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Intelligent, Learning Systems ABI Mark II

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Overview

- Introduction
- ABI System Architecture
- Distributed Agent Applications
- Intelligent Learning System
- ABI Simulator
- Motivation for learning

In a later lab meeting:

- Learning a dynamic living and working environment
- Results / Discussions
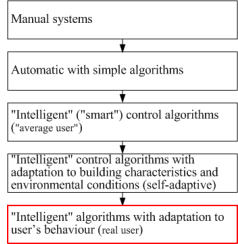- Conclusions and Future Work

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Introduction

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Intelligent Building (IB)

- "An intelligent building is one that doesn't make the occupants look stupid".

Manual systems

↓

Automatic with simple algorithms

↓

"Intelligent" ("smart") control algorithms ("average user")

↓

"Intelligent" control algorithms with adaptation to building characteristics and environmental conditions (self-adaptive)

↓

"Intelligent" algorithms with adaptation to user's behaviour (real user)

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IB Goals

- Not disturb occupants (user comfort)
- Be reliable
- Minimize energy consumption
- Incorporate all available sensor information (Multi-sensor environment)

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Our Objectives (Term Project)

- In our term project we implemented a new ABI System built on the Open Service Gateway initiative (OSGi)
- Integration of wireless devices provided by our industry partner (Feller AG).

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Our Objectives (Diploma Thesis)

- Several major improvements including incorporating additional sensors and effectors (LonWorks)
- Distributed Agent Applications
- Prediction algorithms

ABI System Infrastructure

ABI System based on OSGi
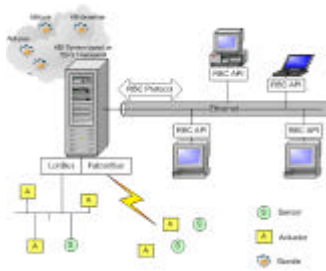
Distributed Agent Applications

Area Controller Agent

- Tool for room administration
- Tasks: Lifting up window blinds, etc.
- Deployed with a single click over the network (Java Web Start)
- Comfortable maintenance

Area Controller Agent PC Presence

- Problem: PIR sensors start to fail to correctly detect the presence of an environment (i.e. no direct intervisibility)
- This user interaction agent combos the latter agent with an additional Remote PC Presence detector software piece (Thanks Tobi).
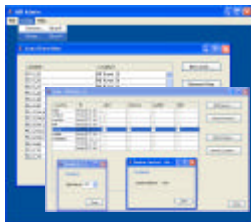- Runs as a thin client, right underneath the regular Area Controller Agent

Area Admin Agent

- Global administration
- Centralize ABI System security

Area Logger Agent

- A database application has been developed that logs any events within a specified building part, in order to be capable to "replay" their collected data.
- Only practical to a certain point of degree since only sensory data can be replayed.
- However it is important to persist data in particular for data mining and to validate any interacting building intelligence.

Intelligent Learning System

Environmental Analysis (55.G.84)
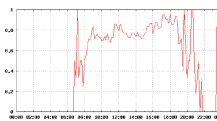
Figure 11.4: $\mathcal{P}(CORRIDOR\ LIGHT\ ON|s_t)$ Figure 11.5: $\mathcal{A}(s_t)$
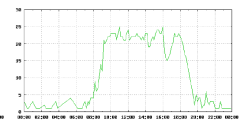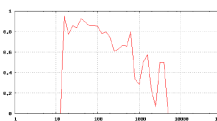
Figure 11.8: $\mathcal{P}(CORRIDOR\ LIGHT\ ON|s_d)$ Figure 11.9: $\mathcal{A}(s_d)$
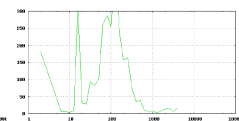
Environmental Analysis (55.G.74)

Figure 11.14: $\mathcal{P}(WINDOW\ LIGHT\ ON|s_t)$ Figure 11.15: $\mathcal{A}(s_t)$ window

- Simple Environments (only a few strong inputs)
- Complex Environments (more inputs required)

Intelligent Building Framework (IBF)

- The IB Framework provides:
  - Enhanced testing possibilities
  - Supports the development
  - Is extensible (Real Time Simulation)
  - A method to measure the performance of the system
  - Defines a set of well defined interfaces that serves as a schema for individual device agents
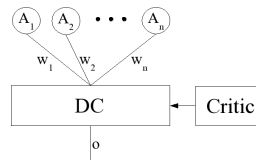
Intelligent Building Framework (IBF)

- Each environment is different
- Likewise each prediction algorithm
- Decision Controller (DC) considers the changing strengths and weaknesses of different prediction algorithms

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IBF Algorithm

- Prediction is performed by taking a weighted vote among a pool of prediction algorithms
- Learns by altering the associated weight
- Vote is steered as a function of user interactions

ABI Simulator

Demo
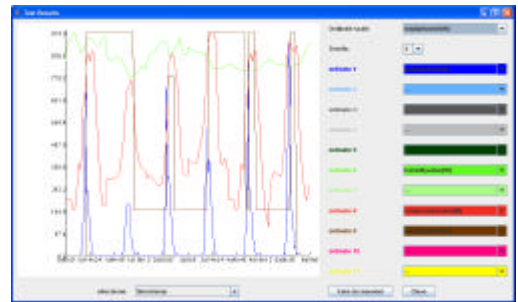
Motivation for learning

Common issues

- Non-stationary environment
- User instructions are very sparse
- Energy savings vs. User comfort

Other Difficulties

- Different skylight levels can be found under the same sunlight condition.
- Commissioning
- Which inputs need to be provided for learning?
- Input pre-processing necessary?
- Practically all existing daylight control systems only provide the interior daylight. Sufficient enough to optimally control all environments?
  - Instant light reflections?
  - Environment located in the basement?
  - Other light sources?
- Occupant (behavior) changes, LTM/STM?

Summary

Summary

- A new ABI System has been developed, based on OSGi, successful LON integration
- Distributed Agent Applications
- IBF has proven to succeed to handle different learning algorithms by judging them in their performance
- Real Time Simulation platform

Questions?