Using Optical Head-Mounted Devices (OHMD) for provision of feedback in education

Georgios A. Dafoulas
Research Group On Development of Intelligent Environments
Computer Science Department
School of Science and Technology
Middlesex University
London, United Kingdom
g.dafoulas@mdx.ac.uk

Cristiano Maia
Research Group On Development of Intelligent Environments
Computer Science Department
School of Science and Technology
Middlesex University
London, United Kingdom
C.CardosoMaia@mdx.ac.uk

Martin Loomes
Computer Science Department
School of Science and Technology
Middlesex University
London, United Kingdom
M.Loomes@mdx.ac.uk

This paper discusses the investigation of using Optical Head-Mounted Devices (OHMD) for provision of feedback in education. In particular it discusses an investigation in the use of Google Glass in real time training and mentoring. First the papers discusses an application created for the device for provision of feedback on student presentation. Next the paper presents, the research conducted with an experiment involving ninety-two participants testing the application in a real life scenario.

Keywords—Optical Head-Mounted Devices, Google Glass, Intelligent Technology support for education,

I. Introduction

This paper discusses the use of OHMD for providing feedback in educational settings. The research study was based on a project commissioned by a multinational pharmaceutical company, aiming to investigate the use of the technology for reducing the time production lines are affected by various problems. As various manufacturing sites exist around the world, it is necessary to support them during the packaging of medicines that operates at a rate of 64 medicines per second. Although detailed procedures are available for local operators, sometimes it is necessary for specialist engineers to be on site in order to fix the problems that are too complex for machine operating staff. This reduces delays on production lines but still has a significant cost on salaries for specialist engineers residing at different sites. The use of OHMD for obtaining machine operators' Point of View (PoV) while assessing problems remotely was the scope for the original project. The scope was to investigate how OHMD would enhance collaboration over distance and coordination of problem fixing remotely. This paper focuses on an investigation in the role of OHMD in educational contexts. The original project scope was extended to cover the provision of feedback to students who used the technology for a range of tasks as discussed next.

II. Background

Although wearable technology has shown vast improvements over the past ten years, there was no evidence that a single application dominated the market in terms of its popularity. The market has some good products such as the Nike+ iPod combination, using the built-in health monitoring sensors, is capable of keeping track of progress during a workout (Thomas 2012). Wearable learning and supporting systems have already been implemented in industry focusing mainly on supporting learning, training and operation of maintenance activity. It is necessary for available devices to improve in terms being able to have access to service, resource information process, and adaptive strategies that are directly related to the task or training being performed at that point in time (Xiahou et al. 2006).

Head mounted devices are useful due to their capability of producing and supporting augmented reality applications, i.e. the integration of information with a live video or even the user's surrounding environment in real time format. Therefore HMD achieve merging new information into an existing image. An example of one of the first commercial applications of augmented reality technology is the analysis systems used in televised football games for post match analysis [Kaufmann et al, 2007]. OHMD are not designed to provide workstations; therefore, traditional input devices such as keyboards do not support the concept of smart glasses as a wearable device [Scheffel et al, 2012]. The devices appear in a wide range of variations. A majority of OHMD will run off of the same core operating components such as visual chips, and the technology within the operating board, however certain devices can focus more on developing a strong audio as opposed to video recording depending on what developers believe the users require [Schweizer, 2012].

One of the main capabilities of OHMD is to be able to provide users with a readable, effective interface that can be an information source whilst not distracting there attention from reality. This wearable technology provides users and developers with the opportunity to exploit a new method of computer interaction and enhancing the users level of control over a system. OHMD can provide educators, trainers and professionals with the ability to train, assist and support workplace or classroom learning [Schweizer, 2012]. Using OHMD for interactions with students and transmit real-time updates should provide improvements in terms of student performance, learning enhancement and participation in learning activities. Students are not willing to ask questions during seminars with a large number of attendees and thus would miss out on gaining valuable training and education [Kuhn et al, 2015].

