Using Augmented Reality to Improve Dismounted Operators' Situation Awareness

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ABSTRACT

Whether it in the military, law enforcement or private security, dismounted operators tend to deal with a large amount of volatile information that may or may not be relevant according to a variety of factors. In this paper we draft some ideas on the building blocks of an augmented reality system aimed to improve the situational awareness of dismounted operators by filtering, organizing, and displaying this information in a way that reduces the strain over the operator.

Keywords: Situation Awareness, Augmented Reality.

Index Terms: H.5.1 [Multimedia Information Systems]: artificial, augmented and virtual realities;

1 INTRODUCTION

Currently, dismounted operators rely mainly on oral communication to acquire and transmit data, as corroborated by [1]. This communication is prone to errors and, overall, very limited. There is some research on the usage of mobile devices for operators and, with the current mobile devices' hardware becoming more and more powerful, they are beginning to be applied in areas such as virtual and augmented reality [2].

Academic research on using augmented reality to aid in communication and, moreover, to improve situation awareness is scarce, at least for dismounted operators.

The objective of this paper is, therefore, to draft ideas on how to use augmented reality to improve the situation awareness of operators in multiple segments (military, law enforcement, and civilian). Keeping in mind the differences in the typical scenarios for these different users, as well as the different magnitudes of money these areas have to spend in the equipment, we propose the use of COTS hardware to present the augmented reality data and hence will not examine hardware.

2 SITUATION AWARENESS

Endsley has defined situation awareness as [3] "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future". The same author extends the definition by saying that [4] "situation awareness therefore involves perceiving critical factors in the environment (Level 1 SA), understanding what those factors mean, particularly when integrated together in relation to the operator's goals (Level 2), and at the highest level, an understanding of what will happen with the system in the near future (Level 3). These higher levels of SA allow people to function in a timely and effective manner".

Further discoursing on Endsley's definition, for an operator to be at maximum efficiency he must not only acquire and understand information regarding his surroundings and his mission, but also use this information to foresee events in the near future and be able to plan his actions accordingly.

2.1 Measuring Situation Awareness

There are many studies on techniques to measure situation awareness, although there are few studies to perform comparison between these techniques [5].

SAGAT is a freeze probe technique that allows the measurement of situation awareness based on the operator's requirements. SAGAT is possibly the best approach to measure situation awareness and numerous studies validate it as a valid metric for assessing it.

Probably the simplest way to verify the impact of situation awareness in the operator's performance is to empirically measure the quantifiable results (e.g. time and accuracy) and compare these to the results of similar tests without situation awareness aids.

Other tools for measuring situation awareness will be studied throughout this research, but as a starting point we consider this two to form a solid base.

2.2 Elements of Interest

The first great concern is to define elements that can be displayed in a HUD (Head-UP Display) to the operator. A few elements, such as a map of the terrain and text messages for communication can be inferred from other domains (e.g. airborne) and are commonly implemented in HUDs. Other elements such as a wireframe blueprint of a building of interest or beacons signaling the position of enemies or points of interest are not necessarily obvious. Another interesting topic is the method of data input, and its potential to reduce errors and how it can affect situation awareness. Hereby we discuss a few of these elements and our ideas on how to check for their effectiveness.

2.2.1 Map and Navigation

Two dimensional map data can be displayed in several ways, being a simple radial mini-map centered on the user the most common option adopted in the gaming industry for a long time. This approach typically shows the user position in real time as well as allies' position and points of interest. While this is a valid approach that may improve the situational awareness of the operator, looking to the corner of the HUD during intensive engagement activities may have the contrary effect due to the narrowing of the field of view.

Bell [6] proposes a way to display information in a god-view of the map by placing it in a way the user can access it by focusing on it. For our purposes, it suffers the same problems as the

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aforementioned mini-map. Nevertheless, these two options must be studied as they may provide invaluable data.

Navigation data could be, instead, integrated by the shading of the appropriate paths utilizing AR techniques to superimpose it in the view of the operator, creating a sort of synthetic view. This approach is already being applied in the avionics industry, such as in the NASA's synthetic vision system[7], Rockwell Collins' Enhanced Vision System™[8], Honeywell's SmartView™ [9] and Elbit System's ClearVision™ [10], where paths and other information are displayed in the HUD of the pilot, showing the path he must follow.

Other elements in the map, such as the position of allied forces and intelligence data can be represented through intel beacons as explained in the next subsection.

The effectiveness of the navigation aid element in improving situation awareness can be measured empirically by simply measuring the time the user takes to navigate different routes with or without the use of the proposed techniques.

2.2.2 Intel Beacons

Allied forces position, enemies, and other interesting intel can be displayed through the use of cylindrical luminous beacons positioned at the right location in the view of the operator, in a similar way as the navigation paths.

For the display of these beacons, we can either use occlusion to display them only when they would be physically visible or show them at user discretion providing sort of an x-ray vision.

The effectiveness of using this technique can be measured by SAGAT [8] with appropriate questions at points of interest during the exercise.

2.2.3 Communication

Verbal communication is subject to sound interference of the vicinity of the speaker, can be misheard due to high ambient noise levels in the area of the recipient or simple interference in the transmission. Moreover, in some cases, the simple act of whispering can compromise the position of the operator in several occasions.

Non-verbal communication can be a powerful tool to avoid misinterpretation of information. We propose a method for the operator to send predefined messages to the allied forces, as well as sending more complex messages in a non-verbal way. This communication through text messages must also be studied to be displayed in a way the user can acquire its information without losing awareness of his surroundings in a similar way as the traditional corner-placed mini-map can affect this awareness.

We can analyze the effectiveness using SAGAT to check if the user received the message, or empirically in the case of directives or orders.

2.2.4 Wireframe

This other form of synthetic vision can provide enough information to the operator so that he may acquire knowledge about potential position of enemy forces by simply analyzing the layout of the area and inferring which would be the probable location of these based on potential cover and field of view. Predicting near future events goes hand to hand with Endsleys' third degree of situation awareness.

A wireframe of the blueprint of a building of interest may be desired in order to facilitate the navigation, as well as providing invaluable data on interesting points to look at when crossing a door or going around a corner.

This element's effectiveness can be measured in an empirical way as well as using SAGAT.

2.2.5 Augmented Crosshair

In some scenarios it may be hard for the operator to correctly maneuver his equipment, whether in a close quarter scenario or in a patrol, where the weapon is at rest at the hip level. Having an augmented reality crosshair pointing to the direction that the user's weapon is currently engaging could improve both the accuracy and the response time.

The effectiveness of this element can be measured in an empirical way by analyzing the response time of the operator during an engagement.

2.2.6 Target Designation and Intel Report

In the same way that the coordinates of the point of aim can be acquired for displaying the augmented crosshair, these coordinates can be used to select the location of an intelligence element or to designate a target. This technique has the potential to be faster and more accurate than the usual way that the operators communicate such elements (verbal communication or annotated pictures) as well as providing a hands-free method of input where the user can continue to be aware of his surroundings and does not have to move his hands away from the equipment.

While the precision of the reported positions can be measured empirically, the actual improvement this technique can provide to situation awareness, in relation to the traditional way of orally communicating them, must be analyzed by other means such as SAGAT.

3 Conclusion

We briefly discussed possible ways to improve dismounted operators' situation awareness and two ways to measure their effectiveness. As this is a work in progress, other resources to improve situation awareness will be studied and proposed, as well as other methods to measure its effectiveness.

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