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Bachelor of Computer and Information Sciences in Game Design and Development (BCIS)

SATCAP WP4

Augmented Reality Training Methodology

Report 1

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Details:

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Role: Provide Game design expertise

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Declaration:

- All the work provided in this document is of my own and none of it has been plagiarised.
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1.Introduction

Augmented reality (AR) can be defined as the enhancement of the physical world by superimposing digital sound, sensory stimuli, and other visuals over the real world using specific technology (Hayes, 2020). Additionally, AR is an expanding trend among a variety of mobile computing and business applications companies. Currently, the most used AR applications rely on smartphones to showcase the digitally augmented world. The process includes the user activating a smartphone's camera- which displays the real world on the mobile's screen-but has various digital overlays enhancing the physical world (Zhang & Zou, 2020). 3D models, real-time directions, labels, colour changes, and altering the environment or the user's appearance through applications such as Instagram (Krieger, Systrom, 2021) or Snapchat (Brown, Murphy, Spiegel, 2021) are a few examples of digital overlays that augment reality (Zhang & Zou, 2020).

The various literature states that AR can be displayed using a myriad of devices such as screens, glasses, handheld and mobile devices, as well as head-mounted displays. However, as mentioned above many AR applications currently use smartphones, and smart eyewear for AR is not yet as mainstream (Hayes, 2020). Due to users having to rely on smartphone screens, it greatly decreases the amount of spatial immersion -the sense of being transported to a virtual world and is similar to the concept of embodiment (Burridge, 2020 :1). Furthermore, the use of digital overlays on phone screens blurs the line between reality and make-believe, the *magic circle* (Adams, 2014: 3), of which all are needed to truly immerse a person. This differs from virtual reality (VR) which completely spatially immerses the user in the digital world leading to the user losing physical awareness of their body and surroundings which aids in greatly increasing the user's engagement with the software (Burridge, 2020). Despite AR lacking the spatial immersion present in VR, it can significantly capitalize on systems immersion. This type of immersion focuses on certain game principles and mechanics which places the user in a state of *flow* as proposed by Csikszentmihalyi (Burridge, 2020: 5), and deeply engages the user in the current activity thus, increases learning potential.

Therefore, the following report examines how augmented reality can be used to modernise as well as vastly improve training in the mining industry, and how game design principles can be used to further improve this training.

2. Literature review

Traditional training methods such as instruction manuals used for training are becoming more outdated as VR and AR training are moving into the working environment (Magic Activity, 2019). The mining industry is an example of this, as AR training provides many benefits such as reducing costs, remote assistance, drilling efficiency and accuracy which all increase overall safety and productivity (Malecaj, 2020). Therefore, this literature review discusses augmented reality training in various industries including the mining industry, as well as the implications of this type of training.

2.1. Industries using AR

The AR industry has been around since the early 1990's and was primarily used for the United States Air Force Military training and was then introduced to the public through gaming industries and other entertainment industries (Houston, 2020). A popular example of this is the game *Pokémon Go* (Niantic, 2021) which brought AR a lot of attention in 2016. The world has since then given AR a lot more attention and started incorporating it in their industries in various ways (Houston, 2020).

According to the Forbes website (2020) many companies are utilizing AR training to train their employees without the risks and challenges that would usually occur during traditional training. Enhanced surgical training superimposes radiographic visuals over images and the surgical site which allows for surgeons to perform detailed and high-risk operations (Forbes, 2020). Heavy Machinery training also uses AR which displays technical information about machinery which greatly reduces errors. "At Lockheed, AR reduced assembly times by 30%, and GE Healthcare's warehouses run 46% faster since digitizing workflows." (Forbes, 2020). Additionally, AR is also used in military training and readiness. Certain aircraft simulators can cost millions of dollars and trainees are only allowed limited periods of time to train on these simulators. Thus, AR provides an opportunity for low-cost aircraft simulators which allows more pilots more time and reduces risk and injury (Forbes, 2020).

These are only a few of many industries that are using AR to modernise and revolutionize their training. Additionally, the AR market is expected to reach around $72.7 billion by 2024 and both AR and VR will have an estimated value of over $1.3 trillion by 2035 (Statista, 2021).

Therefore, it can be seen that AR is the future of training and provides many benefits across differing companies.

2.2. AR in mining

Mining can be dangerous; the use of modern digital technology such as AR aims to make mining more productive as well as safer (AngloAmerican, 2019). In the article, *Virtual Training Applications for the Mining Industry,* Van Wyk (n.d.) examines the safety in South African mines, by analysing the data from 2003, published by the Mine Health and Safety Inspectorate. The report showed that 264 people had lost their lives in mining incidents, 3 808 were injured underground, whilst there were 446 reported surface injuries (Van Wyk, n.d.). Hence, this shows the danger and high risk attached to mining. AR makes use of superimposing digital visuals onto the physical world which allows training and high-risk tasks to be carried out by new employees with reduced risk of injury than performing these tasks at actual mining sites (Forbes, 2021). AR training guides inexperienced workers through various processes by performing virtual actions which then lead to gained knowledge.

