Reflective Report for Novel Human Interactions

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Introduction

In this report we will cover a range of topics and technologies that we have been introduced to throughout this module. First, however, I think it is important that we discuss what we mean by novel human interactions. We live in an incredibly interesting time where technology is advancing at an amazing rate. An interesting observation I have made is that technology is so enveloped in our lives that we are can become blind to the advances of technology around us. Often we will not be perplexed by a new advance in CPU or camera technology within our handheld mobile devices. However, when one takes the time to reflect on the technological advances we have made in the last two decades alone we might realise the potential of our future. The reason for this reflection is because it is essential to understand why novel human interactions are so important. Currently, the most popular interactions between computers and humans are via touchscreen, mouse and keyboard. These interactions have seen optimizations and refinements throughout their existence. However, if we consider that computational power is only increasing and that it no longer takes modern computers ten minutes to execute singular commands, we come to the conclusion that there will be a point in the near future where computational capacity is no longer a restriction. Instead, the restriction or bottleneck between humans and computers becomes the bandwidth of informational transmission between our bodies and computers. In my opinion, this is one of the most important reasons for innovation in the field of human-computer interactions.

Summary of the module

During the module we have discussed a number of different technologies that are currently being used or developed in the field of human-computer interactions. One of the first technologies we discussed was Tangible User Interfaces (TUI). TUI are an intriguing area of human-computer interaction and one that I had not yet been introduced to. TUI work on the concept of having humans interact with tangible real-world objects to interface with a computer or other device. The main strength of TUI is that they can be used to make exceptional intuitive systems. In Figure 1 you can observe Reactable, this is a TUI that functions as a musical instrument. Users move and rotate specific objects to produce unique sounds. What we found with TUI is that users often do not need tutorials or education on the use of these interfaces. Instead, users, especially children, are able to understand the functionality of the interface by the trial and error of using the tangible objects.

Figure 1. Reactable music instrument in use.

One of the weaknesses of TUI is that they tend to be case specific so not easily applicable to great numbers of human-computer interactions. Another weakness to consider is the complexity involved with the development of such interfaces. Often the tangible objects do not provide enough feedback for the user, this means that other methods such as projectors are required to provide feedback. TUI can also be computationally heavy due to the continuous tracking of objects via cameras and feeding this information to the system. This can be problematic as most systems do not want to dedicate a large amount of computational resources to the interface, but instead focus the resources on the main functionality of the system.

After looking into and extensively analysing TUI we moved on to the next topic which was Ubiquitous computing. Ubiquitous computing describes a principle of passively having computer technology integrated into almost all aspects of life. Perhaps one of the most intriguing aspects of this principle is that most of the ubiquitous computing ideas were proposed almost 20 years ago. The problem at the time, however, was that the size and price of computers were too high and thus mass implementation would not be feasible. However, with Moore's law holding - the price and size of computers have decreased dramatically. Because of this, we have seen Ubiquitous Computing increase substantially in the last decade. One of the most fascinating ways to think about Ubiquitous Computing is that the user should not have to go out of their way to make use of the computer but instead, the computer should go out of its way to interpret the natural behaviour of the human. A prominent computer scientist named Mark Weiser proposed a very similar computing principle that he coined “Calm Computing”. He proposed that the majority of the computers we would use in the future would have a background presence. These computers would become context-aware meaning they would be able to act on specific inputs that they obtained via sensor information. Although there have been huge strides in the development of Weiser’s vision there is still a need for development in Ubiquitous Computing. After learning about Ubiquitous Computing I decided to research further into this field and try to understand the bottlenecks that make it so hard to implement some of these visions. I found two intriguing examples of Ubiquitous Computing. One such example was the automated electronic tolling system that is being developed. This tolling system will be able to accurately read the number plates of cars passing through the toll border on motorways. The user will then either be able to pay via an invoice they receive in the post or on an app. I have personally driven through France and this is a perfect example of where computers will be able to streamline everyday life for a large number of people. Another such example is located in the aeronautical industry. The example of Ubiquitous Computing was in the newest iteration of the controversial Boeing 737 MAX 8. There is an autonomous computer system integrated within the aircraft that corrects the aircraft's pitch if it detects the aircraft is pitching at a stalling angle. This system has received a significant amount of scrutiny during the design and testing phase. However, after two recent crashes investigators now believe this system may have been at fault where the system incorrectly detects a problem and overrides the pilots in their attempt to regain control of the aircraft. There are a large number of other

examples such as Philips' Hues locational tracking service that turns the lights on in your house when it detects you have entered your home via your mobile phone GPS signal. I think however there are currently two major factors that are limiting the development of Ubiquitous Computing. The first factor is not so much a technological problem but instead a philosophical one. Over the past 10 years there has been an increasing amount of privacy concerns in technology. People seem to be worried and fearful that large corporations are actively gathering personal information on a large amount of the population. In Figure 2. You can see a graph showcasing the Google searches for "Facebook privacy".

