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Utilizing Virtual and Augmented Reality to Augment Real World Operational Training to Improve Proficiency

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UTILIZING VIRTUAL AND AUGMENTED REALITY TO AUGMENT REAL-WORLD OPERATIONAL TRAINING TO IMPROVE PROFICIENCY

EXECUTIVE SUMMARY

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Project Summary

Recent years have been marked by the emergence of affordable off-the-shelf solutions in Virtual Reality (VR) and Augmented Reality (AR) technology. Those advances created a unique opportunity for exercising transformational approaches to personalized, just-in-time relevant training of large numbers of people. The research studies suggest that the systemic application of novel technical solutions in training will have a major positive impact on operational readiness regardless of community size or Department of Defense (DoD) service demographic. These results are especially relevant during times of financial constraints, or environmental limitations such as pandemics.

We executed a series of research activities to identify best-in-class contemporary VR/AR training solutions used by the U.S. Navy (USN) and map those systems' capabilities to the U.S. Coast Guard's (USCG) needs. Our findings suggest that the most prevalent computer-supported training solutions in both the USN and United States Marine Corps (USMC) are in the class of training simulators; examples include simulators for ship navigation, convoy courses, marksmanship, and flight simulators. They are typically connected with well-structured curricula, and their use is mandated; over time, they became an integral part of the training regimen in both services. Good examples of places where they are deployed are schoolhouses and simulation centers that maintain those simulators and schedule regular training. Training systems that use VR and AR technology are predominantly on the level of prototypes, used locally (not widespread across services), and typically provided as an option to the training force.

In addition to a survey of current training solutions, we conducted technology market research, identified representative technological solutions, and reviewed their capabilities. We illustrated the best use cases and produced a set of recommendations on selecting training systems that match trainees' needs. In addition to VR and AR training solutions, we identified several other candidate technologies and training approaches that hold promise in addressing the United States Coast Guard's (USCG) training needs and produced a set of recommendations on how to select, promote and use training solutions to increase the probability of those systems being adopted and used by the trainees.

Keywords: *training, virtual reality, VR, augmented reality, AR, human performance, large scale adoption of technology, training effectiveness*

Background

The most recent wave of affordable, commercial off-the-shelf (COTS) hardware and software solutions has already generated great benefits in many domains. Scores of VR and AR head-mounted displays (HMDs), also called heads-up displays, with reasonably good display resolution, a field of view (FOV), image quality, and head tracking as well as easy-to-use yet powerful 3D game engines have created a renewed interest in VR and AR domains and applications. Their technological performance, robustness, and low cost made them a great contender as a training solution of choice when addressing the needs of a large number of potential users; they have raised the hopes and interests of stakeholders in many domains, including the DoD. Together with optimized interfaces and pedagogies, those solutions create a unique opportunity for exercising transformational approaches to personalized, just-in-time relevant training of large numbers of people. Systemic application of those systems in operations and training would have a significant impact on operational readiness. These results are especially relevant during times of financial constraints or environmental limitations such as pandemics.

The efforts to leverage the potential and power of those training systems to address the needs of the USN started a while ago; as a result, the service created a good set of solutions that supports its training needs. In the project, we conducted a series of research activities to identify best-in-class contemporary VR/AR training solutions used by the USN and USMC, and mapped those systems' capabilities to the USCG needs. Although the research questions addressed in this effort are focused on current USN training solutions and practices, there is sufficient evidence to support the transferability of training effectiveness across services, resulting in a tenfold return on taxpayer investment. Further, this VR/AR research complements congressionally mandated interoperability requirements for USN and USCG while simultaneously addressing USCG training gaps/shortfalls.

An additional component of the project work consisted of highlighting the domains and areas where neither USN nor USCG has technology-supported VR/AR training solutions. To fully address the latter, we used our knowledge of USN and USCG missions and training needs and our expertise in novel technologies and capabilities of their sensory modalities and produce advice on addressing those needs with novel solutions. Our overarching goal was to provide both leadership and practitioners with the necessary tools and guidance to help them navigate the landscape of novel training systems and select the best option given their requirements, needs, and constraints.

