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The impacts of use of augmented reality wearable devices on human behaviour: A user perspective

Sardar Ahmed Gaziani

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Gaziani, Sardar Ahmed, Halmstad University, Halmstad, Sweden, sadgaz18@student.hh.se

Abstract

The Augmented Reality Wearable Devices (ARWD) are becoming one of the most important digital resources in many industries. The use of augmented reality technology has been explored by many researchers from various dimensions. The main focus of this paper is to investigate the impacts of the use of ARWD on human behaviour. This paper investigates the impacts on human behaviour through analysing different research articles that are based on the use of ARWD from different user experiences. The selected articles are further evaluated and analysed on the effects of the use of ARWD through 'acceptable factors' and 'unacceptable factors' to understand the impacts on behaviour. Very few research results have focused on impacts on user behaviour through a different state of mind. It was discovered in results that there is not much research done to study the impacts on human behaviour with the use of ARWDs. This paper, in conclusion, suggests an empirical study to understand the importance of this knowledge and what are the impacts going to be on human behaviour when these devices will widely be used in society.

Keywords: *Augmented Reality Wearable Devices (ARWD), impact on human behaviour, user perspective.*

Introduction

Augmented Reality Wearable Devices (ARWD) are becoming one of the most important resources for many industries; from education, military, product manufacturing to large scale construction industry. In a very short span of time, this technology has moved from 'virtual reality' to 'augmented reality' to 'mixed reality' and now the research is looking upon 'extended reality'. ARWD is one of the hot topics of researchers in wearable technology and we are able to see the prototype of ARWD being produced by big companies like Intel, Microsoft, Google, Bose, and others. ARWD is being perceived as a resource that will help users to perform better in tasks and it will make the user more efficient and smart (Rauschnabela et al. 2018). This technology not just providing ease to a user to perform its tasks efficiently but also it adds value to many industries where with minimum resources greater outputs can be achieved. The problem is that we do not know yet the impacts of ARWD use on human behaviour, as these devices are going to be used in various long hour work settings.

According to Champney et al. (2015) military training research; the findings showed that the use of ARWD more the 30 min creates sickness and fatigue. We know very little about the limits of usage of ARWD; however, we do not know the impacts of the use of ARWD on human behaviour in other settings nor do we find any empirical study to explore this perspective. When these devices go commercial, the majority will only adopt these devices when the early adopters have a good

experience and according to their positive behavioural remarks, this technology will survive. If we do not investigate this critical issue then this technology will not reach or might take more time to reach the diffusion stage, or it might have severe consequences of human behaviour.

Therefore, my question is: what are the impacts of the use of augmented reality wearable devices on human behaviour? It is important to investigate this unidentified area to understand the importance of this knowledge so that appropriate measures can be taken from designers perspective from both hardware and software point of view. The aim is to contribute the knowledge to the AR research field and to provide suggestion to both user interface and hardware designer to improve user experience while keeping in view its impacts on human behaviour.

In order to investigate this research question, five different user perspective types of research were analysed from 'acceptable factors and 'unacceptable factors'. After the analysis in the discussion section we found out that there have been studies done on usage of ARWD in different settings and report issues like split attention causing frustration (Sharma et al. 2016), visibility issue in bright or sunlight causing fatigue (Sharma et al. 2018), privacy of self and others and socially unacceptable issues causing negative perception and ethical fear (Rauschnabela et al. 2018).

I have come to this conclusion that in order to take this technology to the diffusion stage it is important to understand its impacts on human behaviour. Furthermore, it is important to empirically study this subject matter so that we can identify the appropriate use of these devices and also suggest producers and designers to consider these impacts prior to the launch of these ARWDs.

Background to Augmented Reality (AR)

AR is the technology that combines Virtual Reality (VR) with the user's physical field of depth through various devices, such as smartphones, smart glasses, and smart screens and so on. According to Merriam-Webster (1992) the first known used of the word 'Augmented Reality' was defined as "an enhanced version of reality created by the use of technology to overlay digital information on an image of something being viewed through a device". AR is the extension of VR, where VR wearable blocks the field of depth or surrounding of the user, although the purpose of this technology was to give simulated experience to the user; whereas AR technology was introduced to provide the required information to the user while being aware of the surrounding. In recent pieces of literature, AR is more referred or defined through its different class and different usability perspective. Some researchers explain the same concept with 'mixed reality' like Baldassi et al. (2016) defines mixed reality as a system in some meaningful way connects physical and virtual reality through sensors and databases.

