JST Japan–Austria Joint Workshop on 'ICT'
October 19, 2010 (13:30 – 13:55)

GLOBAL LAB

OpenEnergySim:
an International Collaboration Platform for Green ITS
(Intelligent Transport Systems)

Principal Investigator:
Helmut Prendinger

Project Manager:
Arturo Nakasone

NII 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

Collaborating Institutions:

ITS Center THE UNIVERSITY OF TOKYO 先進モビリティ研究センター

東北大学 TOHOKU UNIVERSITY

i-Transport Lab. Co.,Ltd. アイ・トランスポート・ラボ

JARI 財団法人 日本自動車研究所 Japan Automobile Research Institute

QUT Queensland University of Technology Brisbane Australia

TU Delft Delft University of Technology

Berkeley UNIVERSITY OF CALIFORNIA PATH CALIFORNIA

UC RIVERSIDE UNIVERSITY OF CALIFORNIA

How can OpenEnergySim contribute to Green ITS?

In Japan, about 19% of CO_2 emissions are attributed to transport (incl. 90% for road traffic)

Japan for Sustainability (JFS) Newsletter No. 95, July 2010

► **Intelligent Transport System (ITS)** strategies can significantly reduce CO_2 emissions of vehicles.

However, it is not yet achieved because:

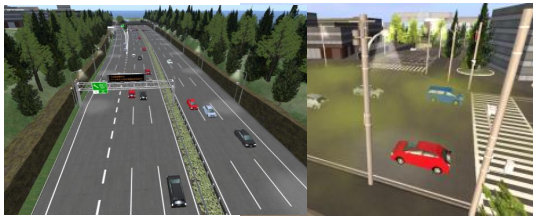
- The impact of ITS is highly dependent on driver acceptance/compliance rates
- No low-cost yet effective method to investigate the impact of energy-saving ITS on driver behavior
- No convenient collaboration platform to compare results of “green” ITS at an international level

Novel Platform

We propose **OpenEnergySim**, an online multi-user three-dimensional (3D) simulation space for **Green ITS** based on the emerging 3D Internet

OpenEnergySim serves 3 key functions in one single online environment:

① Simulation of traffic and CO_2 emission
►Intuitive understanding of sources of CO_2 emission



② Multi-user immersive driving in simulated traffic network
► Large-scale data collection for Green ITS at low cost
► Eco-driving education

Investigation of inter-driver interaction becomes possible!

③ Int’l collaboration space based on shared sources
►Easy comparison of effects of ITS on CO_2 emission reduction

Reliable Estimation of Impact of ITS on CO_2 Emission

Local calibration of TS & Creation of Behavioral Database for Green ITS

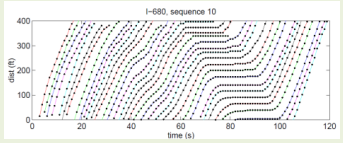
"Human Factor" is key problem: do drivers comply to ITS measures (e.g. route information)?

Available methods for "human factor" are insufficient:

- Web-based survey methods (text or 2D picture based) have low validity
- Driving simulator cockpits are prohibitively expensive & only one driver possible

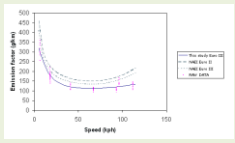
Build Large-Scale DB

Behavioral driver data:
- **driving patterns**
- **decision making**



Traffic Simulation (TS) Model

Computation of Traffic Simulation & CO_2 Emission



CO_2 Emission Model

Large DB

① (Re)computation

Re-calibration of TS model

Traditional Cycle

② Visualization & Application of ITS

③ Assessment of ITS

"In-world" Large-scale Survey

Local Calibration

Immersive Traffic Network

Visualization of Traffic Simulation & CO2 Emission

Interactive Installation of Green ITS Measures

Why is CO_2 emission high?

Virtual Kashiwa-City
Interchange
Intersections
LaLaport

- Inspect adequacy of TS model
- Discover sources of CO_2 emission

- Experts can manipulate ITS effectors interactively

Simultaneous Immersive Driving of Multiple Users

Estimation of "Human Factor"

How do drivers respond to ITS?

