Furniture relocation by combining the virtual and tangible world

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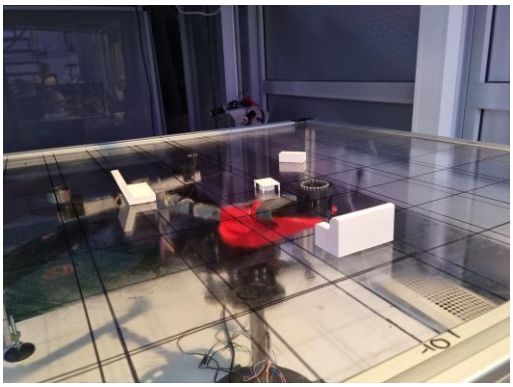
Subject

Developing prototype systems that combine the virtual and tangible world in order to improve the process of furniture relocation.



1 The virtual testbed with some models on top

The VRSI Lab [1] located at the University of Twente wanted to prove the uses of the virtual testbed located there. [2] The virtual testbed is a table with a robot underneath that can move around small models on top of the table. This assignment was offered to show a use case of this testbed. This thesis aims to solve problems with furniture relocation by means of combining the virtual and tangible world. The virtual part can be both Augmented and Virtual Reality, and the tangible part mostly gets fulfilled by a robot partly developed by another student at the University of Twente for his own bachelor thesis. The main research question that aims to fully encapsulate these things is:

“How can a combined system of both the virtual and tangible world improve the process of furniture placement?”

The project is split up into a few pieces to properly come to a satisfying answer to this question. First up a research phase is performed, that seeks to find the problems associated with furniture relocation. For this a questionnaire is sent out. This revealed that a lot of people have issues when moving furniture to a new location. Problems varied from furniture simply not fitting in the desired location, them not quite matching, and other restrictions, such as outlets, radiators, or doors swinging open. Some solutions are also researched that are currently available online. Most of these boil down to either a simple floor plan designer, or a 3D room builder. There are also a few AR apps from IKEA and Amazon for instance, that show you how the furniture that they sell would look like in your room. These are taken into account for the design.

The second part of the project focuses on how such a combined system will look like in order to solve the issues laid out earlier. For this a few key checkpoints were realized. First, the issues laid out earlier in combination with the wishes of the clients form the basis for the requirements. These requirements are then going to be used to create two first designs or concepts, an Augmented

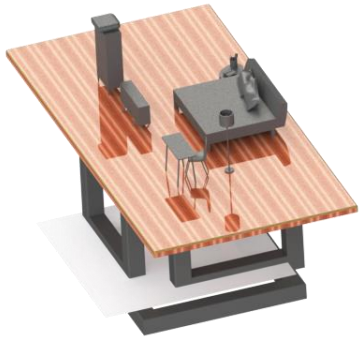
Reality app and a system where a robot mimics the actions performed in Virtual Reality. Both are combined virtual/tangible systems in their own sense, the tangible part of the AR app being the real world. To prove that these designs are viable and could be fully developed, two prototypes are developed alongside as well. These prototypes aim to prove several concepts laid out in the first designs beforehand. Both are developed using Unity [3] since that is a program with a large user base capable of troubleshooting if necessary. A lot of framework for an AR app was already available, so that was worked on first.

2 Concept (top) and a screenshot of the resulting prototype (bottom)

This prototype is able to place down furniture, scale furniture, and measure in AR. This way a user can see how a piece of furniture might fit at another location.

After that, the focus shifted to the system that utilized the testbed. For this, parts of the same code were used to transfer the furniture and room over to a VR world. The current interface for the robot was already developed in Unity, so the next step was combining the two together. Now, the robot mimics the actions of the user in VR. Both prototypes will then be evaluated to figure out what limitations still exist and need solving for the final design. Out of these prototypes, two final designs were also developed. One being the AR app that allows users to place their own furniture wherever they want. The app can also 3D scan to minimize the hassle of adding them to the app. The other is the Virtual Reality program in combination with the robot. This system can be implemented for furniture showrooms, where users can codesign the room together with other people and walk around in the virtual version of the room. Changes in both the virtual and tangible world are being mimicked by the other one. Both the VR and AR systems show that a combination between the two worlds can solve issues with furniture relocation.

3 Virtual room (Photo taken in VR)



4 Concept of the testbed in a furniture showroom

References

[1] Virtual Reality lab | Virtual Reality & Smart Industry lab. (z.d.). Universiteit Twente. Geraadpleegd op 20 april 2021, van https://www.utwente.nl/en/et/vrsilab/virtual-reality-lab/

[2] Damgrave RGJ, Lutters E. Synthetic prototype environment for industry 4.0 testbeds. Procedia CIRP 91 (2020) 516–521

[3] https://unity.com/