



Mixed Environments for Review and Generation of Engineering Designs

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Overview

Engineering design and evaluation has been a traditional application target for virtual environments (VEs). However, successes are still limited, with few systems in actual use. This is due primarily to the difficulty in simulating engineering design and assembly verification tasks at a high degree of fidelity.

Instead of an *entirely virtual* environment, engineering design tasks need a **Mixed Environment (ME)**, a combination of a few real objects with many virtual objects. Our ME system employs a pipeline to rapidly incorporate real objects and develops a means for multiple parties to view and interact with the proposed designs.

Challenge

We have partnered with NASA engineers at NASA Langley Research Center to obtain content and end-user feedback of our ME system.

In payload assembly, integration is a crucial stage in which devices are connected with cables, parts, and tools. Integration issues such as *Subsystem layout* challenge NASA engineers. Mixed Environments provides a tool that can effectively simulate integration, accommodates real-time modifications, provides haptic feedback with a “real-world” look and feel, allows for extemporaneous inclusion of tools and other objects, and supports simultaneous use by multiple users. Such a tool would aid in assembly and layout modification.

Approach

To incorporate real objects, we must:

- Create virtual representations of the real objects involved in the assembly plan.
- Track the real objects such that the corresponding virtual representations mimic their motion and articulation.
- Insert the virtual representation in the ME, such that they are active participants in simulations.

We have developed a pipeline to accomplish:

- Captures real object shape using a 3D laser scanner.
- Aligns, merges, and hole-fills scans to create a complete model of the object.
- Attach colored markers both to the real object and, in software, to corresponding positions on the virtual model.
- Place colored markers on a simple object which will allow the user to manipulate a complex CAD model in the ME.

Highlights

- **Rapid Incorporation of Real Objects:** Our pipeline allows a user to get a tool from the real world into the virtual world in two hours.
- **Mixed Environment:** The user handles physical objects while interacting with virtual objects.
- **Team Based Design:** Primary, secondary, and remote team members can cooperate in assembly design verification.



A user handles real objects and physical correlates (**top**), while visualizing articulated scanned models (pliers, drill), and a CAD model of a yet-to-be-built NASA payload component (**bottom**).

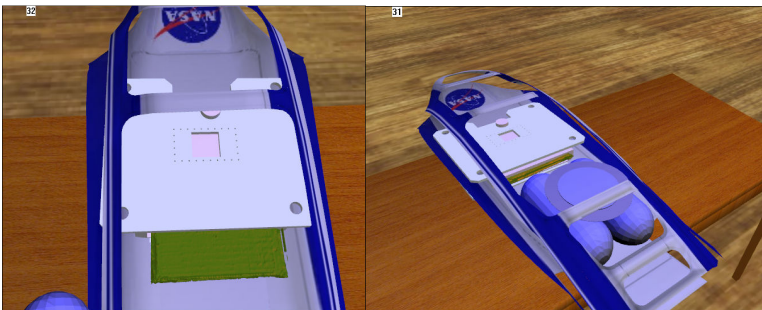
Team Based Interaction

We provide three platforms for viewing the ME:

- **Head Mounted Display for the primary user**
The assembly technician needs the highest level of presence. The position and orientation of the user's head are tracked, giving the most immersive viewpoint into the environment.
- **Magic Lens**
A tracked tablet PC provides other team members with a personalized viewpoint within the ME. The Magic Lens acts as an enabler for communication between the technician and other engineers.
- **Desktop Display**
Remote team members can view the ME from desktop machines connected through the internet.

Task Performance

We conducted experiments with an abstracted layout task, using actual NASA payload models, parts and tools. We obtained both CAD models of the ARES Mars Airplane and real parts used in previous payloads (a circuit board and its docking bay). In our layout task, the user had to position a fuel tank and a circuit board inside the fuselage of the ARES airplane. First, the assembly design called for the user to mount the fuel tank. Next, the assembly design called for the user to insert the circuit board into a slot inside the fuselage. However, the fuel tank blocked the slot, preventing the user from inserting the board. The user was able to detect this, remove the fuel tank, mount the board, and replace the fuel tank.



Left: Inserting the circuit board into the board bay.

Right: A view of the completed assembly.



Left: The technician performs the layout task, while other team members watch with the Magic Lens.

Right: An engineer views the assembly through the Magic Lens.

Project Leaders

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Team Members

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Research Sponsors

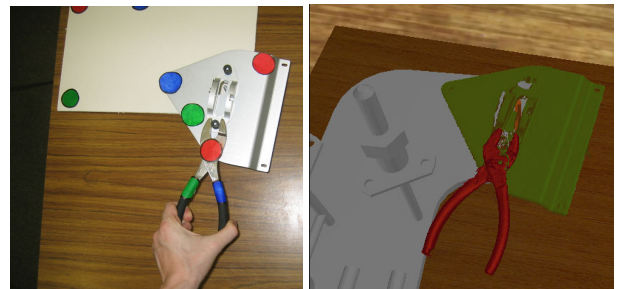
University of Florida, CISE Department
NASA Langley Research Center

Selected Publications

Wang, Xiyong, Aaron Kotranza, John Quarles, Benjamin Lok, and Danette Allen (2005). "A Pipeline for Rapidly Incorporating Real Objects into a Mixed Environment." Proceedings of the Fourth IEEE and ACM International Symposium on Mixed and Augmented Reality, Vienna, Austria.

Wang, Xiyong, Aaron Kotranza, John Quarles, Benjamin Lok, and Danette Allen (2005). "Rapidly Incorporating Real Objects for Evaluation of Engineering Designs in a Mixed Reality Environment", Proceedings of IEEE Virtual Reality 2005 Workshop for New Directions in 3D User Interfaces, Bonn, Germany.

Wang, Xiyong, Aaron Kotranza, John Quarles, Benjamin Lok, and Danette Allen (2005). Enhanced Hybrid Environment---A System for Team-Based Evaluation of Engineering Designs", UF CISE Tech Report 04-012.



Above:

Using a fully articulated pair of pliers to mount a part onto a plumbing assembly from the NASA ARES Mars airplane.

For More Information

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