Parameter Learning in Driver Models

Human Drivers

Comparative Validation of Impact of ITS on CO_2 Emission

OpenEnergySim as international standardization framework (JP, EU, USA)

International Validation

Reference Models

Miniature Traffic Net

Immersive Traffic Net

E.g.: Combining CO_2 model (US) and Traffic Simulation model (JP)

TS and CO_2 emission models

- TS PATH + CO_2 CMEM
- TS Avenue + CO_2 JARI
- TS TU Delft + CO_2 PHEM

PATH Berkeley UC Riverside

JARI 財団法人 日本自動車研究所 Japan Automobile Research Institute

i-Transport Lab. Co.,Ltd.

TU Delft

TU Graz

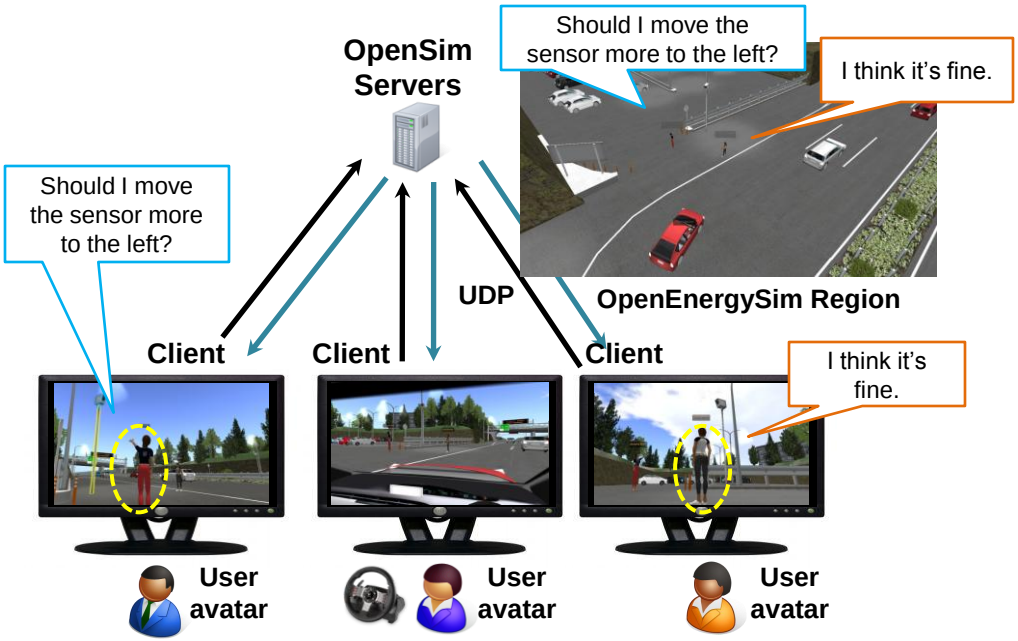
International Collaboration

- Int'l evaluation framework for drafting future ITS standards

Goal: Standardized, internationally validated methods for assessing the impact of ITS on CO_2 emission

Low Requirement Level:
- Internet connection
- Viewer (free software)
- Game wheel controller (optional)

- Real-time communication based on shared sources



- Comparing the effect of ITS and different TS & CO_2 emission models side-by-side

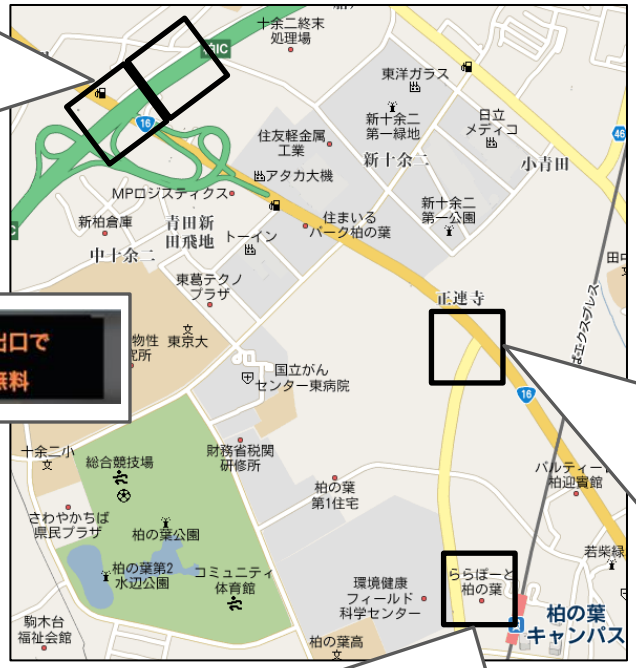
Towards Optimal Carbon Trading Scheme

For effective carbon trading >> participants have to trust the measurements of others (Prisoner's dilemma) >> OpenEnergySim guarantees measurement transparency >> mutual trust