Background to Augmented Reality Wearable Devices (ARWD)

The AR wearables are the combination of a physical device that shows the interface combining virtual information while giving the user a clear vision of the surrounding. Sharma et al. (2018), explain AR wearable as computing devices that are worn on the human body which creates a continuous interaction, displaying computed information through the digital lens that does not block the real depth of field. Authors such as (Rauschnabela et al. 2018) explain that Augmented Reality Smart Glasses (ARGSs) has great potential to explore in fields like marketing, logistics, entertainment, health care, manufacturing and so on. ARWDs have been designed by many such as Microsoft's

'HoloLens' (see image 1), and Google's 'Google Glass' (see image 2) (Rauschnabela et al. 2018). ARWD are becoming more and more sophisticated and stylish as the technology is advancing. The devices that were produced in early stages were mostly known as 'head mount device' (see image 1), that the user has to strap on head and the see-through glass displays the information with the clear vision of field of depth; whereas now with the refined technology; devices are designed more like the normal –daily wear- spectacles or glasses which provides the similar function with less weight and superior technology, for example prototype Bose AR Sun Glasses (see image 3) that provides audio AR capabilities and Prototype Intel Vaunt Smart Glasses (see image 4).

Image 1: Microsoft HoloLens 2 (Figueroa, 2015)

Image 2: Google Glass (Eytan, 2013)

Image 3: Bose AR Glasses (ROSEMAN, 2018)

Image 4: Intel Vaunt Smart Glasses (Mixer Design Group)

Literature Review

Technology has been very resourceful for human in many ways like complex calculations are not so complex with the help of computers and long distance communication does not seem that long now. Similarly, ARWDs are being perceived as a very helpful resource to easy out the tasks and increase efficiency. Soon ARWD will be commercialized for general consumers to satisfy their utilitarian, hedonic, and symbolic needs (Rauschnabela et al. 2018). On the other hand, different industries are exploring the possibility of ARWD in military use (Champney et al. 2015), disaster response use (Sharma et al. 2018), health care, logistics, and entertainment (Rauschnabela et al. 2018). Baldassi et al (2016) said it to be useful for procedural task execution for example in maintenance, surgery, and assembly.

ARWD has been found very beneficial for navigation (Sharma et al. 2016), improve response time in an emergency situation (Sharma et al. 2018), also very helpful in military team coordination (Champney et al. 2015) and so on. ARWDs have proven to be very useful in a different setting but it hasn't been studied empirically to understand the use of ARWD and its impacts on human behaviour. This critical issue is to be explored in order to understand the impacts on human behaviour through holistic usage experience of ARWD. According to Champney et al. (2015) use of more than 30 min of ARWD increases the sickness and increase adverse effect in user experience. ARWDs, when used in long hours, will eventually affect human behaviour.

On one hand issues such as split attention (Sharma et al. 2016) and visibility issue in bright sunlight or ambient background light (Sharma et al. 2018) has been identified as a contribution to impacts in human efficiency, health and eventually behaviour. Such physical distraction can contribute to bad experience which could lead to negative reviews and word of mouth, eventually; it reduces the chances of diffusion of the ARWD technology.

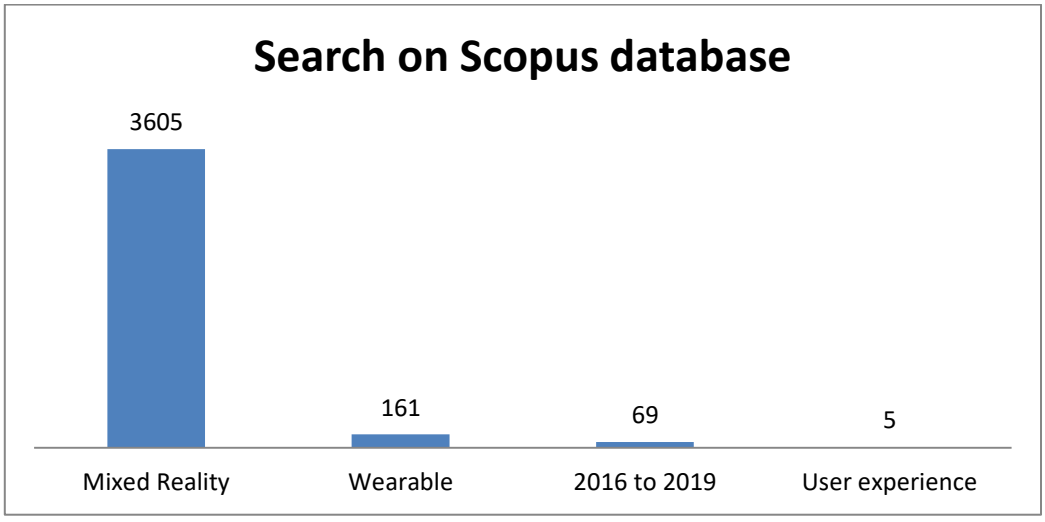
On the other hand, psychological issues are more seriously negate the use of ARWD, especially when it comes to privacy of self and other. ARWD are perceived as privacy threat to self as the devices are being connected to networks and those networks record every move of the user which makes the user

