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Exploring Virtual Reality and Prosthetic Training

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ABSTRACT

Working together with health care professionals and a world leading bionic prosthetic maker we created a prototype that aims to decrease the time it takes for a transradial amputee to train how to use a Myoelectric prosthetic arm. Our research indicates that the Oculus Rift, Microsoft's Kinect and the Thalmic Labs Myo gesture control armband will allow us to create a unique, cost effective training tool that could be beneficial to amputee patients.

Keywords: Health Technology, Oculus Rift, Prosthetics, Kinect, Myoelectric, Virtual Reality.

Index Terms: I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism;

1 BACKGROUND

The Culture, Communication and Computing Research Institute have applied interactive virtual reality as one of its research foci. Specifically we employ the Oculus Rift and sensor technologies to innovate in areas of packaging design and healthcare technologies. An institutional scheme to support inter disciplinary work has enabled us to work closely with healthcare consultants and identify specific health related needs in the domain of prosthetics. This has led to exploring the use of virtual reality to help amputees evaluate how a prosthetic arms design might appear and be controlled prior to its individual prescription and purchase.

We first developed a scene that placed the user in a traditional kitchen environment and allowed basic interaction with the items in it. The environment is created using Unity's game engine and integrated with a Kinect to allow the users to have one or both of their arms to be tracked in real-time and displayed in the virtual environment. In this way users are able to perform basic interactions with the kitchen objects and also observe one of three different prosthetic designs rendered in place of their absent arm and hand.

Improved tracking was later achieved by integrating the Myo - a wearable gesture recognition armband. This allowed the muscle activity associated with intended hand movements to be sensed and correspondingly animated in the virtual representation of the user's prosthetic hand. Using this and rigidbody physics objects, users were able to pick up objects and place objects within the virtual scene.

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2 TECHNOLOGY

The main technologies used are the Oculus Rift, Microsoft Kinect and the Thalmic Labs Myo. These devices are accessed through plugins for the Unity game engine and then altered to work with amputees.

2.1 Oculus Rift DK2

The Oculus Rift is a virtual reality head mounted display, which is currently in its second iteration. It allows for a user to experience a virtual environment along with a strong sense of immersion and sense of place. In order to minimise issues such as motion sickness when using the device we have optimised the scene and we are also using a high spec laptop.

2.2 Kinect

The Kinect is a motion-sensing device for the Xbox 360 that uses RGB camera and depth sensor to track the user's body whilst in the virtual environment.

2.3 Myo

The Myo is a gesture recognition armband, which is being marketed as a wearable device to control applications and devices. It uses the same myoelectric technology that is used within prosthetic arms. Once positioned on the forearm of a user it can monitor muscle activity and transmit it via Bluetooth back to a device.

3 PROPOSED AUDIENCE DEMONSTRATION

While developing this prototype we have showcased it at multiple public events and this has helped inform us regarding potential technical and usability issues. Our demonstration requires the user to be standing just under two metres from the Kinect camera. We then give a brief description about the project and what the user is to expect once in the environment.

The user places the Myo armband on their dominant forearm and puts on the Oculus Rift headset. The user would be presented with the kitchen scene and see their arm rendered as though a prosthetic. The user would be encouraged to explore the scene and pick up and release objects. The demonstration will operate for non-amputees as well as amputees.

Figure 1: Kitchen Scene with prosthetic arm

4 Evaluation

Our project is now evaluating whether this work is appropriate for amputees to assess prosthetic designs and basic functionality. Preliminary results are positive and appear to indicate the virtual reality solution in fact helps amputees realise the effective use of the Myo sensor as means of controlling prosthetic arms. Occupational therapists have reported that amputee familiarisation with myoelectric technology has been improved significantly, and that this should enable a reduction in service cost.

Currently we are developing a training system based on this technology in collaboration with occupational therapists.

5 The Virtual Reality and Interaction Design Team

5.1 The Cultural, Communication and Computing Research Institute

The Cultural, Communication and Computing Research Institute (C3RI) is a diverse multi-disciplinary research institute combining an Art and Design Research Centre and the Communication and Computing Research Centre. This combination means that active connections can be built between the research traditions of art, design, media production, communication studies, computing and engineering. Collectively this enables a diverse range of research and knowledge exchange initiatives to inter-operate. A dominant theme of much of the work is design lead practice with a user centred emphasis. This means that the majority of activity is focused upon applied research that benefits from a thorough understanding of the specific circumstances and environment in which a technology may be employed

In the 2014 UK wide assessment of research excellence: the Art and Design research was ranked as being within the top ten in the UK, and; over 60% of Communication and Computing Research was rated as internationally excellent or world leading. In addition 90% of research reach, significance and economic and social impact were judged to be internationally excellent or world leading.

5.2 Virtual Reality and Interaction Design

With the Communication and Computing Research Institute an Interaction Design team has been developed to explore innovative technologies and methods. The team specifically supports innovation and collaboration with industry and contributes to research projects. The team consists of four researchers with expertise in: software development; games development, virtual reality, augmented reality and location based technology. Coupled with this is expertise in interaction design, including: user interface design and evaluation.

The team works on a range of projects with the use of virtual reality technology being applied predominantly in the area of health technology. The research is exploring situated virtual interaction with an emphasis upon integrating body movement and position sensing with immersive 3D simulations. Our team has experience of developing interactive systems with hardware such as Oculus Rift, Myo, Kinect, LeapMotion predominantly using the Unity game engine. In addition, the inter-disciplinary design skills have led to the development and evaluation of a unique prototype haptic interactive device.

5.3 Health Technology

Strategic links with local hospitals and health professions has underpinned various health technology collaborations. In particular access to affordable and portable virtual reality kit has enabled the technology to serve as focus for innovation. This potential has resulted in projects supporting surgeon training, aiding amputees in the selection and operation of prosthetics, and phantom limb treatment. In addition, the same technology's potential to support types of rehabilitation is being explored.

The interaction design team maintains strategic links the healthcare sector. In particular the team works closely with the South Yorkshire Institute for Innovation and Research in Child Health and the Yorkshire and Humber Academic Health Science Network.

5.4 Conclusions

Advanced interactive virtual reality provides a powerful means of facilitating innovation and enabling users to see beyond technologies that they are familiar with. Realising their integrated use provides a means of: driving technical research; developing unique user experiences and examining how best to assess the impact and veracity of such experiences.

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