Kashiwa-City as Testbed for Social Experiment, Education & Collaboration

- **Social Experiment**: test compliance rates of drivers to ITS measures and its effect on CO_2 emission at intersection and LaLaport
  Validation of high-level decision making through large sample size
- **Eco-driving Education**: EneMeter ("Energy Meter") teaches green driving to next generation of drivers

Will drivers comply to the "Park & Ride" Variable Message Sign (VMS) at the Interchange?



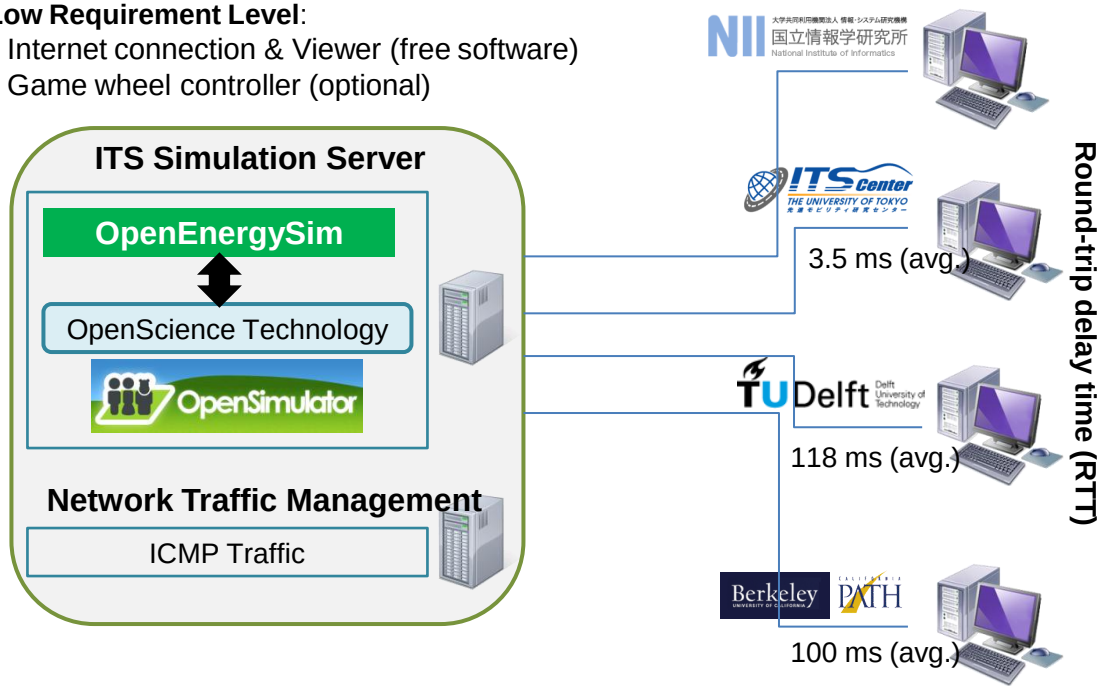
How will traffic induced by the "Park & Ride" VMS affect CO_2 emission at the intersection?

How will the increased traffic in LaLaport affect CO_2 emission, bus schedules, and pedestrian security?

