The IIEG Work

- **Primary Research Focus** - the creation of intelligent (learning) mechanisms that can be embedded into networked devices making up everyday living environments (targeting so called Ambient Intelligence, Pervasive and Ubiquitous Computing)

- **Secondary Research Focus** - Network Infrastructures, HMI, novel sensors / effectors

**Projects**
- eGadgets
- careAgents
- Social
- MAN project

**Test Beds**
- iDorm
- “Tomorrow’s World” Set
- pDorm/mDorm
- iFlat
Intelligent Ubiquitous Environments

The iDorm

Appliances

- Multimedia PC
- Desk lamp
- Bed lamp
- Room Heater
- Room Cooler
- Window Blind
- Active lock
- Ceiling lights
- Mobile (Servant-) Robot
- Telephone
- TV
- DVD
- CD Player
- Desk
- Chair
- Bed
- Mood Cube

Active/Passive Agents

- Actuators’ state
- Occupancy
- Location
- Window state
- Indoor light level
- Outdoor light level
- Indoor humidity
- Time

Other existing environments

- iHOME
- MIT’s Intelligent Room
- Microsoft Smart House
- Cisco’s Internet House

- most of the approaches focus on general-control mechanisms on the system-level
- number of agents is limited and known to the designer of the MAS
- the addition or disconnection of agents cannot be done dynamically
- future trends show that agents might be self-identifying and support self-configuration

How can a system deal with the configuration management needs of an extensively “agentized” environments?
### Intelligent Associations

#### What are Associations?
- Link between two or more agents/devices

#### How to establish associations?
- Manual
- Automatic
- Intelligent

#### Type of associations?
- Permanent vs. Temporary/Dynamic
- Vital vs. non-Vital
- Single-directional vs. bi-directional

#### Why are associations needed?
- Avoid communication overhead
- self-configuring, fault-tolerant multi-embedded agent system
- Overcome dimensionality problem in rule bases

### Intelligent Association System

#### Definitions
- **Agent Societies**
  - collection of agents with a common objective goal
- **Embassador Agents**
  - facilitates communication between societies
  - ability to (re)-combine/dissolve associations
The IAS Editor

- Initial Experiments on manual associations (“connect everything with everything“)
- Three phases of operation:
  1. User sets associations manually with the Editor
  2. Rule Generation and Agent Control
  3. Learning new associations through monitoring

Intelligent Association System

Flow Chart

Table 1: Rule base, specified by the user

<table>
<thead>
<tr>
<th>Condition</th>
<th>Temperature</th>
<th>Switch Lamp</th>
<th>Heater</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>COLD</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>OFF</td>
<td>COLD</td>
<td>OFF</td>
<td>OFF</td>
</tr>
</tbody>
</table>
Intelligent Association System

The IAS Editor

Flow Chart

Each agent starts reading sensory information

Did the state of any agent change?

No

Yes

Control

Create new association

Example of two new associations

<table>
<thead>
<tr>
<th>Bed Pressure</th>
<th>Bed Lamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Light Level</th>
<th>Bed Lamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>ON</td>
</tr>
</tbody>
</table>

Inter-agent Communication

DIBALight

Experiments on manually associating agents over long distances

The message format:

<table>
<thead>
<tr>
<th>Tag</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANUS</td>
<td>S_ SEND</td>
</tr>
<tr>
<td>PIONEER</td>
<td>R_ REQUEST</td>
</tr>
<tr>
<td>VISION</td>
<td>N_ NOTIFY</td>
</tr>
<tr>
<td>ISR</td>
<td>IDORM</td>
</tr>
</tbody>
</table>

Truncations:

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Tag1</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_</td>
<td>SEND</td>
<td>MANUS</td>
</tr>
<tr>
<td>R_</td>
<td>REQUEST</td>
<td>PIONEER</td>
</tr>
<tr>
<td>N_</td>
<td>NOTIFY</td>
<td>VISION</td>
</tr>
<tr>
<td>ISR</td>
<td>ISR</td>
<td>ISR</td>
</tr>
<tr>
<td>IDORM</td>
<td>IDORM</td>
<td></td>
</tr>
</tbody>
</table>

Separators:

<table>
<thead>
<tr>
<th>Tags</th>
<th>Information/Values</th>
<th>Command</th>
<th>Multiple Requests/Notification</th>
</tr>
</thead>
<tbody>
<tr>
<td>_</td>
<td>(</td>
<td>;</td>
<td>+</td>
</tr>
</tbody>
</table>

17/10/2002
Intelligent Inhabited Environments Group
Conclusion

Benefits of learning associations

- Reduces storage and processing capacity, and the communication overhead
- Overcomes the dimensionality problem in rule bases through extracting/deleting rules and modifying the input-output vector
- No requirement of pre-knowledge of the agents existing within the society
- No requirement on expert knowledge for setting up the association, generating the rule base and entering the rules
- Ad-hoc, Fault-tolerant, and self-configuring agent societies without the need of an network operator

Future Work

Calculating learned association weights

- Why is it required to learn association weights?
  - Physical limit of agents might allow only a limited number of connections
- What are the benefits of knowing association weights?
  - Discover better connections dynamically (if the weight is low then this association is of less interest to the system)
Any Questions?

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More information can be found on:

http://iieg.essex.ac.uk