The Future - Integration of Real and Digital World

Kiran C Shettar (Author), (M.Sc.,) Dept. of Computer Science
University of Massachusetts, Lowell, MA, United States – 01854
KShettar@cs.uml.edu

***Abstract*—Augmented reality in the field of human interaction has been a most attractive concept in the recent past. Integrating human interaction with gesture detection techniques having physically activity like grabbing, dragging, dropping etc. creates a user experience which is intuitive. AR-based natural user interface goes one step further by enabling the contents of the interface to switch domains from a virtual instance in Augmented Reality to a physical instance in the real-world. All instances stay associated and changes made to the physical instance will be reflected on the virtual one. There is a huge contribution of digital world in the real world that we are going to see further.**

I. Introduction

In computing, a natural user interface or NUI is an interface that is effectively invisible. A NUI will help a person in such a way that he will turn from a novice to an expert in short time. Even though the new interfaces require learning, it's eased through the design which would make a user feel that he's comfortable enough and successful in adapting to the new features. The history for the user interface goes as follows – 1. CLI – Command-Line Interface, 2. GUI – Graphical User Interface and 3. NUI – Natural User Interface.

We have been hearing that people are adapted to use the Keyboard and Mouse as the source of inputs to the machines since 19th century, which has increased dramatically in the recent past and is the most common way of user interaction with a machine. Recently, from 1970's we started using touch/multi-touch as the source of input to the machine, like multitouch laptop screens, multitouch mobile devices, watch, touch-buttons and many more. Then comes the arm gestured gaming consoles etc., which has been introduced recently. All these things that are used as a source of input to a machine are summarized under the term natural user interface or NUI.

There are some problems that remain with this insight. One of the major problems is, whenever users switch between multiple electronic devices to overcome the limitations of using a single device, they must adapt to a new method of interaction. During this process, they must go through a User Guide as they want to use a new device.

In our system, we want to overcome the problem of adapting to new technology/device which most of the people are facing in our day today life and this can be resolved by offering a natural way to switch between several devices and domains. For a better User Interface, we are going to make things much easier by using Augmented Reality (AR) where it can detect the gaze, gesture and voice commands. And, the user can listen to the machine via it's in-built sound speakers which would be very helpful for the interaction.

II. System description

A. Implementation

The implementation of a CNUI has a 3D gesture interface, a multitouch-interface, and a paper based instance. Here, we will be using a paper that can be transferred into a virtual interface. A camera placed on the top of a paper, will be used to capture the sheet. A different object can also be used in place of a sheet of paper. For the device continuity a touch table is connected so that the user can move the sheet of paper in multiple directions. The content is inserted into the corner of the table we are using. Then, the user can then access it from there. After some time, the content disappears thinking that the user did not remove it intentionally.

B. Description

The major part of the system is AR-based 3D hand gesture interface for all possible actions with the real-world objects. Using the hand gestures, the user can interact with the object like selecting parts of the object just like how we do it on devices like Microsoft HoloLens. User can pull information by 'grab' and 'move away' hand gestures. The gestures being used in the system are like pointing, grabbing, dragging, and dropping to interact with the virtual paper. For the hand gesture detection, an extension of hand posture classification is being used here. There are two fixed cameras, one above the table, and the second one near user's head location.

As you place the virtual piece of paper, the content of the virtual piece of paper is printed in an Anoto pattern where the user can take real-world instance and he can use the grab-and-pull procedure. By doing this a consistent look and feel of a real paper can be achieved.

What's an Anoto pattern? The Anoto pattern activates a respective optical pen to identify the piece of paper and it precisely locates the pen's position on the paper during handwritings. This pen is equipped with wi-fi. A paper can be transferred into the virtual interface in a similar way.

C. Demonstration

To demonstrate how a continuation between devices could look like, a touch table is connected to the system. To transport a virtual sheet from the AR-based interface to the touch table, the user just moves the sheet out of the demonstrator in the direction of the table while the content is still being grasped. At this point of time, the content is inserted into the touch table at the corner, closest to our demonstrator. The users can then

access it from there else it'll disappear after a short period of time, if the user did not remove it intentionally.

Basically, the entire process could be explained as - A sheet of paper is placed on the table, then the sheet is captured by the camera placed above the paper when it's put up on to the table. Once the content is printed on it, then can be picked up from where it's as a virtual instance within the AR-interface. At the end, this can be demonstrated as an object.

III. Concept

CNUI is an extension of natural user interface. By keeping the continuation, it helps the user in keeping the complexity low.

During the paper based continuation (using it in the system designed) there are some additional advantages. 1) Even though there is lack of electronic infrastructure, the interface is present. And, 2) A paper is a hard copy where you can sign and submit.

Continuous natural user interface can be felt in the system for the following reasons

- Domain continuous – Content is transferrable in the real world
- Device continuous – Content can be transferred between connected devices
- Interaction continuous and consistent – The way of interaction remains constant when switching between different domains and devices
- Content centered (Non-Interface centered) – Object oriented user interface
- Ubiquitous – Interface can be extended to real world objects like paper and other
- Natural – Interaction is oriented on real world objects

IV. User study

An investigation has been done on how quickly users adapt to the new interface and how fast a task can be accomplished with the use of hand gestures. There were three major comparisons. Namely, Solution performance, using mouse with same type of interaction, using mouse on a standard graphical user-interface.

A user study with a group of 15 probands is done that had 10 females and 5 males at an average age of 25. None of the probands had any experience with the device. The study also included three well trained users of the system and separate results were achieved.

V. Experiment and Questionnaire

There were three different interaction approaches that were taken care of and the users were asked to accomplish the task of querying and printing information from a real-world object.

- Gesture-Interface Solution: This solution is from the new system designed. Some Parts of the industrial pump were chosen. Probands had to use the gesture control and aim at the devices.
- Mouse-Interface Solution: The same steps as in Gesture interface solution had to be performed by the same Probands this time but the only difference was they'd to use the mouse instead of gesture.
- Graphical User Interface (GUI): The Probands were made to print a page in a .pdf file from scratch using Windows Vista operating system.

The steps performed in these three tasks were very similar within each interface. Like pressing a key, pointing at some object, double clicking, dragging etc.

All the experiments performed here were first demonstrated by a user. After the experiments, users were given a set of questionnaires to answer.

VI. Results

Most of the users in this experiment completed the task using the gesture interface on the first or second attempt. They did not face any issues while operating the user interface.

After considering the overall test results that were carried out for a maximum of 3 minutes, we could conclude that the gesture-interface gave much better results when compared to GUI-interface for both trained and non-trained users. We could also observe that gesture-interface gave better results than mouse-interface for trained users.

Most of the users chose GUI as very intuitive and liked using this interface compared to any other user-interface where the results were poor. Very less people mentioned that they would prefer using the gesture-interface.

VII. Conclusion and Future Work

Here we have presented the natural user interface concept that follows continuous user experience approach of connecting devices with real world objects like paper. The major thing in our system is a 3D-gesture control interface for getting information from real world objects. A touch table and the paper is used here to demonstrate this model.

Future work includes things like testing and implementing this system in the industries. To get better results, a long-term study is required. More gestures can be added to the system and can also be tested on different real-time objects apart from the paper. The test we conducted with the help of Probands with the three different interfaces was only for 3 minutes. This process can be enhanced in future where the test will last longer.

Acknowledgement

This paper was re-written as a part of Computer Graphics 2 course at the University of Massachusetts, Lowell, MA

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