Multi-Continent Immersive Driving & “Car Following” Study

Feasibility of large-scale data collection

Low Requirement Level:
- Internet connection & Viewer (free software)
- Game wheel controller (optional)

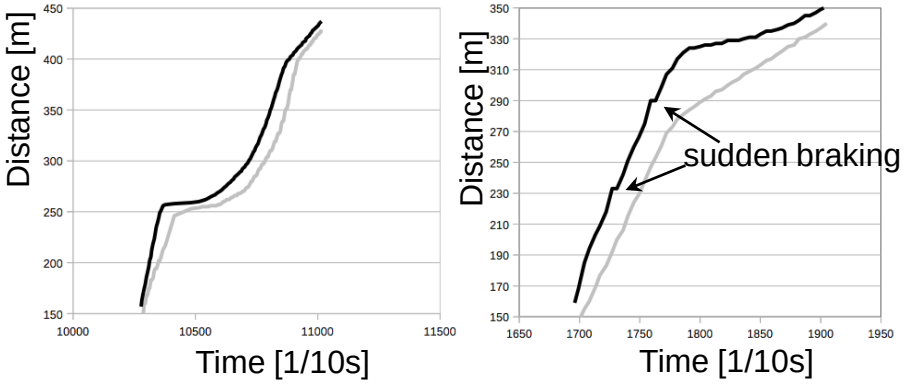


“Car Following” experiment (8/2010): Feasibility study for global behavioral data collection

- Drivers from 3 continents could follow each other without serious delays
- *Validation* of micro-level driving behavior (e.g. “car following”) by comparison to real-world data

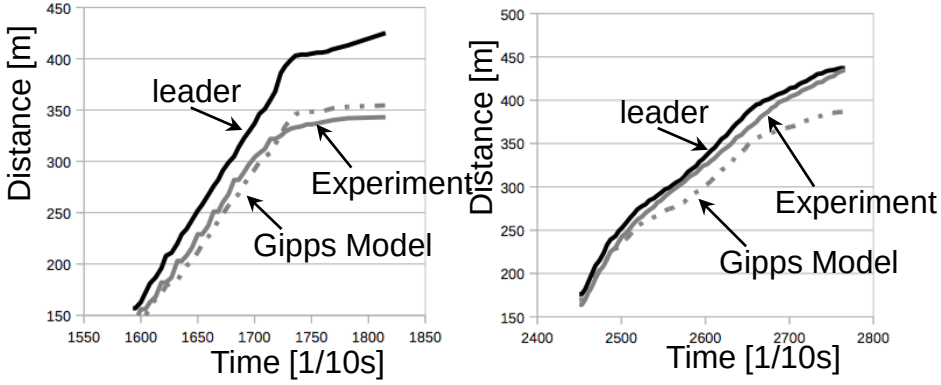
“Car following” study (domestic setup)

- Emergency braking due to drake-down on Interstate 80



Smooth following behavior in VW – increase in headway when breaking

- Comparison to Gipps’ model for driving behavior



Similar trajectories, but headway too small

Easy Scenario Authoring for Green ITS

Maps
(Topographic,
Land Use, etc)

Traffic Simulator

CO_2 Emission Simulator

Pedestrian Simulator

Procedural Road Network Generator

Planned

ITS Scenario Specification

ITS Behavior Specification
(Ontology, Interaction Rules between Scenario Objects)

ITS Structural Specification
(Geometry ,Topology, Co-ordinates)

ITS Authoring System

OpenVWML Execution Interface

Content Parsing

Command Executor and State Management

State Storage

OpenAppCore

Management Component

VWML (VW Markup Language)

Implemented

Component Database

Component Manager

VW Event Manager

OpenLibrary

API Connector

OpenAppCore (VW Component Framework)

Network Interface

Avatar Functionality

Environment Manipulation

World Interaction

External Data Connectivity

OpenLibrary (VW Core Framework API)