III. TECHNOLOGY

Google Glass was the OHMD of choice for this study. A concerning development was the announcement that Google revised the development of further versions of the device. The pharmaceutical company that sponsored the original project determined the selection of the specific device. The authors had reviewed a range of OHMD devices in terms of their features and their suitability for similar studies.

Topic	**Well below**	**On track**	**We are there**	**Exceeded**
Wearable Computer Systems				❋
Garment Integration			❋	
Displays	❋			
User Interaction		❋		
Case Studies & Applications		❋		
Augmented Reality		❋		
Networking				❋
Context Awareness			❋	

Fig. 1. Have we made the technologies of the ultimate wearable computer? (Thomas, 2012)

The Head Mounted Display (HMD) was the predominant option for hands free wearable computing in 1997, including the Eye Glass, which was made commercially available, in 2005 (Glaros, I. Fotiadis 2005). Thomas (Thomas 2012) analysed the technology available in 2012 and compared to the original researches from the IEEE International Symposium on Wearable Computers in 1997. Its researches' goals were to analyse if the goals set in the 1997 symposium has been achieved, and how the direction of research has changed in the past fifteen years. The result has rated the advance of displays technology as "well below" the expectations. The author has explained that the cost of HMD technology compared to the number of consumer products that requires such component was too high to justify the investment. As we will discuss in a later section, OHMD technology may not be suitable for continuous use in learning settings yet. The main issues relate to the ability for streaming video continuously, taking snapshots without significant time delay, aligning camera focus and dealing with heat.

The devices reviewed as part of this study included (i) Oculus Rift an OHMD developed by American start-up Oculus VR in 2012, (ii) Samsung Gear VR launched in 2014 by Samsung Electronics that requires connection to a smartphone as it has no screen of its own, (iii) VR for G3, launched iby LG in 2015 as an accessory to the G3 phone, (iv) Sony SmartEye Glass supported by Sony with a suite of tools used for developing OHMD software, (v) Microsoft HoloLens that is a headset with its own processor, (vi) Meta Pro, including dual 820p ZEISS displays supported by an Intel core i5-based computed providing a pricey but very powerful piece of hardware, (vii) ODG R-6S Smart Glasses include 3D stereoscopic see-through HD display and stereo sound running Android, and (viii) Google Glass being the lightest wearable device on the list (43 grams), displaying the second smallest resolution, although is the equivalent of a 25 inch high definition screen from eight feet away. One of the key benefits is that it can be used as a Bluetooth headset with any Bluetooth compatible phone.

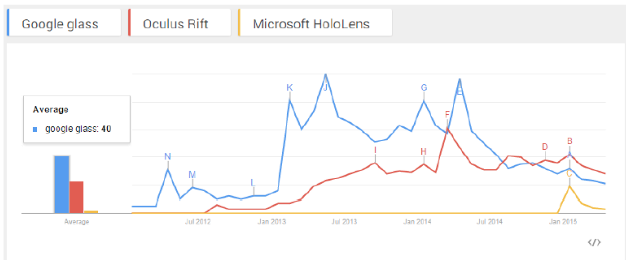

Fig. 2. Google trends on OHMD devices

It is obvious that although this research does not wish to be bound on a vendor-specific solution, it is important to consider an OHMD that is widely available, affordable, usable and allowing the replication of our findings. It must also provide a feasible solution in terms of accessibility, scalability, and development support. Prior to the deployment of the pilot studies, an investigation on interest patterns was made covering a period of almost three years up to January 2015, when Microsoft announced its product launch. The steep disinterest in Google Glass in the first month of 2015 was due to a miscommunication among the media. A considerable amount of media was announcing that the Google Glass project has been discontinued (ABC NEWS, 2015). The sales halted indeed, but a Google announcement states that the device is officially "graduating" from Google[x] to be an official Google product and it will be re-launched (GOOGLE GLASS, 2015).

