Don't be caught unaware! Enhancing Situational Awareness in Oil & Gas Industry through Augmented Reality

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Proceedings of the CHI 2017 Workshop on Amplification and Augmentation of Human Perception, May 07, 2017, Denver, CO, USA
ACM .
http://www.hcilab.org/amplify-chi17/

Abstract
In various industrial settings, to ensure the safety of workers and their operations, Situational Awareness (SA) needs to be maintained at a higher level. This is particularly relevant to offshore oil and gas drilling crews, given the strenuous and hazardous nature of their work. The purpose of this position paper is to look into possible prospects to enhance SA among oil and gas workers using Augmented Reality (AR) technology. We propose a scenario using Microsoft HoloLens to demonstrate potential use case for Offshore Installation Manager using AR to enhance SA. The preliminary framework using AR provides insights into SA that can be used to inform intervention, such as training programs and enhance overall User Experience for Oil and Gas workers.

Author Keywords
Augmented Reality; Situational Awareness; Human Perception; Optical see through AR glasses

ACM Classification Keywords
H.5.1 [Information interfaces and presentation (e.g., HCI)]: Artifical, augmented, and virtual realities; I.2.10 [Vision and Scene Understanding]: Perceptual reasoning

Introduction

The oil and gas industry is facing an unparalleled efficiency shortage with the additional impact of accessing, finding and extracting the oil and gas becoming ever more technically difficult due to dwindling supplies [5]. The result is an industry in which constantly evolving technology is being introduced to work alongside technology that is sometimes quite dated. This is represented by increasingly multifaceted training and development challenges as well as an ever more difficult situation for the operators, technicians, and engineers in meeting the maintenance and servicing challenges of the modern oil and gas industry.

Most recently, an oil spill occurred in Chennai, India on January 28, 2017, leading to 40 tonnes of oil spill in the sea causing enormous water pollution and damage to sea life. The officials reported human perceptual error as the primary cause of the incident [3]. A similar scenario occurred on April 20th, 2010; the Deepwater Horizon drilling rig experienced a significant blowout that resulted in the death of 11 workers and the worst oil spill in U.S. history [2]. In 2001, the largest semisubmersible rig at the time, the Petrobras P-36, sank, killing 11 men as a result of series of explosions in the rig‘s columns [1]. One factor that links these incidents is human error, mostly not being aware of critical emergencies that can be attended and avoided. This inaccurate SA was cited as contributing to the events and resulting outcomes [13]. A crucial human aspect in ensuring safety and the reduction of operator error includes the ability of workers to maintain awareness of their work environment, to understand the information that it holds, and to predict how situations will develop [16]. This cognitive skill, known as SA, has been given considerable attention by the human factors community over the past two decades. In essence, SA is the cognitive skill of knowing what is going on around oneself and using that understanding to predict how the situation may develop in the future [6].

AR systems allow users to see the real world, with virtual objects superimposed upon with the real world [4], virtual objects are computer graphic objects that exist in essence or effect, but not formally or actually [11]. An example would be addition of digital information in the visual field to update user about the system status. AR can also help in displaying live data from sensors to enhance SA.
In Oil and Gas industry, it is important that workers be informed of the overall situation and at the same time have their hands free to work on their current task. For this very reason, the presented AR system relies on the use of Head-Mounted Display (HMDs), Microsoft HoloLens rather than handheld devices. To avoid any strain for the user using HMDs, information can be provided in the direct view of the users which can help keep their hands free [15]. By adopting an user - centred approach [8], a use case using AR for Offshore Installation Manager has been identified.

Related Works

Jin and Jae [10] has designed and implemented a mobile handheld device for situation awareness system and modular mobile mapping. This mobile handheld targets military computing system application development and focuses on modular mobile mapping as a core element of situation awareness system. Morales et al. [12] implemented an Underwater AR system that enhances divers’ capability to detect, perceive, and understand elements in underwater environments.

Hou et al. describes approaches for using AR to improve facility management for the oil industry [9]. Richardson et al. [14] study witnessed an almost 90% improvement in first time quality between desktop and AR modes, with AR reducing time to build the wing by around 30%. Authors

also found that when instructions are presented with AR, people gain a faster understanding and need less convincing of the correctness of tasks.

Proposed Use Case: Situational Awareness Aid for Offshore Installation Manager

Offshore Installation Manager (OIM) is the most senior manager of an offshore platform. OIM is responsible for the health, welfare and safety of the personnel on board the installation, whether a drilling rig, production platform or a support vessel (e.g. a flotel) [7]. According to the U.K. offshore legislation (HSE, 1995), OIMs and their command teams should undergo exercises to provide them with practice in emergency decision making. OIMs report that the advantages of managing simulated emergencies are (a) discovering how one responds and makes decisions under pressure, (b) practice in thinking of possible courses of action to deal with emergencies, (c) an increase in self-confidence from having performed well, (d) the opportunity to test the team structure and identify strengths and weaknesses, and (e) an appreciation of the importance of communication during an incident.