AR training requires more physical interaction and engagement from the user which results in more efficient learning as many people learn through actions and practicing the tasks (Forbes, 2020). Whilst many may argue that by using AR training it takes away from the physical aspect of actually completing the task on the mine site, and that no amount of virtual training can properly prepare a person for carrying out high risk and dangerous activities in the mines, a concept that proves AR training is just as or more effective is *embodiment.* Embodiment refers to the full body, felt experience of a specific state or experience. Thus, one cannot purely rely on the mind to create a sense of embodiment but should also feel the sensations that occur within the body of that state (Levin, 2018). Additionally, Corness (2008) emphasises the importance of knowledge gained through bodily experiences and one's perception of the world received through bodily sensations. Therefore, despite AR training being virtual the trainee still experiences the same bodily experiences and perceptions as if the trainee were at the mining site. Through the repetition of mining activities and processes these actions become bodily experiences which then becomes gained knowledge through actions. Game design principles can then be applied to AR training to evoke certain emotions and feelings which is remembered by the body and thus, enhances the learning process. AR training aids in improving knowledge, skills, and workforce quality (Forbes, 2020).

A type of job that can use AR training is using rock drills for drilling. Specialised geologists define rock patterns in the rock face to be drilled. These patterns and drill holes define the diameter of explosives to be used, drill hole gaps, depth, and the overall shape to be exploded (CRDigital, 2021). AR training could be used here to ensure that the drill holes positioning is accurate and precise. Furthermore, AR promotes remote support, information from experts, and the increased accuracy reduces additional potential damage to the quality of the material (Forbes, 2020).

Thus, the above demonstrates the need for AR to simulate mining environments where various types of workers can practice mining processes and actions that will be experienced daily when working at the mining site. Through planning and practicing using AR training methods miners' safety increases as well as the productivity, resulting in more profitable mining operations (Van Wyk, n.d.).

2.3. AR advantages and disadvantages

As previously mentioned, AR has many benefits such as improving safety, engagement, and productivity but there are also a few more advantages to using this type of training. For instance, AR training enhances learning and comprehension across all types of workers, equipment costs are reduced, the equipment is reusable, dependency on other personnel is decreased, and AR is accessible as physically and mentally disabled people can use it (VSight, 2021). A core advantage is that AR provides a rich interactive experience between the human and computer.

AR also has a few disadvantages which include the user becoming overly dependant on the AR training and technology, users becoming too comfortable with making mistakes in the virtual world and not fully realising the extent of their mistakes and the consequences it will have on site, AR is costly to develop, and smaller companies may not have the budget to develop full AR training programs. Additionally, AR requires AI (artificial intelligence) to an extent which is quite costly as well, and AR might eventually phase out and become obsolete as the technology industry is constantly evolving.

2.4. Gaming and AR

As mentioned above, AR attracted a lot of attention after *Pokémon Go* (Niantic, 2021) was released. Many view AR in gaming and AR training as separate and many companies have tried to combine the two to create more engaging and exciting training (Nguyen & Meixner, n.d.); however, the concept is still evolving and companies are running to a few problems with user experience as game design user experience is very specific. Despite this, Nguyen and Meixner (n.d.) conducted a research to examine if inexperienced people would perform better without gamified elements or with gamified elements. The results showed that many preferred gamified elements and the participants had a higher level of engagement and better performance. Thus, this shows the potential for integrating game elements in AR training.

3. Data gathering and insights

A mini on-line survey is to be administered, in August 2021, by the SATCAP Programme team, to get some views on digital training methodologies, including VR and AR training methodology. High-level insights will be provided, once obtained.

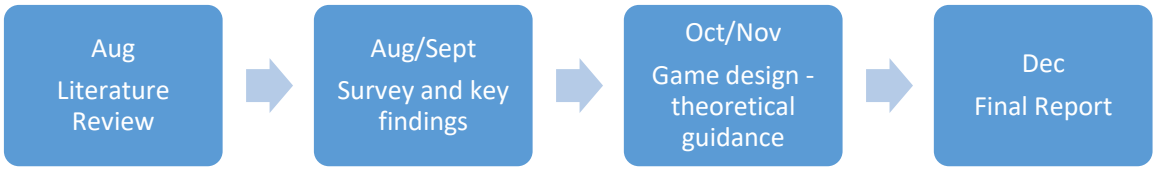
4. Game design - theoretical guidance

The Game Design theoretical guidance to be added as project progresses. This game-design theoretical guidance document may allow for game design principles, which mines may take into consideration in potentially designing for modern training. To note, the game design is provided as theoretical guidance only.

5. Conclusion

The mining industry has a high mortality rate. Given the riskiness of this sector, the workforce needs to be experienced, have sufficient knowledge and be well trained. Through the use of AR training, workers may know exactly what steps to follow in each situation, which will allow them to perform virtual moves and gain the necessary knowledge for on-job situations. Such training may enable workers with more skills, knowledge, and confidence to do their jobs. AR training methodology should not be used exclusively for training – it may be used to support and complement other training methodologies.

Timeframes planned for completion this report:



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