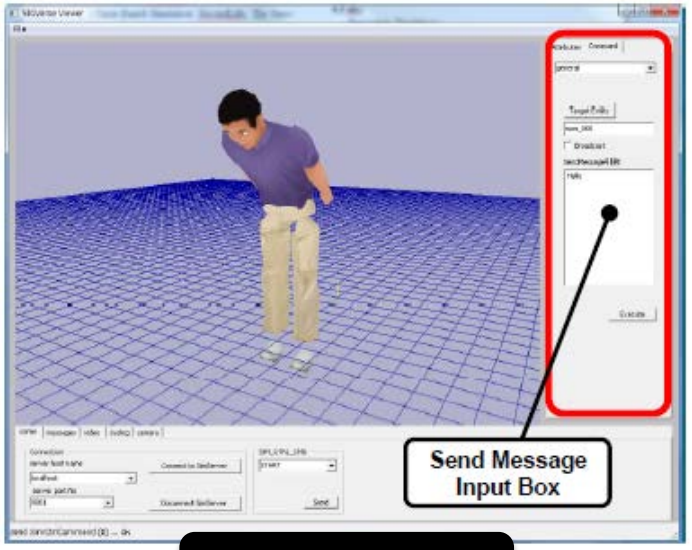


3. Multi-Agent and Multi-User



4. Human-Agent Interface

- **GUI Interface**
- **Haptic Devices**
- **Motion Capture System**



GUI Interface

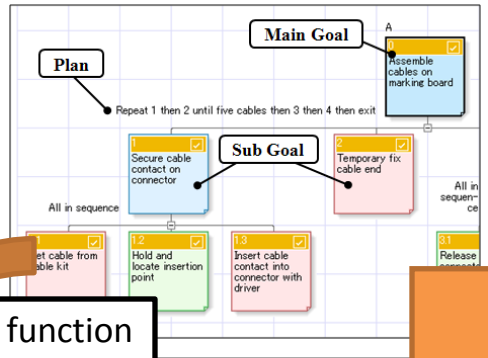
Motion Capture System

Haptic Device

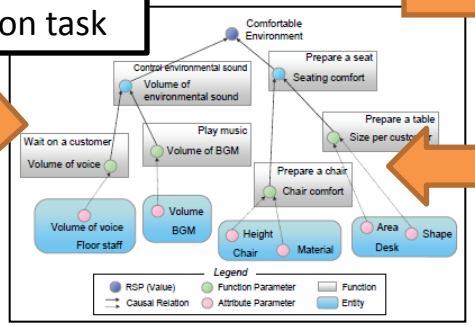
5. Human-Robot Task

Task Analysis

The performance of a personal robot can be studied from the **task-based analysis** of the human-robot interaction



Service function based on task



Service Modeling

Service modeling quantifies tasks in service terms to determine the parameters for evaluations

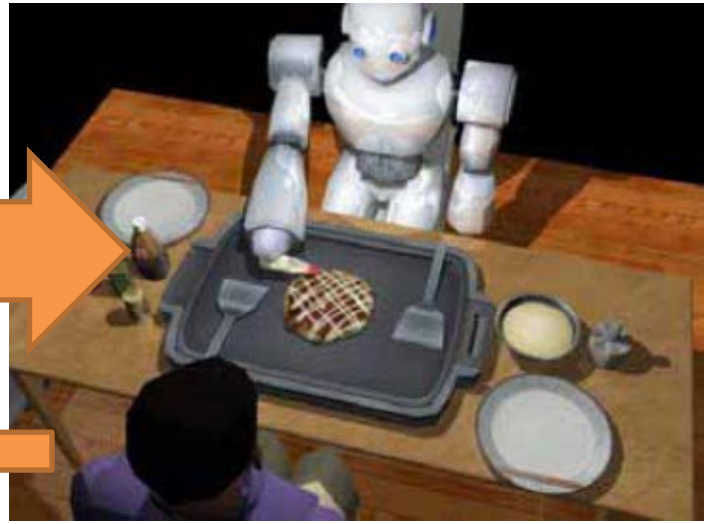
Functional requirements – tasks have direct influence to the main goal (e.g. mobility)

