

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



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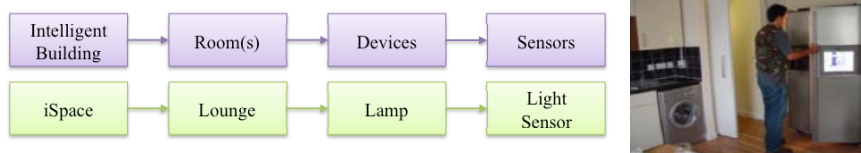


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What are Intelligent Environments?



- 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**



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Mixed Reality Intelligent Environments



Connected Realities – iSpace & iWorld



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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 MR 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.

