iWorlds: Building Mixed Reality Intelligent Environments using Customisable 3D Virtual Worlds

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What are Intelligent Environments?

- Intelligent Environments are spaces outfitted with micro-computers, sensors and other technologies, embedded into walls, ceilings, furniture and devices.
- Common items, (chairs, heaters, lights, etc.) are networked together, allowing them to be controlled remotely by computer programs, (agents).
- Devices in intelligent environments can potentially be controlled from anywhere in the world via the internet, including by many modern smart phones.

What are Intelligent Environments?

- The University of Essex iSpace
  - Several full-scale rooms, including a lounge, study, bedroom and bathroom.
  - Fully outfitted with all the furniture and devices from a standard household.
  - All embedded technologies are designed to exist and operate in the background.

- Purpose built for researching intelligent environments
  - Hollow walls and ceilings containing a myriad of computer based technologies.
  - An extensive sensor grid, including an external weather station.
  - Automated curtains, HVAC and lights in every room.
  - Numerous X10 enabled devices.
  - A Ubisense tag tracking system.
  - RFID door locks.
Virtual Intelligent Environments

- Advantages of Virtual Intelligent Environments
  - They can provide a convenient mechanism for interfacing with physical devices.
  - They can be used to exhibit the influence of running agent programs.
  - Virtual worlds don't need to follow the same rules as a physical environment.
  - Using mixed reality a virtual world can augment a physical intelligent environment.

- Virtual Intelligent Environments can vary greatly in design
  - Three Dimensional vs. Two Dimensional graphics.
  - Viewing perspective, i.e. first person, third person or top-down).
  - The complexity of the world, [e.g. size, number of devices].
  - The level of realism used when modelling the world and its contents.

Virtual Intelligent Environments

- Issues restricting the use of Three Dimensional Virtual Intelligent Environments
  - Costs, [e.g. time and resource requirements].
  - Necessary skills.

- Solution # 1
  - The Computer Games Industry: High quality 3D worlds with realistic avatars and device models.
  - Issues with using off-the-shelf titles.

- Solution # 2
  - RealXtend: Open-source high quality 3D worlds with realistic avatars built from Second Life code.
  - Google 3D Warehouse: Collections of 3D device models that can be converted for use in RealXtend.
  - Google SketchUp: A free 3D graphics editor that can be used to modify 3D Warehouse models.
Mixed Reality Intelligent Environments

• The Mixed Reality iSpace Environment
  – Physical Component: The University of Essex iSpace.
  – Virtual Component: A RealXtend based replica of the physical iSpace.
  – Java Bridge: A bespoke bridge program written in Java to link the virtual world to the iSpace.

• Augmenting the Physical Intelligent Environment
  – Counterpart devices exist in the virtual world for each intelligent device in the physical iSpace.
  – Using Python scripts a user can control the physical devices by clicking on their virtual counterpart.
  – Some virtual devices can perform different actions to their physical counterparts, e.g. switches.
  – Virtual device models need not have a similar appearance to their physical counterparts.

• Demonstration: Light & Television Controller

Connected Realities – iSpace & iWorld
Future Work

- Massive Virtual Intelligent Environments
  - Massive Multiuser Online (MMO) Virtual Worlds have become increasingly popular in recent times.
  - The MMO capabilities of RealXtend could be exploited by the iSpace Environment.

- iCommunity
  - Multiple instances of various virtual/mixed reality intelligent environments grouped together in a single online virtual world, (iWorld).
  - Different “zones” for residential, commercial and recreational themed environments.
  - Each individual who accesses the virtual world could “own” an iSpace instance.
  - The world is expanded with new environments/device models being added by user customisation.
  - A tool for worldwide collaborative research into intelligent environments.

Conclusions

- We have discussed issues surrounding the use of three dimensional graphics in virtual worlds for intelligent environment research.

- We have presented a methodology allowing the easy creation of low-cost virtual intelligent environments with realistic three dimensional virtual worlds.
  - This technology can be used to provide low cost and highly flexible test-beds for prototyping intelligent environments and related technologies, demonstrating concepts, or for remote control.

- Continuing on we described and demonstrated how a virtual world created using the methodology could be augmented to create a Mixed Reality Intelligent Environment.

- Finally, we outlined our plans for the near-future, including the expansion of the virtual component of the Mixed Reality Intelligent Environment into an iCommunity, existing online as an iWorld.