OpenSimulator Virtual World (VW) Environment

Example of OpenITSML

```
<OpenITSML>
<RoadSegment  RSId = "RC24"   Type = " Highway>
      <VWStartPosition X = 10  Y = 45  Z = 20 > </VWStartPosition >
       < NoOfLanes > 4 </NoOfLanes>
</RoadSegment>
<Building  BId = "B1200" Type = "Admin" >
      <VWLocation X = 100  Y = 200  Z = 20 > </VWLocation>
</Building>
<TrafficLight  TLId  =  "TS126"   Type  = "IntersectionSignal">
    <VWLocation   X = 120  Y = 245  Z = 20 >  </VWLocation>
    < LightTimingLength >  60 Secs  </LightTimingLength >
    <CurrentState > RedLight  </CurrentState >
</TrafficLight>
<Sensor  SId =  "S78"    Type =  " CO2  Sensor">
     <VWPosition X = 150  Y = 145  Z = 20 > </VWPosition >
     <CurrentReading> 5 ppm/v   </CurrentReading>
     <FunctioningState> Active   </FunctioningState >
</Sensor>
<ComputerControlledCar   CCarId = "CC123" >
     <Model  Color = " Red" > Toyota Hybrid  </Model>
     <CurrentState>  FreeDriving </CurrentState>
     <CurrentVelocity>  50 Km/H  </CurrentVelocity >
     <CO2EmmisionLevel> 0.0005 ppm/v  <CO2EmmisionLevel>
</ComputerControlledCar>
<UserControlledCar     UCarId = "UC145" >
    <Model  Color = " Blue" >  Benz E Class </Model>
    <OwnerAvatar FirstName=" K." LastName=" Gajan"> </Owner Avatar >
    <CurrentState> WaitAtSignal  </CurrentState>
    <CurrentVelocity> 0 Km/H  </CurrentVelocity >
    <CO2EmmisionLevel> 0.00001 ppm/v  <CO2EmmisionLevel>
</UserControlledCar>
< Pedestrian  Pid = "P120"  FirstName = "T." LastName = "Imbart">
    <AssignedTask>Walk to LaLaport</ AssignedTask >
    <StartLocation>  LalaPort Crossing  </StartLocation>
    <EndLocation>  LalaPort SubwayStation  <EndLocation>
</Pedestrian >
</OpenITSML>
```

Road Infrastructure (Roads, Buildings, Vegetation)

ITS Installment (Traffic light, VMS, Sensor)

Computer-Controlled Traffic (Car, Pedestrian)

User-Controlled Entities (Car, Pedestrian Avatar, Bike)

Global Lab NII Grand Challenge Project (FY2008–FY2010)

Establishment of collaborative cyber science for eco-friendly society based on the 3D Internet

- 35 partners (domestic & int'l), 100+ people
- 5+ successful production-level applications
- Several science/eng. communities created
- Software users: 20 inst. & 1,000+ general
- 10,000+ views on YouTube video platform
- 60+ peer-reviewed papers in int'l jour/conf

***Seminal papers*: Trans of VR Soc of Japan (2009), IEEE CG & A (2009), Presence (MIT Press, 2009), IEEE Trans on Visualization and CG (2010), Int'l Jour of Human-Computer Studies (2010), ACM Multimedia (2010), etc.**

OpenAstroSim

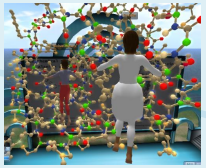
INSTITUTE *for* Advanced Study, Princeton, USA

国立天文台 NAOJ

Discovery in Galaxy Formation

OpenMol

Exploration in Molecular Dynamics



NAREGI

UNIVERSITÄT DES SAARLANDES

"Discrete Encounters"

NICTA

Validating Mobile Social Networks

GLOBAL LAB

OpenScience Technologies & Real-time Collaboration based on the 3D Internet

Innovative software for real needs of users

OpenEnergySim

Reducing CO_2 by ITS

ITS Center THE UNIVERSITY OF TOKYO

TU Delft Delft University of Technology

PATH

Berkeley UNIVERSITY OF CALIFORNIA

AgriVillage

Kasetsart University

NECTEC National Electronics and Computer Technology

inesc id lisboa

Training Farmers

OpenBioSafetyLab

Training Health Workers

NIID National Institute of Infectious Diseases

KYUSHU UNIVERSITY

Homeland Security (planned)

Vision of Global Lab Project

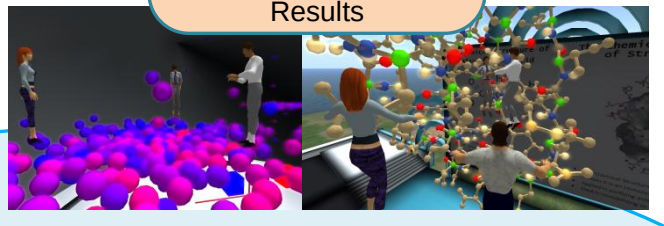
Pioneering Shared, Real-time Collaborative 3D Environments as a Novel Research Infrastructure & Methodology

Remote collaborators can define research questions naturally in **Face-to-Face communication**

