A mixed-reality-oriented eCommerce customer interface

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Abstract: - Current eCommerce technologies cannot provide enough information on products offered like physical dimensions, color. There exists incongruity between the Internet-based worlds and customers' real environment. Mixed reality (MR) technology can help for reducing this discrepancy. MR implementations often require bulky infrastructures and/or laborious installations. An easy to use MR system is proposed. Relevant guidelines for study and design of MR-oriented eCommerce customer interfaces are defined. MR customer interface implementing these guidelines will allow the customer to easily grasp and manipulate three dimensional (3D) products on their computing environment which may significantly increase retail sales.

Key-Words: - eCommerce, Business-to-customer, Mixed reality, Interface, Three dimensional, Usability

1 Introduction

Three-dimensional customer interfaces (3D) allow customers to interact with virtual objects, environments, or information using direct 3D input in the physical and/or virtual space [1]. The term "3D interface" is used to describe a wide variety of interfaces for displaying and interacting with 3D objects. With the exception of games for which technology and usage are quite mature, 3D systems are still essentially in a period of innovation with widespread experimentation. True 3D interfaces i.e. interfaces with all its components in a 3D environment have not yet had any major impact outside the laboratory. The interfaces nowadays referred to as 3D graphical user interfaces are almost exclusively "hybrids" between 2D and 3D interfaces. Hybrid interfaces are may be more efficient than either purely 2D or 3D interfaces [25].

The development of electronic commerce has been constrained by the inability of online consumers to feel, touch, and sample products through web interfaces, as they are able to do in conventional in-store shopping. This limitation can be partly alleviated by providing consumers with virtual product experience, to enable potential customers to experience products virtually. Its two dimensions identified are: visual control and functional control. Visual control enables consumers to manipulate Web product images, to view products from various angles and distances. Functional control enables consumers to explore and experience different features and functions of products. The visual and functional control increase the consumer overall perceived diagnosticity and flow (i.e., the extent to which a consumer believes the shopping experience is helpful to evaluate a product) of their corresponding attribute factors [13]. Case studies prove that interactive 3D graphics have the ability to increase the productivity of online businesses.

The human-computer interface can be enhanced by incorporating virtual reality (VR) with 3D visual and audio displays to enrich the Web shopping experience [19] or by creation of 3D virtual reality web application architecture [27]. Second Life is the fastest growing avatar-based 3D virtual environment, as well as a promising media channel for marketing and advertising. Spokes-avatars are increasingly used as company (brand) representatives, personal shopping assistants, conversation partners, recommendation agents, and persuasion agents in such virtual environments [14].

In the following 3D and mixed reality user interfaces will be analysed in relation to their applicability to eCommerce. An MR customer interface and relevant guidelines for its design will be presented.

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2 3D User Interfaces

Companies such as Sharper Image Inc. have seen their online number of visitor augment by 300% after placing three dimensional models for some of their products on their website. Visitors stayed 50% more time in the 3D area. This increase in visitors generated a significant increase in revenues; the profit went up to $30 million, compared to $4.9 million the year before [6].

As 3D display technologies improve, 3D interfaces will play an increasingly important role in the areas of design and interaction, where traditional interaction modes (e.g. keyboard, mouse) may not be as appropriate or intuitive. Product designers and engineers could more naturally design and visualize future products with the appropriate 3D interfaces. The research in the area of Augmented Reality (AR) increased significantly in the last 10 years [2].

A central problem for three-dimensional interaction is that of virtual manipulation, which concerns the general problem of grasping and manipulating computer-generated 3D virtual objects. Virtual manipulation includes tasks such as specifying a viewpoint, planning a navigation path, cross-sectioning an object, or selecting an object for further operations (cf. Figure 1).

