Creating Multimodal Interactive Environment Using Augmented Reality and Natural User Interface

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Abstract –Human-computer interaction (HCI) is one of the most important issues when designing any real-time interactive system. An ideal augmented reality system must be able to combine the virtual information with the real information in a user friendly way as well as allow users to interact with the system naturally. The main objective of this article is to explore the multimodal augmented/mixed reality interfaces when designing innovative applications along with the use of Natural User Interface.

Keywords – *Natural User Interface, Augmented Reality, Gesture based Interface, Human Computer Interaction, Headset and Smart Glasses, Multimodal Interaction System*

I. INTRODUCTION

The term 'Natural User Interface' was introduced for the first time by Steve Mann in 2001. It was defined as "the use of wearable computing or of physical matter (solid, liquids and gases) as direct user interfaces for metaphor-free computing".

Boeing researcher Thomas P. Caudell coined the phrase 'augmented reality' in 1990 to describe how the head-mounted displayed that electricians used when assembling complicated wiring harnesses worked. The first properly functioning AR system called Virtual Fixtures was developed at USAF Armstrong's Research Lab by Louis Rosenberg in 1992. It was an incredibly complex robotic system which was designed to compensate for the lack of high-speed 3D graphics processing power in the early 90s.

II. NATURAL USER INTERFACE

Natural User Interfaces' allows the user to interact with computer systems in natural and direct way by using their whole body or a part of the body. These interactions can be done with the use the technologies such as touchscreens and motion-sensing controllers. The interaction here is said to be direct because the user operates the contents displayed on the screen with their own body without the requirement of any intermediate hardware such as a mouse or a keyboard. In NUI interactions can be done by certain gestures, using body language, contiguity, position, input type (audio or visual), eye direction and movement, expression, smell, object location and touch. It can be operated in different ways, depending on the user requirement, specification and purpose.
The main features of NUI are -
- Familiar context must be designed keeping in mind the user perspective

- No need for intermediate devices for interaction, i.e. interaction between user and machine must be direct
- It should imitate real world interactions (by using augmented reality or mixed reality)
- The interactions should be enjoyed by the user.
- The mode of interaction must be easy to learn and should use pre-existing knowledge.
- The interactions are consistent with our natural behaviour.

The input and output devices that can be used for NUI are –
- Touchscreen –
  A display screen that can be interacted by touching its screen with finger or stylus; User can touch the exhibited pictures or words on it for interaction with the device.
- Motion sensing control or Motion detector –
  A device that detects the movement of the object; It is integrated as a component of a system that automatically performs a task when motion in the specified area is detected.
- Speech recognition system –
  A device or software program that identifies the words or phrases spoken, and decode it; It can be used to operate the devices using just voice.

The natural User Interface can be divided into following types –
- In air Gesture Interface – This interface can recognize different types of interactions in distance
- Tangible Tabletop Interface – This interface allows the user to interact with physical objects kept on a table
- Touch Gesture Interface – It is further divided as –
  o Single user manipulation, which requires only two points of contacts

o Single user gesture, which requires a small number of points of contacts
o Multi user gesture, which requires a large number of points of contact

The common method to interact with Natural User Interface is by using gestures. These gestural interfaces are based on a regular command gestures and its purpose is to create a set of guidelines for using the system rather than creating one definite type of user interface. These guidelines provide users with usual ways to interact without learning or training for specific gesture. These systems track the user motions and then translate them into instructions for further processing.

The advantages of using gesture-based interaction design are as follows-
▪ It provides a simple and interesting user interface
▪ It is easy to understand and use.
▪ It provides user new experience and great pleasure.
▪ It makes the communication between human and computer more natural.
▪ It is widely used in various application areas as it gives the user a new experience of feeling.