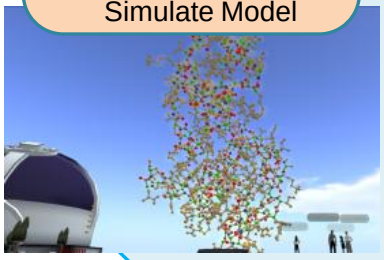
A **paradigm change** from publishing scientific papers to **publishing persistent, interactive, immersive experiences of science & engineering**

Formulate Research Challenge

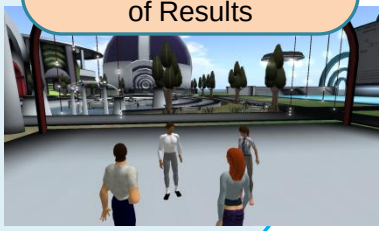
Publish & Share Results



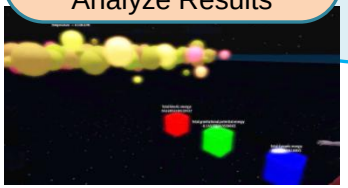
Develop Experiment & Simulate Model



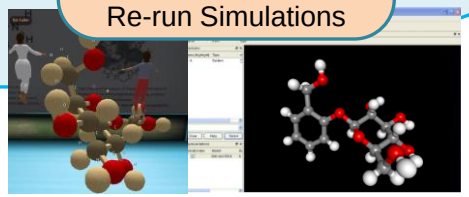
Informal Discussion of Results



Measure Data & Analyze Results



Visualize Data & Re-run Simulations



Using a **plug-in interface**, scientists can easily contribute their own algorithms, e.g. for potential/kinetic energy calculation

Integration to major scientific modeling and simulation tools. Right: BALLView molecular modeling/visualization app (Saarland Univ.)

GLOBAL LAB

Astrophysics

Exploration and Discovery in Stellar Dynamics and Galaxy Formation

State of the art

Dome Theater of Four-Dimensional Digital Universe (4D2U) project

High-quality visualization **but**

- "Mitaka" software does not provide support for collaboration
- For real-time collaboration, experts have to go to Mitaka

IEEE CG&A 2009

Collaboration with

INSTITUTE *for* Advanced Study

Princeton

国立天文台 NAOJ

►Real-time collaboration and interactive experience of astrophysics becomes possible!

OpenAstroSim

The world's first real-time remote collaboration space in astrophysics

Flexible Simulation Operation

Commands issued through chat interface

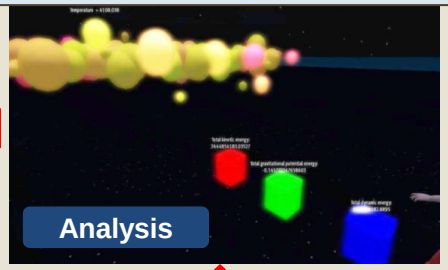
Operations:
- Request NAREGI simulation
- Play
- Rewind

1. Galaxy Formation
2. N-Body Problem

Operation

Dynamic Value Display

Real-time display of kin./pot. energy



Real-time Collaboration

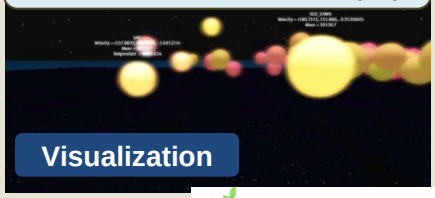
I think we are close to cluster collision state now

Yes, more and more red stars

Right, the stars are changing color because of higher velocity

Interactive Feature Display

Interactive selection and display



Validated by:
- Astronomers from Princeton, Caltech, MIT
- KIRA group
- MICA group

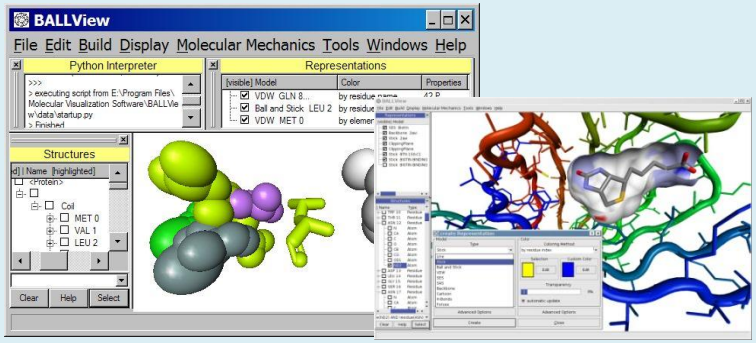
GLOBAL LAB

Bio-Molecular Science

Remote Collaboration in Molecular Modeling and Molecular Dynamics (MD)

State of the art

BALLView
Stand-alone molecular modeling & visualization software (developed at Saarland Univ.)