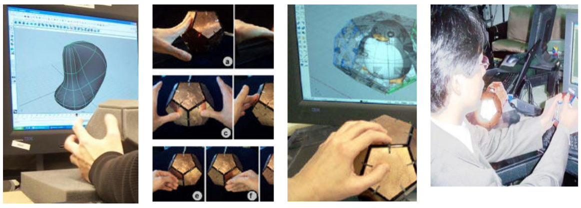

Fig. 1: Virtual manipulation iSphere [17]

The interface design challenge is to find ways that real and virtual objects and behaviors can be mixed to produce something better than either alone can achieve. Part of this challenge is to discover interaction techniques that do not necessarily behave like the real world, yet nonetheless seem natural. This leads to a key point: to design interaction techniques which meet these criteria, short of taking wild guesses in the dark, the interface designer needs to understand the human. Virtual manipulation presents tasks with many degrees-of-freedom; using both hands can potentially allow users to control these many degrees-of-freedom in a way that seems natural and takes advantage of existing motor skills. Even though users can hardly grasp computer graphics directly, appropriate physical control devices can achieve correspondence of the input activity to the resulting motion on the screen. The Globefish, for example, provides a 3D trackball for rotational input (cf. Figure 2).

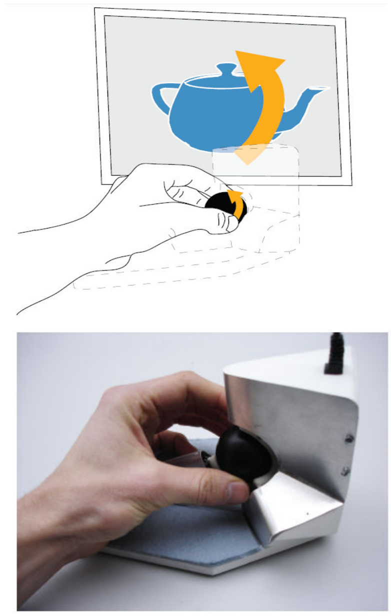

Fig. 2: 3D (top) interaction [15] and Globefish (bottom) [16].

3 Mixed Reality User Interfaces

The mixed reality (MR) environment is one in which real world and virtual world objects are presented together within a single display, that is, anywhere between the extremes of the Reality-Virtuality (RV) continuum (cf. Figure 3). Encompassing both Augmented Reality (AR) and Augmented Virtuality (AV), the MR portion of the RV continuum covers essentially the entire breadth of the spectrum, but also excludes the end points [20].

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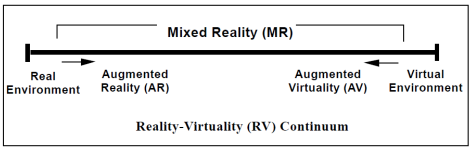
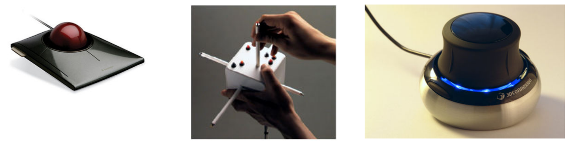


Fig. 3: Simplified representation of a RV Continuum [20]

By using a number of different approaches, technologies and interaction paradigms, a MR system should sufficiently overlay physical and virtual environments to varying degrees [21]. It involves the integration of the physical and digital worlds in a smooth and usable way. However, their specificity is to stage a form of fusion between real and virtual worlds.

Here the MR display system is distinguished by the nature of the underlying scene, how it is viewed and the observer's reference to the viewed object. The surrounding environment is principally virtual, but mixed through the use of a real object. This mixed reality forms a partially immersive environment. This MR class of display uses the real objects, such as a pen/pencil, to be introduced in a principally graphic world in order to point at, grab or manipulate a virtual scene object. The display concepts used to classify this mixed reality environment is partially immersive MR systems, which allows real-object interactions, such as 'holding' and 'rotating' with one's own (real) hand.

One promising research direction for exploiting tangible input devices' physical properties is to toggle interaction modes on the basis of the device's spatial orientation and performed gestures [3], [24]. It is also possible to assign such mode changes through explicit switching, but basing them on how the user holds and operates the device implicitly provides user awareness. Instead of forcing the user to mentally keep track of frequently adjusted system states; this approach exploits context information that the user already has from passive haptic feedback of the input device.