more concern (Rauschnabela et al. 2018). Privacy of others is more of the problem while ARWD used in social settings, they are perceived as privacy breach, the user does not take consent before extracting the other information is pushing back users to use such devices in social settings (Rauschnabela et al. 2018). How these privacy breaches going to effect on human behaviour when these devices will be widely used in formal, informal social settings is a big concern. Even in one of the empirical researches, participants were uncomfortable to wear the ARWD in a crowded area as they were concern how they will be preserved by others (Baldassi et al. 2016).

The recent technological advancement in ARWD is raising more questions where the devices are designed as regular glasses, for example, Intel Vaunt Smart Glasses, where the user can spy and other won't be aware of their privacy. These upcoming technologies will have severe effects on human behaviour. Not just the smart glasses but now Samsung is looking ahead at AR capable eye contact lenses which is going to be the novel invention of AR technology. Having all these latest ARWDs will eventually have physical and psychological impacts on human behaviour.

Methodology

The research topic was ideated from the latest ICAS 2018 call for the paper event from the domain of 'Information systems foundations' and from the track of 'human behaviour and IS' (ICIS 2018). The search was done on the Scopus database. The entry query string was based on the title, abstract and keywords. The first keywords search was done on 'mixed reality' as the research was based on mixed/augmented reality. The search was further refined with 'wearable' keyword as the purpose was to specifically study the wearable technology. In order to reflect upon the latest researches the search scoop limited from 2016 onwards. To narrow the focus on impacts on human behaviour, few relevant articles were selected that were based on the use of ARWD from different user experiences.



The search of the first keyword 'mixed reality' resulted in 3,605 hits and after combining the keyword 'Wearable' it resulted in 161 hits. In order to reflect upon the latest researches the search scoop limited from 2016 onwards which limited the hits to 69. After going through 69 articles the selection was narrowed to 5 articles which are the blend of empirical study, role play, and research through a questionnaire to get a variety of knowledge. These five types of research represent different user experience and therefore are very helpful to analyse the aim of this paper from a different perspective. Further, in this paper, we will evaluate and analyse these five types of research from 'acceptable

factors' and 'unacceptable factors' and try to identify the use of ARWD and its impacts of human behaviour.

Results

In this section, we will evaluate and analyse the ARWD user experience and extract its impacts on human behaviour from 'acceptable factors' and 'unacceptable factors'.

Table 1: Analysis

Author	Context (AR User)	Type of study	Acceptable Factors	Unacceptable Factors
Rauschnabela et al. 2018	Social users	Empirical study (n=23)	-Utilitarian Benefit: It makes life more efficient - Hedonic benefit: Entertainment, enjoyment - Symbolic benefit: Fashion icon	- Privacy issue of Self - Privacy issue of Others - Loss of Autonomy
Sharma et al. 2018	Disaster response team (responsive task user)	Role playing design competition, the Icehouse Challenge	- Ease of use - enhance team coordination	- Background light decreases the visibility on content on ARWD - Linear content layer
Baldassi et al. 2016	LEGO assembly Task (focused /attentive procedural task user)	Empirical study (n=50)	- Faster and accurate and frustration free execution of task - Improve cognitive learning	N/A
Sharma et al. 2016	Photo Navigation Game (split attention task user)	Empirical study (n=12)	N/A	- Split attention issue - Sunlight decrease the visibility of content on ARWD - Socially unacceptable - ARWD does not support in navigation as compared to other handheld devices
Champney et al. 2015	Military Training user	Questionnaire (n=5)	-excellent utility tool for task execution - ease of use with minimal training - High fidelity	-frustration due to ambient light in outdoor environment -increase sickness after extensively using ARWD for more than 30 min.

In table 1 we have evaluated the five different user experiences in order to understand what the factors are considered to be acceptable or unacceptable from a user perspective to get the deeper

understanding of ARWDs impacts on human behaviour. The ARWD user experiences are covered in these researches are from a general user's perspective where the use of ARWD is studied from the social and personal point of view. In this research, the user's reaction to the use of ARWD are discovered and shows favourable results in use of ARWD from utilitarian, hedonic and symbolic point of view and also shows concerns from socially unacceptability and privacy of self and others (Reuschnabela et al. 2018).