According to Dan Saffer, Director of Interaction Design at Smart Design and the author of four books: Designing for Interaction, Designing Gestural Interfaces, Designing Devices, and Microinteractions, the NUI has 12 principles –
1. Design for fingers, not cursors
2. Have always in mind the physiology, avoid repetitive task
3. Reduce Gorilla Arm Syndrome caused by excessive use of touch sensitive screen
4. Screen coverage in such a way that all elements are clearly visible
5. Be aware of the technology used for interaction
6. Always have in mind that the more challenging the gesture, the harder the interaction and functionality
7. Function activation should be On Release, not on press
8. Affordance, i.e. gestures should be obvious
9. Avoid the involuntary activation of actions
10. Gestures and common keys should be simple and easy to use
11. Same functionality can be accessed through different, but similar, gestures
12. Define the complexity of the gesture according to the complexity and the frequency of the task to be executed.

III. AUGMENTED REALITY (AR)

Augmented Reality is the interaction of digital information with the user's environment in real time. It mimics the existing environment and overlay new information over it (if required) rather than creating an artificial environment as done in virtual reality. Since the user is used to of the real world and this real world cannot be replicated completely and

accurately by the digital system, so AR builds this real world by augmenting it with the computational capabilities. The main properties of AR are –
▪ It combines real and virtual objects in a real environment
▪ It runs interactively and in real time
  The displays that can be used for AR are-
▪ Head-Mounted Displays
▪ Hand-held displays
▪ Ambient projections
▪ Hand-held projectors

The two major device forms of AR that are being used are Headset and Smart Glasses. Headset is a head-mounted specialized display device used to provide a simulated visual environment through physical display optic lenses. It allows the user to see both a digital display and the world through the glasses. It provides the same reality-based environment that can be seen through the naked eye, and adds visual simulation or information to provide an enhanced view to the user. Smart glasses are wearable computer glasses having the ability to change their optical properties at runtime. The smart glasses use some type of transparent display that allows user to see a small floating screen displaying information. They're capable of sensing the surrounding around the user and represent information in such a way that it feels like it is actually present in reality rather than just projected onto a transparent screen.

Some of the AR apps are –

Augment	AR Browser SDK
Sun-Seeker	Pokemon Go
Argon4	AR GPS Compass Map 3D
Real Strike	AR GPS Drive/Walk Navigation

IV. COMBINATION OF AUGMENTED REALITY WITH NATURAL USER INTERFACE

Augmented reality can augment the universe around us and fetch any information by just using contact lens and glasses. This new and unique interface won't be confined to a tiny screen, but moved to a bigger 3D world. For instance, a system that consists of an auto visualization and natural interaction uses special sensors to track the movement of users' hand and fingers. The user location along with front view was captured by the camera and the system tracks the user's movements and it allows users to interact with the virtual world with their hands. For interaction purpose, the system draws two virtual hands in the position of user hands on the screen, so the user can quickly understand that the way to interact with the system is using their own hands. These hand gestures provide an effective and natural way for Human-Computer Interaction (HCI). By combining speech and gesture input, we can create multimodal interfaces that allow users to interact more efficiently and enhances user interaction.

A real time mixed reality is created by combining augmented reality with virtual reality, i.e. the elements of a direct or indirect view of a physical real-world surroundings are combined with virtual elements. A combination of augmented reality device and ordinary tablet or smartphone to connect the users on either side to enable mutual service is achievable. This augmented based reality incorporated with natural user interface can be used in various areas including engineering, medicines, architecture, entertainment along with video conferencing and path planning /navigation. The custom-built multimodal interface offers access to any type of information in real time environments.

V.   CONCLUSION

Augmented reality is the general design strategy behind "Natural User Interfaces". A system with a NUI supports the combination of real and virtual objects and allows the user to interact on the working area in direct manipulative way. To make the user experience best with augmented reality applications is by making it multimodal. For making the multimodal interaction system, multiple on-body input and output device like a speech-based dialogue system, a head-mounted augmented reality display (HMD), and a head-mounted eye tracker can be combined. These combinations can make the interaction fast and effortless for the user.

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