The OIM is responsible for the operation of the vessel, the gangway and all other plant and equipment within safe limits and in agreement with the terms of the contract. They are the client‘s and the diving operator‘s (if relevant) contact person on board in connection with any contract. They will inform the owner of the consequences of deviating from the contract requirements and at no time shall they agree to any deviation without advising the owner.

The proposed workflow using AR incorporates SA as follows:

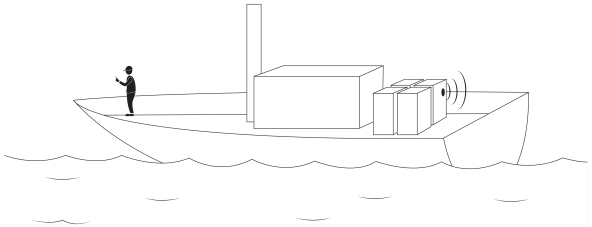

Figure 1: Offshore Installation Manager on Deck

In figure 1, the OIM is on the deck of the ship doing his regular duties. In an emergency situation, there occurs an abnormal change in parameters on the other end of the deck which needs to be attended at the earliest to avoid a catastrophe. As the OIM is occupied in his work, he might not be aware of the situation and might even end up not noticing it. In such a scenario, the OIM‘s primary responsibility should be to attend the malfunctioned component in order to prevent a major blowout.

Using the concept of SA, we propose a solution to the above-mentioned scenario using Optical see through AR glasses. The designed solution helps the OIM not to just focus on his primary tasks at hand but also to notify him of the recent changes in the system. It helps him be aware of any abnormal activity going on in any part of the deck. In our example, OIM wearing a HoloLens gets a critical notification in his peripheral vision that “Equipment 13 needs attention” . This attracts the attention of OIM to shift his focus to the system at risk.

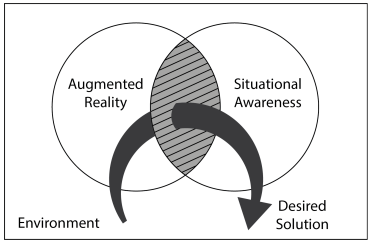

Figure 3: Proposed solution at the intersection of AR and SA.

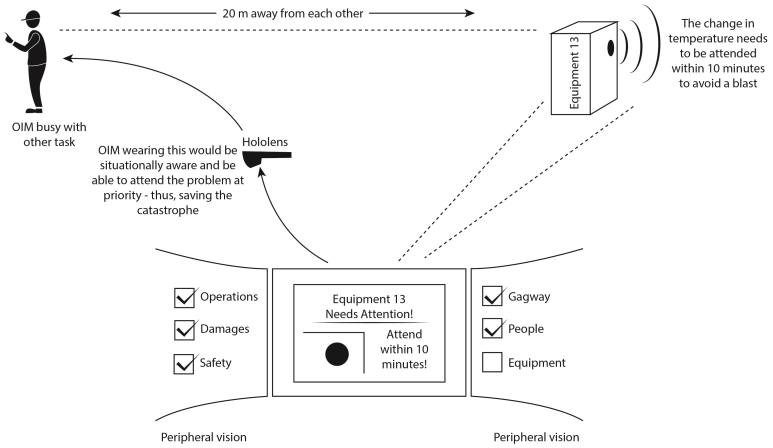

Figure 2: Visual Display for OIM using Optical see through AR glasses

On further navigating to the cause of the problem, OIM gets a message on his wearable device that “The change in temperature needs to be attended on equipment 13” and also intelligently suggest the OIM attend the problem within the time shown, along with the health indicators for other tools and operations. This helps the OIM immediately channel his attention to the location specified by the Optical see through AR glasses.

Figure 3 explains the plausible solution for OIM on offshore platform. A visual system is built up using SA and AR that can be used by OIM and in turn by Offshore Driller for efficient handling of the drilling and rigging operations. The system will be designed in such a manner that it enhances human perception.

We are in the process of developing a working prototype to test on real users. However, we speculate that the ability of the AR system to add information to a real situation and to support collaboration among distributed users will show positive effects on enhancing human perception and overall SA.

Conclusion

This study provides a preliminary insight into how SA can be developed and maintained by drillers in the oil and gas industry using AR to help avoid disasters and save lives. Despite its limitations with maturity in the state of the art, AR technology provides an added value to the oil and gas industry. It offers strong possibilities for further development as a tool for advice and support in stressful situations. Once further developed, the framework could be applied to develop SA-specific training programs or work design recommendations.

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