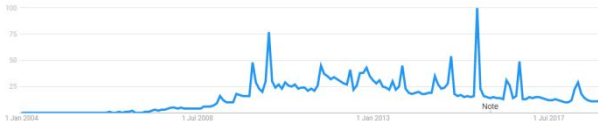

Figure 2. Google trends graph on "Facebook privacy"

This graph shows us that people have become increasingly concerned with online privacy. This is a fundamental problem in the field of Ubiquitous Computing as it discourages further development from large companies for fear of public outrage. The second factor is very closely related to the first and it is in regards to computing accuracy. Ubiquitous Computing works on the premise that the computer is able to accurately predict human behaviour and needs. However, if humans are fearful of sharing private behaviour and habits with those who wish to develop Ubiquitous Computing solutions then it will be much harder to accurately develop these systems.

Another rising interaction technology is Augmented Reality (AR). With recent increases in hardware performance in smartphones, the possibilities of AR have increased significantly. AR describes the process of actively changing the way our surrounding environment appears using computing technology. One such example can be seen in Figure 3 where the user is holding a tablet over a floor plan and the device then recognises this floor plan and accurately displays a 3D model of the property.

Figure 3. Using AR to showcase a 3d model of a floorplan.

Figure 4. AR GPS app

AR can be an exceptional tool to convey a message or experience that may have been impossible without its use. However one of the drawbacks of augmented reality is that there is a lack of truly enhancing applications. When used correctly however AR can be a powerful tool. AR used to be hard to develop and manufacture however recently there has been an increase in tools and technologies that allow developers to manufacture AR applications with relative ease. I think one of the most productive AR applications I have come across is the GPS AR app. In Figure 4 you can see an example of the application. This application will allow users to easily navigate unfamiliar environments without the confusion of reading a map.

Although AR applications tend to be case specific, I believe there is an emerging market for the use of these applications and that we will see more AR integration in the years to come.

We also studied Haptic Interaction Technology (HIT) during the course. Haptic is a word derived from ancient Greek and defines the sense of touch. HT is an emerging technology that allows digital devices to interact with humans by way of motion and vibrations. Almost everybody who owns a smartphone or a modern game console has experienced Haptic feedback. The vibrations that one might feel in a controller or on a mobile phone is a form of Haptic interaction. On our mobile phones we might feel a vibration when we receive a notification whereas on game controllers we may experience vibrations when an explosion occurs in the game to intensify the immersion the user has with the game. From my research, I have found two intriguing examples of HT. The first is Haptic Feedback in touch screens. This emerging technology has already been implemented in modern smartphones. It has allowed users to more accurately determine how much pressure they have to apply onto the screen and based on the pressure they have applied different actions may occur. If a user presses hard on the screen they will feel a strong vibration, the opposite is true for light touches. I think this will increase the usability of touch screen devices, allowing users to achieve their desired outcomes in a faster time period. Another interesting development in HT is the use of full Haptic bodysuits, an example of which you can see in figure 5.

Figure 5. Haptic bodysuit by Teslasuit

I think Haptic Interactions will see an increase in usage, especially in the virtual reality market as it allows for far greater immersion in virtual environments. However, the limiting factor of these products is the price of production due to a large number of servo motors needed in specific places to produce the Haptic feedback to the users, these products can be expensive to manufacture. However, as the demand for these types of products increases, we will see them become more common and eventually essential to any VR experience.

Next, we delve into a discussion on the field of wearable technology. Wearable technology has seen a recent spike in innovation with many large tech companies on the quest to find a device that will bring disruptive innovation. Companies such as Apple and Samsung have brought out a variety of different digital watches also referred to as smart-watches. There are a number of advantages to having wearable devices and one of the main ones is accessibility. By having a device attached to one's body you might imagine it being easily accessible such as a smart-watch. Another major advantage to wearable devices is that companies can make use of a larger array of sensor input. For example, most smart-watches are outfitted with infrared heart rate sensors that allow the monitoring of a person's heart rate continuously whilst wearing the device. This means that the person wearing these devices is able to track and keep a record of their health and fitness routines and perhaps detect any problems related to their health. It also allows medical professionals to non-intrusively monitor patients with increased accuracy[3]. I personally have experienced

wearable technology and I have noticed that although smart-watches are beneficial in some circumstances the problem of battery-life still remains the primary issue. By increasing the number of devices we carry daily we also need to charge more devices. This can often be a hassle for people and thus decrease the attractiveness of wearable devices.