Non-functional requirements – can be derived from human factors (e.g. noise level)

Interaction Intelligence

- **Audio and Visual Perception**
- **Behavioral Recognition and Prediction**
- **Robot Control**
- **Machine Learning**

Update parameters by simulation attributes

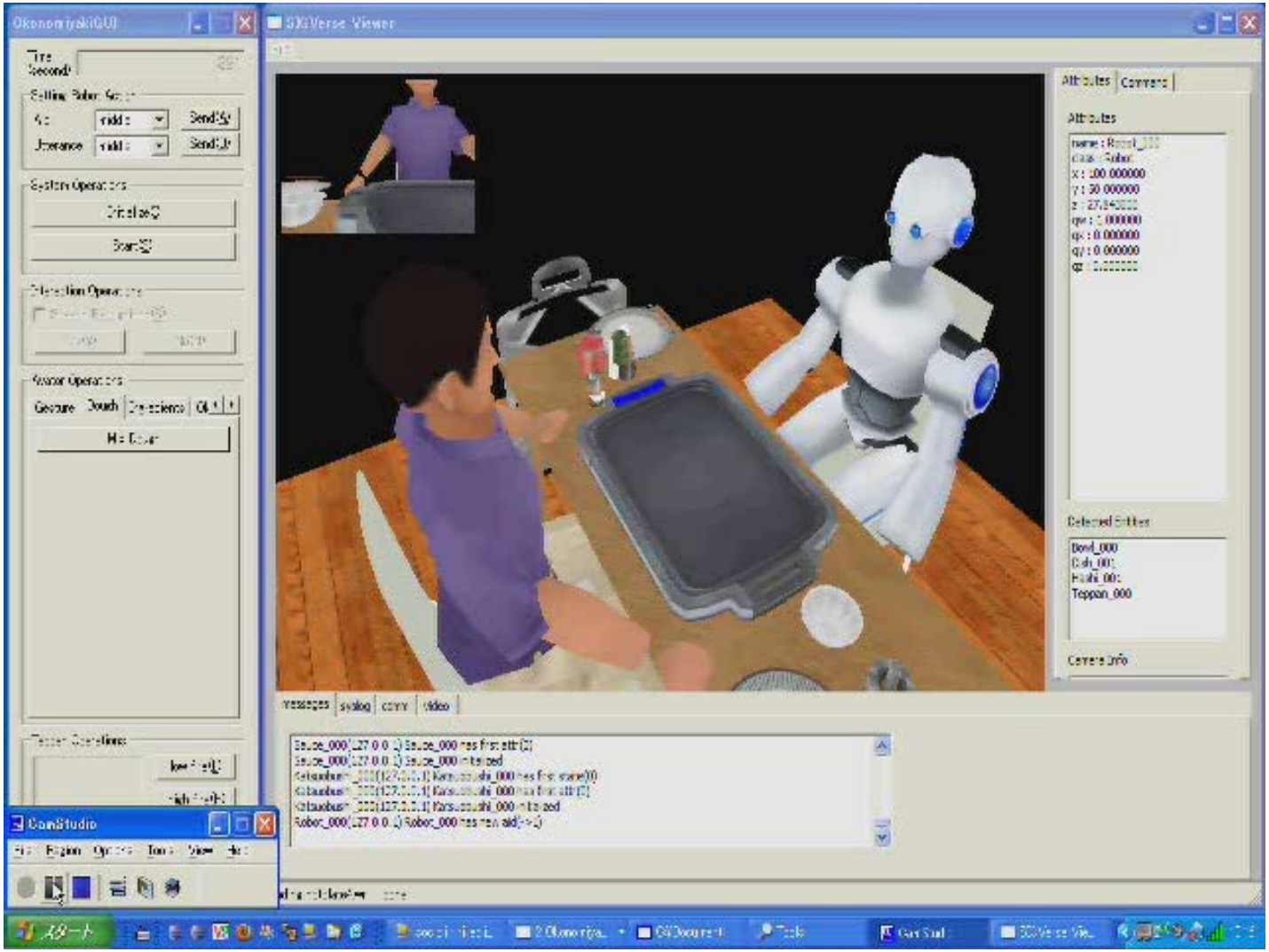


SIGVerse Simulation

- Physical Simulation
- Perception Simulation
- Communication Simulation

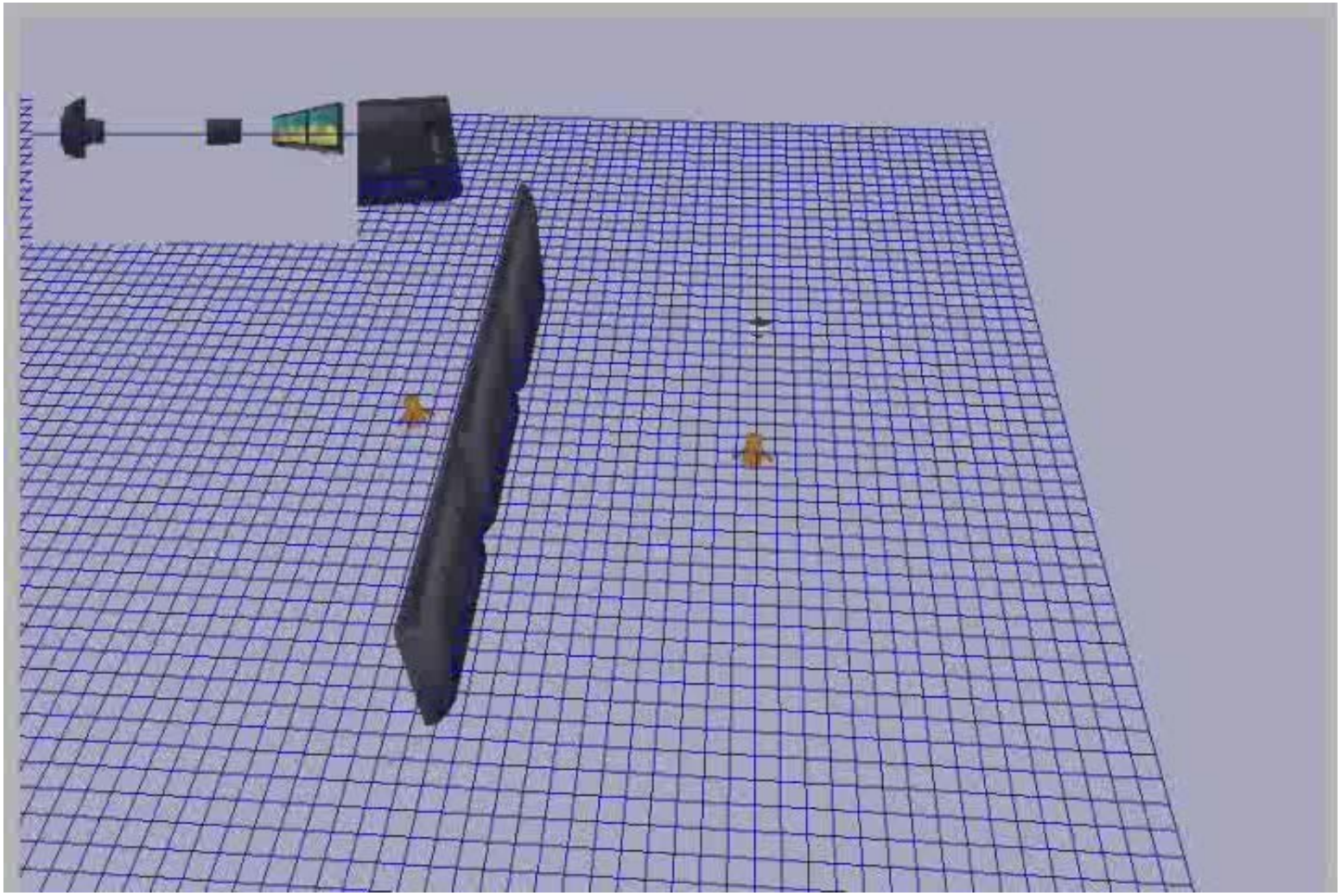
Application (1)