It is important to choose a device that the device is both technologically feasible as well as easily accessible. The popularity analysis included comparison of interest for the three most secure technology (GOOGLE TRENDS, 2015):

IV. USING OHMD IN EDUCATIONAL CONTEXTS

Our focus was to examine the suitability of using OHMD technology in a number of educational settings, and consider the usefulness of the technology for the provision of feedback. Currently, training support is provided in a session-centred, topic-oriented approach where trainees receive guidance on specific case studies and possible problem scenarios. The introduction of OHMD technology can assist in developing innovative training models where peer-support is provided with experienced users guiding in real-time problem-solving tasks novice users. The use of such technology allows training to be more specific to real needs and to be aligned to real problems. Training can take many forms including vocational training that may involve problems that are more practical, but may also involve more theoretical aspects such as traditional in-class teaching. In such cases the training can cover a range of topics such as (i) putting in practice a lesson plan, (ii) teaching a particular topics with the aid of audio-visual support, (iii) assessing students, (iv) responding to student questions, (v) controlling a classroom, (vi) engaging students and (vii) establishing rapport.

In this paper we consider how Google Glass is used from students to describe a range of activities that they have undertaken. The scenario requires a student to use OHMD while performing certain tasks in his/her computer. The entire process is recorded on video and photographs of the participants' facial expressions. The objective of this work was to reflect on users' perceptions of how suitable the technology is for the specific learning purpose.

The study involved two undergraduate modules (i) BIS1001 first year module covering foundation topics of business information systems and (ii) BIS3324 third year module covering strategic management in information systems. Both modules used social networks as part of the learning process. Facebook was used in both modules, while the second module involved the use LinkedIn and Twitter. Participants conducted four activity types:

- Reading, social media content relating to specific tasks.
- Writing on social media as required by their coursework.
- Showing, sections of their group report they have created.
- Browsing, though various social media features and explaining their use.

Participants were required to take snapshots of their screens for each of the above activities. The following sequence diagram explains how the experiment took place. The duplication developed was based two classes StartAppActivity and SlideshowActivity. The StartAppActivity class is the main class and is responsible for showing the splash screen, managing the menu, and calling other classes. Thirteen class packages were imported so sounds could be played, gestures on the touchpad could be managed, listeners could be added, and the menu could be controlled.

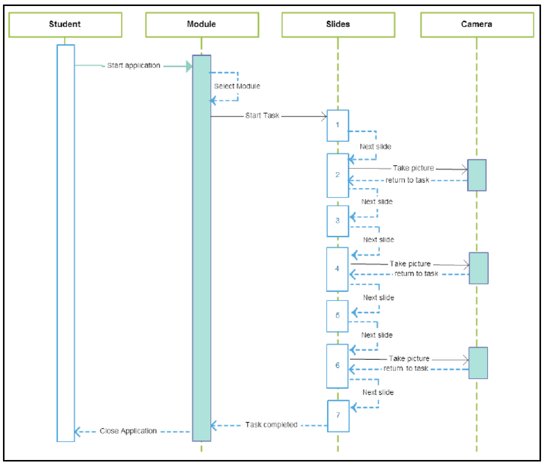

Fig. 3. Sequence diagram of Google Glass student actions

Students navigated through several instruction slides before instructed taking snapshots. Durign the process they were required to provide a narration of the entire activity as it was recorded as part of the cooperative evaluation of the OHMD technology and the interface developed for Google Glass. The process is illustrated in the following figure.

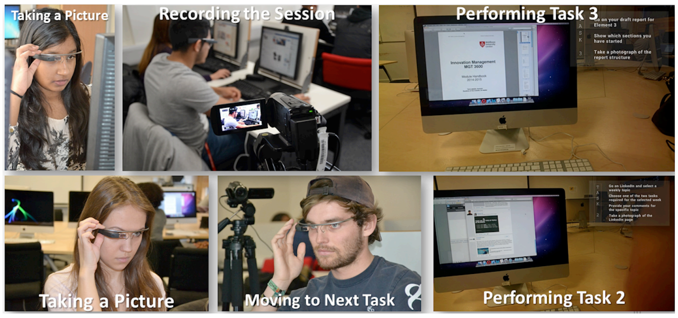

Fig. 4. Experiment setting

Once the participants completed the task, they were requested to provide their views regarding their experience. The evaluation was concerned with the simplicity of the technology during the multi-tasking process, the comfort of using the specific OHMD (Google Glass), and the navigability of the software application that was created for the purpose of this study. The participants were also required to rate their experience with respect to the four learning activities as well as provide the main benefits and drawbacks from using the technology.