We also came across a novel interaction technology named Proxemic interaction. Proxemics is the study on how we behave and perceive the space around us. Human nature can be predictable so by carefully analysing how humans move around spaces to perform certain tasks we can gather this information and make use of it when designing interaction methods. We took a look at how we might develop technologies based on proximity. For example, a home TV screen could display different information based on the distance of its users. In general Proxemics we have classified distances in 4 sections. The first being at a distance of greater than 4 meters, this is called public distance. The second being between 1.5 and 3.5 meters, we call this social distance. The third is between 0.5 and 1.5 meters, this is called personal distance. Anything less than 0.5 meters is called intimate distance. Based on these 4 criteria we could have a display showcase of pictures or artworks if the user is detected to be at a public distance. When the user approaches at a social distance we could display information related to that user such as weather and traffic information. If the user approaches further we could showcase the controls for the house such as lighting, music and heating controls. I think Proxemic interactions will be used more commonly in the future as they can be beneficial in streamlining the usability of devices. However, as with other interaction technologies, the question of privacy remains. To make use of Proxemic devices we will have to integrate sensors that could be seen as an intrusion of privacy.

Comparison

For our next chapter, we will look at some of these technologies and compare them within specific use cases and design concepts. During the course we have produced two prototypes that made use of novel interaction technologies. The first coursework was a prototype that would be developed for educational use. We produced a robot that could be sent a series of commands via a TUI. Our project was successful and it allowed users to learn the fundamentals of programming with ease. The benefit of using a TUI was that it was intuitive to use and so people were not as intimidated as being put in front of a computer screen and having to write code. I think there is certainly a market for this type of educational product. One must also consider the negatives of using a TUI. From our analyses, one of the greatest disadvantages was the setup time and the probability of losing some of the tangible objects. For our second coursework, we made excellent use of AR to enhance a user's visit to the Imperial War Museum in London. In this situation AR was perfect and it was exciting to see the enthusiasm of people who interacted with our software. One of the reasons why AR could be considered a great technology is because unlike some other novel interaction technologies we have discussed AR does not necessarily need to obtain personal information from the user. From the research I have collected I do not believe there are a set list of criteria we can use to compare our interaction technologies. All of the interaction technologies we have listed could be creatively implemented to have a wide range of functionality from recreational to educational. What I have however been able to conclude is the fact that out of all these technologies AR has by far the lowest setup and development costs. Most of the target audience for AR applications will posses a mobile device on which this application could run. We have also concluded that due to its intuitive nature tangible user interfaces and AR applications are perhaps the most suitable for use in educational activities.

Comparing these technologies outside of specific use cases is important. One thing we must question is the likelihood that privacy will remain one of the greatest issues of our generation. As companies develop these revolutionary personal products with an increasing number of sensors, it is inevitable that they will also gain access to our private lives. We must, therefore, trust these companies to keep our private information secure. This is daunting, but it may be a sacrifice and risk we must take if we wish to have technologies that are tailored to us to make our lives easier and more fulfilling. I think however that most of these technologies will soon be redundant and outdated. Although these technologies will, of course, be implemented in devices in the future I believe that the underlying problem still remains. There will still be a lack of bandwidth in the interactions between humans and computers. It is a problem that all these interaction technologies share. However, there is a slow-moving innovative trend within the field of human-computer interaction. Some people refer to it as interacting with computers at the synaptic level[5]. Neuralink, a company partly owned by Elon Musk, specialises in high bandwidth brain-machine interfacing[4]. The aim is to build a non-invasive technology that will allow us to transfer our thoughts directly into a machine. By having such technology available it will fundamentally change the way humans interact with computers. It will allow computing devices to act as an extension to the human brain. I imagine in the future we will be able to wake up in the morning and turn the lights on with simply a thought. Then perhaps the blinds will open and coffee will be made because we are thinking of these actions. Although this might sound like a utopian future I believe it is closer than we may think. There is currently a large amount of research being done in this field of computer science and I believe we will see the implementation of these type of brain-computer interfaces within the next two decades. Initially perhaps only at the basic level where users will be able to transfer simple binaries such as "yes" and "no". But in the future, we might be writing essays from our thoughts alone. I think it is fundamentally important to strive to develop technologies that seem utopian and highly disruptive as incremental technological advantages seem to be the trend. Perhaps because of the economic factors involved in developing groundbreaking technologies or simply a lack of free-thinking imagination. I will end this paper with a quote that future computer scientists and revolutionaries should consider.

"Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand." - Albert Einstein

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