In Sharma et al. (2018) paper the study was to understand the AWRD usefulness from disaster response situation point of view. In this paper, the ease of use was appreciated and the frustration of disturbance for ambient light was stressed; similar results were shown in Champney et al. (2015) military training user experience research with the additional recommendation of maximum use limit of 30 min in a length in order to avoid the sickness.

The study from procedural task user experience from Baldassi et al. (2016) results shows no discomfort or un-comfortableness in ARWD usage rather the results show positive remarks of faster learning and efficiency in performing procedural tasks. On the contrary Sharmaet al. (2016) paper results only shows negative user experience in photo Navigation game setting; the un-comfortableness was shown by split attention issue and perception of the socially unacceptable device.

Eventually, regular use of the ARWD will affect human behaviour and all the above-mentioned experiences indicate that there are some negative and some positive impacts on human behaviour. These experiences were timed and the results of all previously mentioned researches were analysed within the short time period; a detailed study is required to understand the regular use of ARD and its impacts on human behaviour. In the discussion part, the user above-mentioned user experiences are linked with human behaviour in order to understand the depth of impacts on human behaviour while using ARWDs.

Discussion

There are many factors that contribute in favour or against of the particular technology but what are the impacts of these technologies on human behaviour can only be understood after it has been widely used and accepted in the market. As ARWD are fairly new in the market and we know very less about its usability, affordances, and acceptability but we can draw a fair discussion on the existing knowledge by evaluating the recent user experiences. ARWDs will be used by many companies for many digital services, by using limited resources the company will reach to their targeted consumers and promote sustainability but looking into the ethical dimension is also an important concern.

In the result, we found out that the major concern for ARWD use is the privacy issue portraying negative perception not just of self but also for others in any given social setting. This issue is posing a question on the acceptability of ARWD from the masses, and the people who are going to use these will not be perceived ethical and they will receive a negative reaction from others (Rauschnabela et al. 2018). These behaviours will eventually aggregate when the use of ARWD will be commercial. The user will also hesitate to use ARWDs because of the ethical fear (Rauschnabela et al. 2018), but what behaviour it will shape into is unclear.

On the other hand, the issue of split attention depicting frustration (Sharma et al. 2016) is going to be a major concern when these devices are near its diffusion stage. Whether we require or not the information will be available at all times which will create distractions in many situations, it can cause

serious mental illness and there will be impacts on human behaviour. As yet we are unclear because of the lack of study in this area.

Finally, the usage limits suggested by Champney et al. (2015) in military training settings where pressure and fear of impairment increase tiredness; but in normal social setting no such tiredness will frustrate users to take off the devices. We as a human being of social society are unable to stay away from our phones will not be able to stay away from these devices when they will serve the purpose of the phone, computer, and other communicating devices. These long terms usage will have its impacts on human behaviour that we are unaware of at the moment.

Conclusion

Any good technology passes through many stages before reaching the diffusion stage, and many factors are involved in its successful journey. Positive impacts on human behaviour are one of the key factors that help a good technology reach its destination. It is utmost important to know what shape is the ARWDs are going to take place in the future. Big companies are investing in this technology, like Microsoft, Google, Bose, Intel and so on. These companies seek great potential and foresee huge commercial value in these devices. These devices will soon be commercialized and will be available for general and specific use. It is therefore important to know the impacts of the use of ARWDs on human behaviour.

In the conclusion I, will suggest that the above mentioned knowledge is very important to be found through empirical research, as it will be ethical for the research community to help this technology to reach its diffusion stage but contributing to knowledge that will be useful for not just general users but also designers, manufacturers and future researchers. As we are living in a society that is continuously transforming itself digitally and humans are adapting new technologies with just the knowledge of short term impacts of the particular technology. The long term impacts take ages to overcome; just like we were happy with the industrialization and now we ended up in the global warming situation. The loss of not knowing this knowledge will negatively affect human behaviour, take the mobile phone, for example, it has become one of the important resources of our life and now various researchers are making people aware of its adverse impact on behaviour from health, social life, and cognitive, psychological perspective and so on.

There are many ways we can contribute knowledge to the field of augmented reality; we have the technology and it is being tested at this stage, it will be wise for us to study these technologies from human behaviour aspects too; so at the initial stage, these curiosities can be addressed. We have to understand the impacts of this technology on human behaviour, for which it is recommended to further study in this knowledge gap area. This knowledge will help shape the technology and will be used by user interface designers, manufacturers and critics so that the better technology with positive impacts human behaviour can reach its diffusion stage in the technological world.

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