V. FINDINGS

Every participant received detailed explanation on how to operate Google Glass. After making sure the instructions were clear, the students had the chance to spend some time with the hardware so they could adjust it as they wished. There were no incentives provided for student participants of the study. The task was based on volunteers in both modules. Overall the pilot study involved 92 participants of whom 27 were females and 65 males, while 30% of the students were enrolled on the Business Information Systems in Practice (BIS1001) module and 70% were enrolled on the Strategic Management and Information Systems (BIS3324) module.

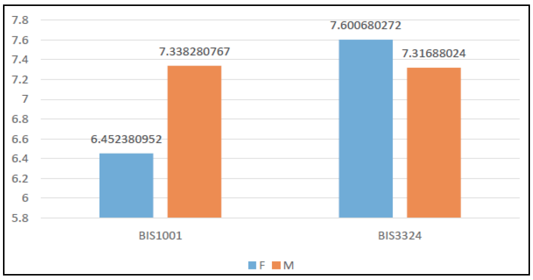

Fig. 5. Average score per module/gender

The overall satisfaction for using the technology was quite high for both modules (74.1% for the final year module and 71.43% for the first year module). However there were different patterns when we see responses according to gender for both modules.

As this is a short, positioning paper we are not able to discuss to full extent the analysis of participants' responses or demonstrate the other two pilot studies. However, it is interesting to reflect on the responses received in relation to the different aspects of the OHMD use, as sown in the figure below. Initially it is evident that the device received similar responses for simplicity, comfort and ease of navigation. For all the years and genders, the Google Glass was considered very simple (7.92), comfortable (7.52), and easy to navigate (7.90). The scores for participant experience during writing and browsing activities were not as high but were similar for both modules with 7.14 and 7.19 for the first and third year modules. Finally, BIS1001 students scored their experience for showing (6.75) and reading (6.50) activities lower than the BIS3324 students who scored their experiences at 7.32 and 6.97 respectively.

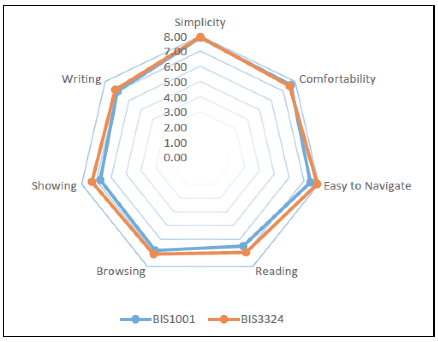

Fig. 6. Average score per module/category

It is interesting to observe students' behaviour during the cooperative evaluation process. It appears that there are significant differences in relation to their ability to perform two tasks in parallel (multi-tasking) by identifying the students who had to stop their narration and learning activity in order to take the snapshot. Furthermore, students demonstrated different levels of confidence in terms of their facial expressions, request for support and clarification questions asked during the experiment. Another observation related to the distance from the keyboard and screen during the experiment.

Some key considerations from the study and key findings are as follows:

- Technological readiness – it appears that the size of the display, the delay in taking snapshots, the device over-heating and the ability to wear them over reading glasses are important constraints for a significant number of participants.
- Usage complexity – the technology require users to perform true multi-tasking, when using another computer, affecting the productivity for certain users.
- Communication support – it appears that users who were unable to provide a detailed narration for the observer were the ones who performed more errors.

VI. Further Work

Further to the work described in this paper, the authors have conducted another experiment, using Google Glass for providing feedback to students by imposing vignettes on photographs taken during group presentations. The feedback focuses on the content of presentation slides and presenters' body language. Current work extends the pilot studies further, focusing on the alignment of student perceptions of feedback provided by instructors against the feedback types monitored and recorded through OHMD used by an observer.

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