Trackball Mouse | Cubic SpaceMouse | SpaceNavigator

Fig. 4: 3D motion controllers

Devices shown on Figure 4 feature different ways for user 3D manipulation tasks, but for eCommerce are only applicable if the customer uses the device for online shopping.

4 MR-oriented eCommerce

Conceptually, 'virtual experience' has been defined as "psychological and emotional states that consumers undergo while interacting with products in a 3D environment" [18]. Virtual experience may have advantages that have previously been associated with both direct and indirect product experiences. Direct experience has been defined as "an experience that stems out of an unmediated interaction between the consumer and the product, with a person's full sensory capacity, including visual, auditory, taste-smell, haptic and orienting" [7] and is thought to cause consumers to have greater confidence in their product choices [10]. In contrast, indirect experience stems from symbolic representations of the world experienced through communications with others and mediated representations of the world presented in books, magazines, and television.

Indirect experience is believed to result in less affective responses and thus be less effective in changing attitudes than direct experience [22]. However, providing consumers indirect experiences through media have traditionally been one of the easiest and cheapest ways to persuade large audiences with commercial messages. Virtual experience is beneficial because it has the common factor of interactivity [10], yet it is a mediated experience [8] that can be provided to large audiences. Virtual experience may be able to enjoy the advantages of both direct and indirect experiences [5]. In fact, [18] found that virtual experience created by 3D environments was much better than indirect experience created by

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traditional media in facilitating learning. [9] proposes that the novelty of 3D products heightens situational interest, increases involvement, and results in a favorable attitude toward the experience.

Allowing customers to 'touch' and 'feel' in the virtual world can be extremely powerful, especially for object manipulation. During the last years, eCommerce, and online shopping in particular, has known a strong popularity and rapid growth. As we move from a 2D world to a 3D world, the opportunity for aligning virtual worlds and eCommerce emerges with even greater potential.

For consumers, eCommerce is currently the most successful application for 3D. Internet shoppers have been reported to spend 50% more time in the part of the site that offers interactive 3D images. Experiments concluded that interactive 3D graphics have attracted more customers on the Web. [4] conducted several experiments to examine the effects of interactive 3D product presentations on buyer behaviour. The results show that with the availability of 3D product presentation, instead of still images, buyers tend to spend a greater amount of time viewing the products, and that there is a higher likelihood of purchase.

5 MR eCommerce Customer Interface

The means by which one can depict virtual objects using graphic techniques which are of sufficiently high quality to make those virtual objects appear real is of high importance. [21] proposes a taxonomy for mixing real and virtual worlds. Reproduction fidelity which refers to the relative quality (shading and texture) with which the synthesizing display is able to reproduce the actual or intended images of the objects being displayed, and the metaphor of 'real-time imaging' by which the observer's sensations are ideally no different from those of unmediated reality [23], is of great significance when developing MR eCommerce customer interfaces. In more complex virtual reality software, such as Second Life, or 3D modeling software and 3D animation software, the customer needs to have diverse controls of all aspects of 3D world, including walk-thru, same in first-person-shooter, and fly-thru, same as in flight simulators, and view mode same as in panorama application, and object view same as in 3D Model applications. In viewing 3D-models, the customers are not so much concerned about yaw, pitch, roll as in driving a plane, but rather, customers want to focus on their object and be able to rotate it, zoom in/out, and sometimes pan. Typical applications are rotating molecules models, math surface plots and product 3D view.

We propose an effective 3D customer interface based on free-space interaction. By 3D interaction interface customers can manipulate virtual objects by moving real-world tools or 'props.' The design of such interface should be informed not only by knowledge of the capabilities of the human sensor motor system [12], but also by the way in which 3D tasks are conceptualised. Customers perform many manipulation and navigation tasks without conscious attention. It is this level of naturalness and transparency which virtual environments seek to attain — the interface almost becomes invisible when we can manipulate the virtual objects as if they were really there. This interface should be natural and effortless for the customer and thus good MR customer interface usability is expected. The underlying design principle [11] is that "the structure of the perceptual space of an interaction task should mirror that of the control space of its input device" (cf. Figure 5).

