Assembly Guidance using Mixed Reality

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1. Background

DIY, or more specifically “Assembling items” are tasks that people often encounter in modern days. Whether is for building a DIY PC or even more common work such as setting up some furniture, this kind of tasks are not that easy for average people. Sometimes, people need better instructions in order to construct correctly. Some articles claim that the current instructions can be confusing or hard to read [1]. Nearly 40% of people deal with an “imagination gap” when comes to the setup of DIY furniture [2].

There are some existing ways using AR technology that tries to improve the current paper manual [3, 4, 5]. These proposed methods are indeed better when compare with simple paper manuals by whether introducing the AR technology with smartphones, using HMDs to setup and read instructions or trying to point out any mistake by monitoring user’s hand movement. However, there are still a lot of improvements can be done.

2. Assembly Guidance

This paper proposes an idea called Assembly Guidance that we think might be one of the solutions for daily assembly tasks. Different from any other existing work, the Assembly Guidance can provide functions such as guidance creation support, hands-free experience, intuitive instructions and good interactions. (Figure 1)

In our research, we tried to use Mixed reality. With the help of MR, merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real-time becomes possible [6]. In our system, we convert tradition text instructions into more understandable and intuitive virtual objects. A virtual object can be a virtual component indicates what user needs in this step, a virtual arrow mark shows where and how a user should use the screw, or a 3D virtual model indicates what will be like when finished. Therefore, it is much easier to understand compare with text instructions.

Other than traditional manual or instruction, our idea is to make an Assembly Guidance which can provide interactions between the user and the system. Instead of just showing the steps, we think to be able to monitor the progress of user and avoid mistakes is a very important point.

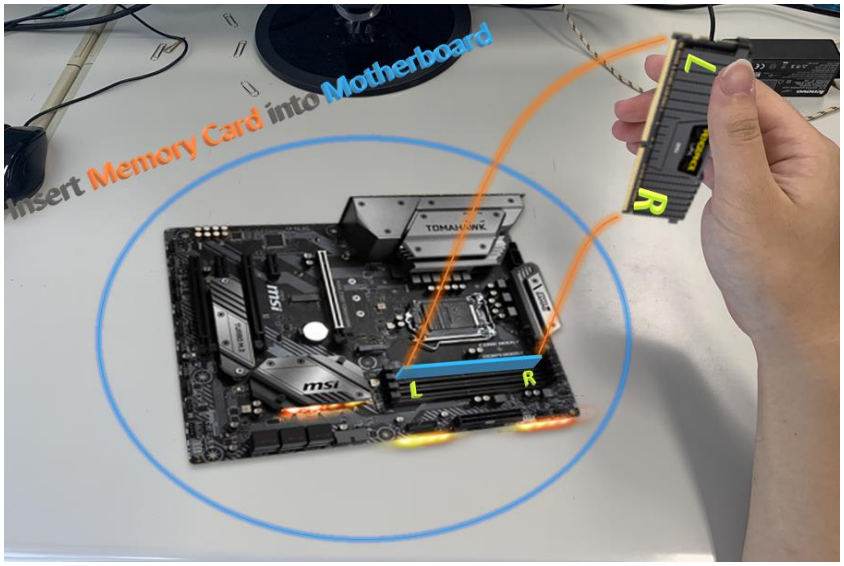
Different to any other solution that exists, our proposal can achieve the following functions.

I. System can automatically generate the steps and sequences
II. System can provide intuitive instructions instead of texts.
III. System can interact with the user by object recognition and gesture recognition technique.
IV. System can support a hands-free experience.

For the above reasons, the Assembly Guidance can be considered as a relatively new and effective solution for daily life.

3. System design

In our system, we use a Microsoft HoloLens as the display and main recognition device, combining with a



System ask user to “insert memory card into motherboard” in Assembly Guidance

Figure 1: Overview

Leap Motion sensor as an alternative recognition device. Furthermore, a PC is required which acting as a server and we use Unity as the development platform and engine of this research.

Microsoft HoloLens is a good hands-free MR HMD that also support object recognition function through its built-in depth sensor. However, our system is designed to achieve good interaction by both object recognition and gesture recognition. Because the limitation of HoloLens's sensor, an extra Leap Motion sensor is added only for recognizing the user's gesture and hand movement.

3.1 Interface for creating guidance

The creator only can upload the 3D model of all essential objects and set up how things can be attached together with specific tools.

3.2 Automatically generate the sequence

The system will automatically generate the step sequence by following certain algorithms. Data such as a 3D model of objects, 3D arrow, 3D mark, highlighting effects etc. will be combined into 3D animations that ready to be played.

3.3 Spatial understanding and Object recognition

The built-in sensor of Microsoft HoloLens can extract and analyze different vertical and horizontal surfaces by applying Spatial Understanding Library to a meshed space. We use Vuforia API for object recognition, then the system can attach the 3D animation from 3.2 into specific real-world objects.

3.4 Gesture recognition

The sensor of Microsoft HoloLens can only specify a certain simple gesture. However, this system requires the ability to read whether the user is using tools in the right way. We introduced a Leap Motion sensor which can simulate the user's hand skeleton and support complex gesture. The Leap Motion sensor will synchronize the coordinate of hand skeleton with HoloLens and provide recognition result, while the HoloLens is mainly focus about positional data.

3.5 Progress monitoring for avoiding mistake.

The sensors are constantly checking the status of the user, such as whether the user is using the correct tool or whether the user is performing the action in the right way. Virtual marks or warning messages will be shown if the user doing something wrong. (Figure 2) In addition, user can check the current progress in this system.

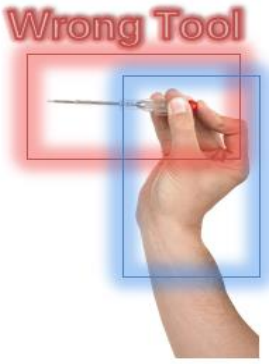


Figure 2: Warning message

4. Conclusion

This paper proposed a new approach to enhancing the experience for daily assembly tasks with Microsoft HoloLens, offering a Hands-Free experience while performing the work. By using the see-through type MR HMD, we think that intuitive 3D guidance other than traditional texts can give a better understanding for the user. Furthermore, this system can recognize and track the tools or the items for assemble, which can provide the function of monitoring the user's progress and interact with the user.

References

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