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Exploring the Use of Mixed-Reality for the Design& Innovation of Future Ubiquitous Devices & Intelligent Environments

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***Abstract*—The ever evolving range of user centric technology promises new and exciting applications which will permeate society and change the very nature of our social interaction. The increasing demand of collating our physical and digital lives is putting pressure on companies to come up with innovative products. Companies have to plan far ahead into the future, despite lacking the technological infrastructure. In this paper we describe the goal of a research project that, together with Intel, is investigating tools and methodologies which would allow companies to plan into the future by building online virtual prototypes. Real users, from different domains, would use these virtual prototypes to test different aspects and attributes of these potential products to provide relevant user-experience feedback. The feedback would be recorded in an automated and intelligent manner to improve the design. Developing prototypes in such mixed reality environments would enable the involvement of end users from early on. We believe such an approach would allow for better design innovation by providing mechanisms for collaborative research and development across distributed geographical locations. This short work-in-progress-paper will describe the concepts underpinning this research direction.**

Keywords-component; Virtual Prototyping, Design Evaluation, Human Factor

I. INTRODUCTION

The rapid proliferation of user centric devices in our daily lives is shifting our social interaction in to the digital world. Increasing processing power and information capabilities is putting pressure on IT companies to roll out new and improved devices constantly, to stay ahead in the market. Companies have to envision products that will integrate with the society in the next ten to twenty years [1]. These plans undergo a rigorous research, design and development regime to ensure efficient manufacturing processes. Customer polls, user opinion surveys, peer market reviews and other feedback techniques are employed to keep a reality check. However, the technical, physical and financial challenges make it next to impossible to produce functional prototypes at an early stage. This delay causes the detachment of stakeholders and end-users from the project until the time that significant resources have been spent and, at which point, reiteration is expensive both in terms of cost and resources. The sheer number of planned devices and models coming out makes it more difficult to do an in-depth market analysis for every prototype. It is often only when these devices hit the consumer shelves that the actual test of their viability comes into play. Usability in real environments proves to be the key factor for success.

Virtual prototyping is already employed by companies to improve resource utilisation. CAD based tools are used to design and simulate the products without building the physical mock-ups [3]. For example, high investment systems such as aircraft designs are routinely prototyped in simulators before being built. However, traditional CAD based designing techniques have many limitations. These stand alone software CAD packages might be suitable at the architectural design level, but restrict end-user and other stake holders' involvement. Furthermore, collaboration becomes a challenge when the design teams are geographically distributed.

In this paper we present an outline of our mixed reality product prototyping project. The aim of our project is to enable better product design for future ubiquitous computing gadgets by utilizing the potential of augmented virtual environments.

II. PROJECT DESCRIPTION

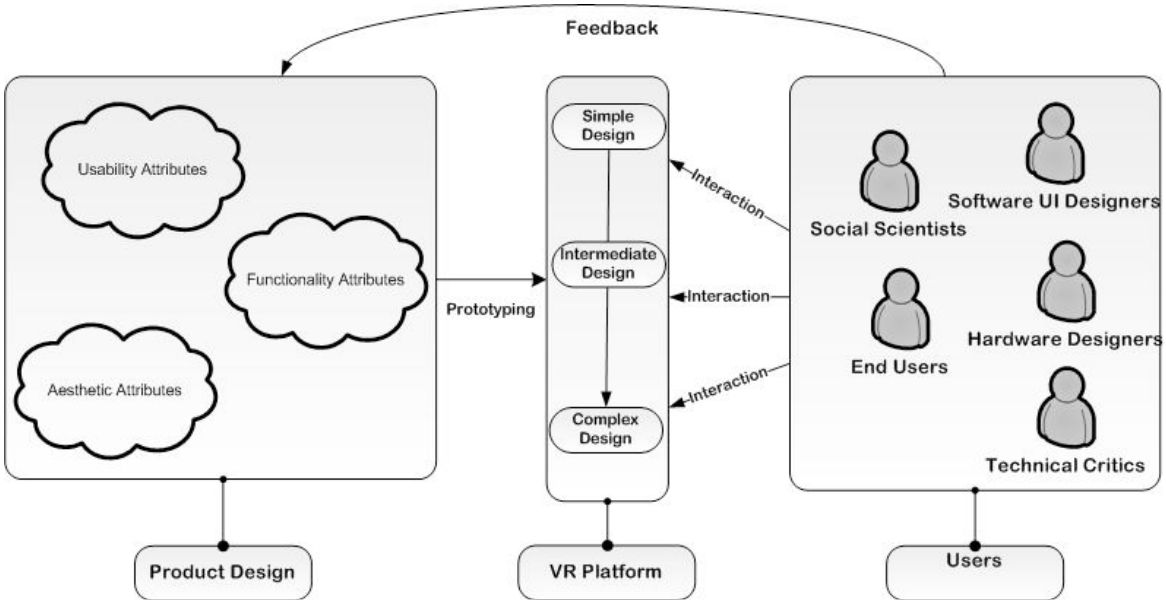

Figure 1: Three Stages of Virtual Prototyping.