- **Human-Robot Collaboration Simulation**



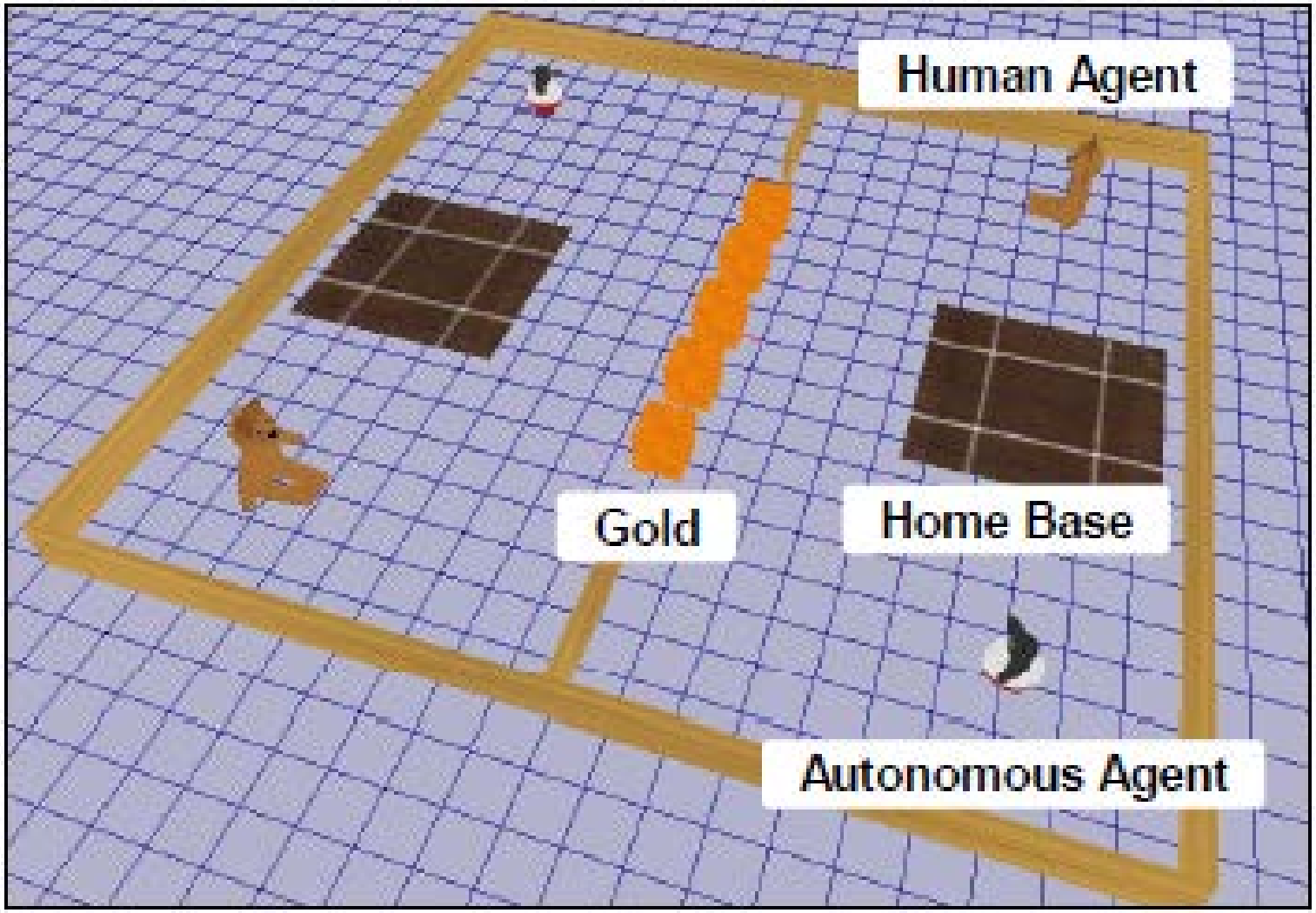
Application (2)

- **Multi-Agent Hunter-Target Simulation**



Application (3)