High-quality visualization and rich modeling functionality **but**

› No support for remote collaboration in molecular modeling

Smart Graphics 2010

Collaboration with

UNIVERSITÄT DES SAARLANDES

Center for Bioinformatics

►We can do MD and molecular modeling by remote collaboration in real-time!

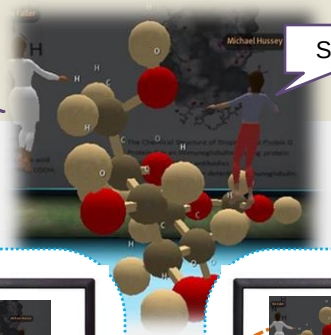
OpenMol

The world's first integrated environment for single-user and collaborative molecular modeling and dynamics

Collaborative modeling

I will show you how to transform Salicin to Aspirin

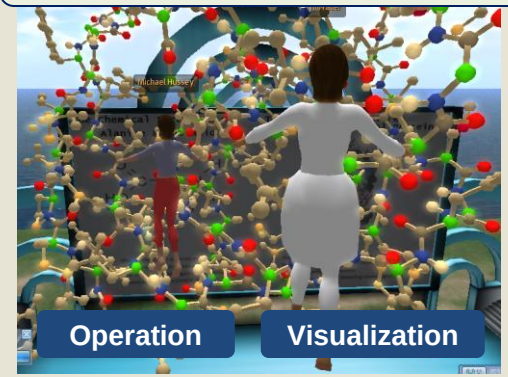
Sure



Tested by:
• Bioinformatics experts from Saarland Univ.

Flexible Simulation Operation

Commands issued through chat interface



GLOBAL LAB

Agriculture

Training the Next Generation of Farmers in OpenScienceSim

Wisdom sharing / Decision making

Real-time Data Visualization

"In-world" control of real sensor

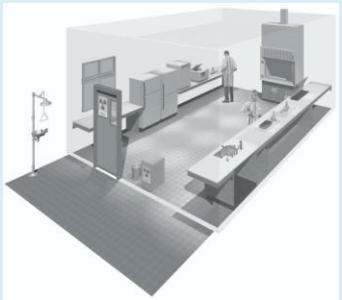
Increasing environmental awareness through an agricultural game

Games for Serious Applications 2010

Bio-Safety Lab

Training Health Workers in Realistic Virtual Environments

State of the art



Left: Textbook
A typical Bio-safety Level 1 Lab (Graphics by CUH2A, Princeton, NJ, USA)

Right: Real BSL
A Bio-safety Level 1 Lab in Japan

Current training methods suffer from severe **limitations**

- Textbooks: Not effective since students receive no vivid impression of hazardous situations
- Real BSL: Expensive to maintain and mostly unavailable

J Japanese Assoc Infectious Diseases 2010 (A)

Collaboration with NIID National Institute for Infectious Diseases & Kyushu University

►Immersive, cost-effective, and easily accessible space for basic infectious disease education!

OpenBSLab

A unique training environment for handling hazardous substances

Initial tests by:
• Medical students from Kyushu Univ.