The success of consumer products is still determined by the sales figures and return on investment. Even a highly sophisticated technological product might fail as the aesthetics might be wrong or it was marketed to the wrong audience. On the other hand a device may prove to be a big success because of the usability rather than the functionality. Market success involves many factors other than the product usability and aesthetics. The approach employed by this project we will enable product designers to keep a focus on the design issues for such devices by using better end-user involvement. In our approach we divide the design process in to three stages, as shown in Figure 1, which can run in parallel. The user feedback will be used to improve the design.

A. Identifying Future Attributes

The first stage of our project is to identify key product attributes, both functional and non-functional, for designing the user centric devices. As the prototype is going to be created in Virtual reality, any technological limitations can be compensated for. Clearly, in contrast to long-term product design, for near future products, it is easier to characterize their attributes based on the current technological trends, abilities and limitations. Thus, defining attributes for the future products can prove to be a challenge.

We will be exploring three aspects of product design namely usability, functionality and aesthetics. Usability and functionality are closely related and complement each other. Research in HCI and tangible user interfaces is bringing natural action closer to the digital world. Ubicomp is shifting the traditional use of appliances to enhance context driven HCI. Intelligent environments, such as smart homes, monitor user actions to create models of human behaviour that can assist HCI by providing pre-emptive control of devices and system (so-called smart devices and environments). Research in these fields is improving the usability of devices. Decreasing hardware size, efficient energy consumption and networking capabilities is enabling the integration of rich feature set in devices that are embedded into everyday products. Aesthetics also play an important role in the market success of a product and gives an edge in competition with similar devices. Consider the evolution of mobile phones from bulky telecom devices to modern day powerful function-rich, intuitive and fashionable devices that offer a range of services like GPS, digital photography and internet access. .

B. Identifying User communities and their roles

Product design is a complex process and usually requires collaboration of different individuals with different domain

knowledge. Hardware designers, software developers and social scientists all play an important role in the development of ubiquitous products. We believe categorization of the users, in groups, would enable us to identify the individual and common goals. For example software designers might be interested in providing a natural interface to the system where as a social scientists might be concerned with the privacy and information security aspects of the device. However, the challenge becomes to integrate different perspectives together especially when they are contradictory in principal.

Providing a common platform for different user communities to collaborate and interact can lead to better design innovation. Problem descriptions and knowledge base can be extended by iterative collaboration. The can lead to a better shared understanding of the design process.

C. Virtual Prototyping

Virtual prototyping allows the illustration of conceptual ideas for real products to be presented in a digital world. These illustrations get more complicated with the evolution of design process through different disciplines. Rapid iterations on these virtual prototypes allow a quick and low-cost ways to engage users in the design process. Virtual Reality environments have matured over the decades. Advances in computer graphics and network technologies have empowered the computer gaming industry which has contributed a lot to the development of virtual reality environments. The latest gaming engines try to mimic physical characteristics of the real world to provide a realistic gaming experience. Multiplayer capabilities allow user interaction and collaboration across the globe. Research and projects are emerging which are utilising the power of these gaming projects for social and educational causes. Traditional virtual environments make use of visual and audio systems to make more realistic real world simulations. Haptics, force feedback based technology, and tactile interfaces are gaining popularity to take the advantage of user's sense of touch to make the virtual experience more real [2].

With all the advances in virtual reality, we feel that product prototyping can be moved further in this direction allowing users to interact with virtual product prototypes that are still at a conceptual stage. These virtual prototypes can be enhanced to provide functional realism, at least for the audio and visual senses. However, to incorporate other senses such as kinesthetic or tactile interaction, it is necessary to incorporate haptics and tangible user interfaces.

Once the product is defined in terms of its characteristics and attributes. It can then be represented in Virtual Reality at different abstraction levels to different user communities. Different versions of the prototypes with different levels of abstraction will allow focused interaction. Feedback from such interactions would be recorded in an automated intelligent manner and used to improve upon the product design.

III. FUTURE WORK

The next step for us is to do an in depth literature review. We will try to identify the changing trends and themes of research in Ubicomp and HCI. Further collaboration with different user communities will allow us to identify their appropriate roles as stakeholders. We will be exploring existing virtual environments like the Open Wonderland, Open SIM or Real Extend as our virtual reality platform. We will also be creating virtual prototypes and providing hierarchical interaction capabilities for different user groups. Intel has suggested we target domestic intelligent robotics as our first futuristic product and, for one of our next stages; we will try to capture the requirements for that.

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