- **Multi Human-Agent Collaboration Simulation**



Application (Summary)

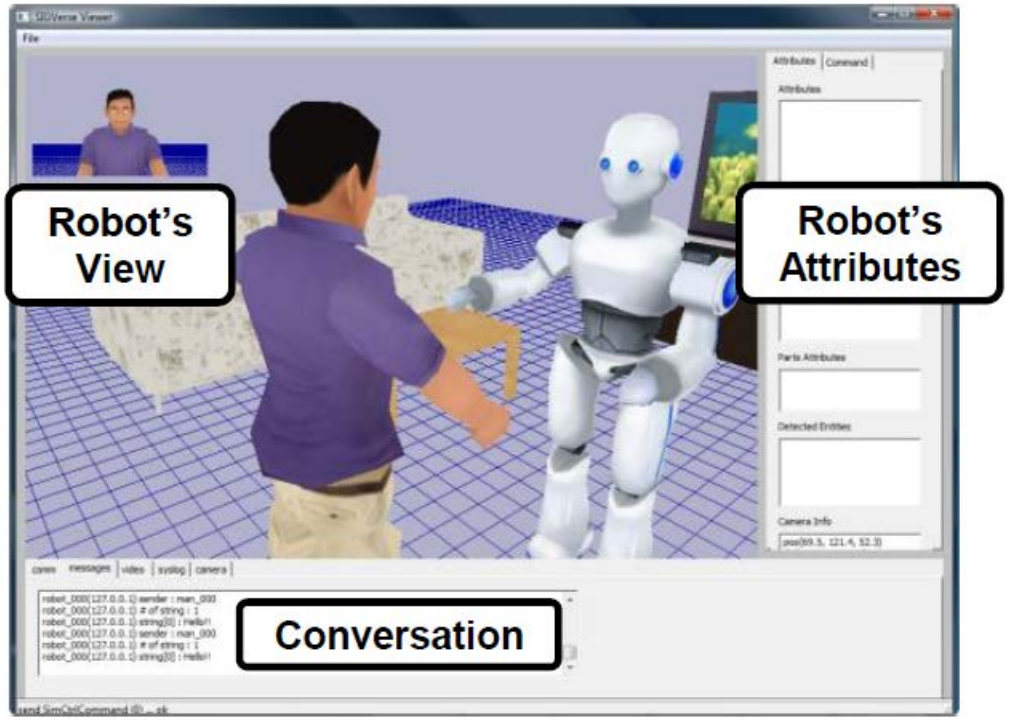
The HRI Problem	*Human-Robot Collaboration Simulation*	*Multi-Agent Hunter-Target Simulation*	*Multi Human-Agent Collaboration Simulation*
Autonomy	Modeling of humanoid robot and human avatar	Modeling of autonomous mobile agents	Modeling of autonomous and remote controlled mobile agents
Information Exchange	Verbal communication via text message and non-verbal communication via visual perception and gesture behaviors recognition.	Verbal communication via text message with perception physical constrains	Verbal communication via text message with perception physical constrains
Teams	Human-robot	Multi-agent	Multi-agent with multi-user participation
Adaptation, Learning and Training	Various interfaces: GUI, haptic device and motion capture system	GUI Interface	GUI Interface
Task-Shaping	Task planning in human-robot collaboration	Multi-agent collaboration	Human-agent collaboration with real time strategy

Conclusions

1. **Robot Design**
   - General development platform that offers physics simulation, realistic perception and robot modeling
2. **Communication**
   - Verbal and non-verbal communication with different level of perception data
3. **Multi-Agent and Multi-User**
   - Social interaction that involves all multi-agent and multi-user
4. **Human-Agent Interface**
   - Highly customized interface to suit application‘s needs
5. **Human-Robot Task**
   - Application on collaboration that improve task planning and evaluation

Future Work

- **Social interaction between human and robot**
  - Humanoid robot modeling: **natural body gestures** and **facial expressions**
  - Agent‘s intelligence development: expand text based communication to include **emotion expression** and **behavior recognition**
  - With learning methods and **knowledge database development** over a large group of users with the multi-agent and multi-user capability



Thank you

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