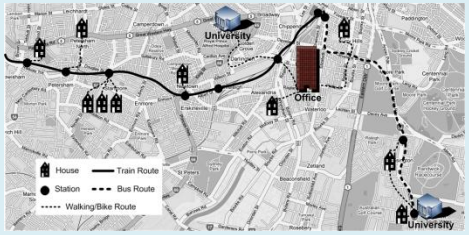
GLOBAL LAB

Novel Method for Validation in Mobile Computing

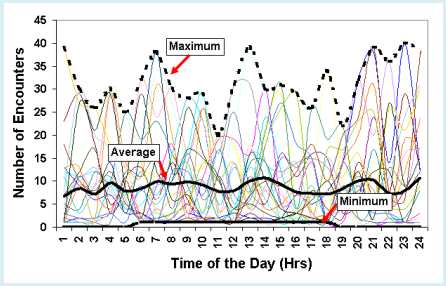
Validating Content Dissemination Algorithms for Mobile Social Networks

IEEE ICC 2010

State of the art



Real-world experiment



Mathematical models
(encounter-based, time-variant, etc)

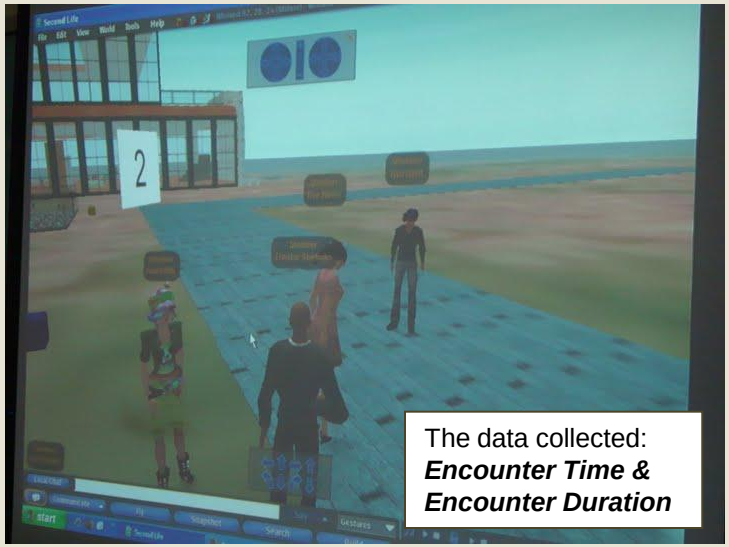
Current validation methods are often **impractical**

- Real-world experiment: prohibitively expensive
- Mathematical models: real life movement patterns are difficult to model mathematically

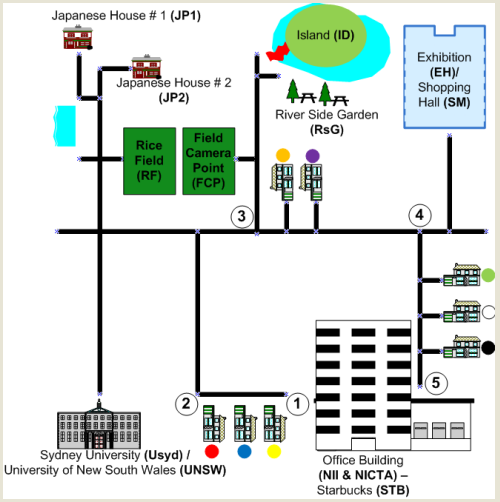
Collaboration with

NICTA
&
National Univ. of Science & Technology (NUST), Pakistan

►Our virtual environment provides a realistic and cheap alternative – by using a game to engage real people where they follow real-life movement patterns!



Testing algorithms while users enjoy a game



Tested by:

- Students from NUST, Pakistan

GLOBAL LAB

Global Lab - Participatory science in virtual worlds implementing an eco-friendly society - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.prendingerlab.net/globallab/

GLOBAL LAB

Participatory science in virtual worlds for implementing an eco-friendly society

HOME | ABOUT | TECHNOLOGY | PROJECTS | OUTREACH | CONTACT US

Welcome to the website of the Global Lab NII Grand Challenge project!

The Global Lab project aims to develop the infrastructure for advanced communication, collaborat
Immersive virtual worlds, or the 3D Internet, refer to online three-dimensional world-like environm
naturally and intuitively with each other and with virtual objects. The 3D Internet is manifest in the p
open source world simulator.

The Global Lab infrastructure contributes to the vision of an eco-friendly society by replacing move
social communication. In the project, we target real-time collaboration in science and engineering
increases awareness of environmental issues by allowing anyone to experience the consequenc

Project website:
http://www.prendingerlab.net/globallab/
Homepage:
http://research.nii.ac.jp/~prendinger/
E-mail:
helmut@nii.ac.jp

What's New

2010/04/09 Welcome

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