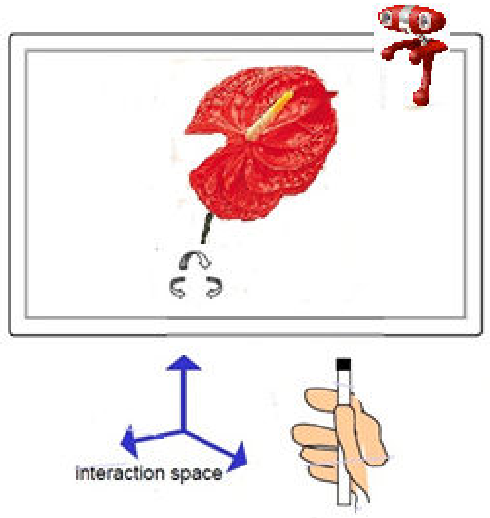

Fig. 5: Free-space 3D customer interface

We propose the following guidelines for study and design of MR-eCommerce customer interfaces:

1. Combine the physical and digital worlds in ways that amplify positive customer experiences. MR interface should have direct real-world analogues. Customers should employ real-world perceptual and action skills to work with objects in the MR world intuitively noting the limitations to the level of intuitiveness which could be reached.
2. Use of 'hold in hand' scenario for MR-based systems which allows control via manipulators. The MR customer interaction technique should fully integrate the input device actions in the MR world by integrating interaction algorithms and by giving better feedback than regular desktop UIs.
3. MR-based system should mimic known interaction techniques, for example, the sensation that the mouse and cursor are connected, a sensation that is easy to learn and equally hard to forget.
4. Interaction device should visually suggest its function, contrary to mouse usage where the mouse has no visual affordance that it is a pointing device.
5. The customer should not be allowed to switch between fine and gross motor skills too often.
6. The MR manipulation technique should allow straightforward object manipulations with continuous visual feedback. Even though it is natural for the MR system not to produce a full, physical MR replica of the object, it should still evoke the effect for the customer as if observing and interacting with 'believable' and 'significant' MR object(s) floating in space.
7. MR design should take into account the 'lack of precision' of the human perceptual and motor skills in viewing and other mixed reality-based interaction techniques. It should allow the customer to use skilled hand-eye coordination to inspect the object and manipulate parts of it in a natural way with a structured integration of flow of control and interaction.
8. MR applications should have very flexible redesign and development environments.
9. Provide sufficient reactivity to customer's commands. The systems fluent reactivity is very useful when combined with 'intuitive' CI. The MR CI should provide a more intuitive, interactive exploration with enhanced viewing and interaction mechanisms.

6 Conclusions

MR eCommerce customer interface implementing the above design guidelines will contribute to more customer retention than ordinary eShops. As visitors of a MR-shop are more likely to spend more time looking at items, there is also more chance that they will look at items they may not have intended to look for when they entered the shop. MR-shops give customers the impression of being "emerged" in the world. Customers are "transported" from their familiar Web environment, where from a mental point of view it may be more difficult for customers to navigate away from the shop once they are in it.

Customers cannot only contemplate the displayed products from every angle but, depending on the possibilities of the application, they could also alter some of their features (like color or size) and immediately see the results of their actions [26]. This facilitates product selection and customization, for example, the application could offer the possibility to display some flower bundles together, e.g., in a virtual garden. Customers would then be able to visualize how a specific combination of flowers would look like and customize the bundle to suit their needs. They would also have the possibility to rearrange the different flowers according to their taste, for example, different flower sizes/colors per basket, and choose the best combination according to their needs and taste.

Further applied research is required to ascertain from a customer's perspective/usability, whether MR eCommerce customer interfaces can offer advantages compared to their counterpart 2D and 3D ones.

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