This research produced a master's student thesis; the text includes a manuscript that will be submitted for publication in a professional journal.

Findings and Conclusions

Our initial plan was to focus only on VR and AR training solutions; however, it became apparent that we would need to include training simulators in our survey. Frequent examples of this type of training solution include simulators for ship navigation, convoy courses, marksmanship, and flight simulators. These are characterized by a range of visual displays and the physical mock-up of the panels with instruments and the seat for the operators; in some cases, they include physical simulation of the entire room within which a group of operators is expected to work.

Our findings suggest that the most prevalent computer-supported training solutions in both USN and USMC are in the class of training simulators. They represent capital investments on the part of each service, and they have been established as alternatives to costly training in the real-world environment; the reduction of the costs and flexibility they afford to the training force have been the main reasons for their introduction. The same solutions are typically supported with well-structured curricula, and their use is mandated; over time, they became an integral part of the training regimen in both services. In some cases, they represent the only training option available to trainees (flight simulators are in that category), and in other cases, they are used as a means to increase trainees' skill level in case they did not achieve performance standard measured after traditional training approaches (marksmanship trainer Indoor Simulated Marksmanship Trainer is used that way). Good examples of places where they are deployed are schoolhouses and simulation centers that maintain those simulators and schedule regular training. They are funded each year, and in that sense, they represent stable and reliable training solutions.

We also found that in contrast to simulators, training systems that use VR and AR technology are predominantly on the level of prototypes, used locally (not widespread across any service), and typically provided as an option to the training force. Their longevity has been lacking; the systems

that we have been familiar with through our prior work in the training domain no longer exist. We also found that the current number of VR and AR solutions in USN and USMC is remarkably low. It is also possible that introduction of those training solutions was not done properly and that adoption of VR and AR solutions failed in some aspect. At this point, we have some indications of why that is the case; however, to form well-based conclusions, one would need to engage in additional data collection focused solely on finding the reasons for that situation.

Lastly, our project produced a set of recommendations on how to select training systems that match trainees' needs. We also created a set of recommendations aimed at increasing the probability of future training systems being adopted and used by a large number of prospective trainees.

Recommendations for Further Research

The large scale adoption of any solution is the ultimate goal in many domains; having tools that are widely and effectively adopted by a majority of intended users creates the necessary conditions for a paradigm shift in terms of dramatic change in the way those people operate. Having the majority of firefighters exposed to training solutions that effectively teach life-saving skills, and providing the surgeons with alternative ways of practicing their surgical skills in as near-realistic conditions as possible, are important goals that virtual reality (VR) and augmented reality (AR) communities aspire to.

Our recommendation for the follow-on effort is to focus on technology adoption across individual services; here, we have in mind the use of VR and AR solutions not only in the training domain but also in the operational environment. The goal of that investigation would be to identify a set of issues that affect the adoption of VR and AR systems; this also includes the issue related to the lack of their longevity over time, even when they are initially (successfully) adopted and used. This type of work would include extensive data collection across each service. As a form of data collection, we advise a mixed approach where a large number of individuals would be asked to respond to the online questionnaires, and a smaller number of individuals who are representative of typical groups of operators (novices, intermediate and experts) and instructors would be involved in focus groups and interviews. The type of data collected this way would help us further refine the model of technology adoption in DoD and identify specific issues that may be unique to a particular technology, in this case, VR and AR (Yates-2013; Sadagic-2015).

References

Yates, F. A. (2013). *Diffusion and Large-scale Adoption of Computer-supported Training Simulations in the Military Domain* (NPS Master Thesis) Sep 2013. Available from NPS Calhoun database.

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Acronyms

AR	augmented reality
DoD	Department of Defense
USCG	United States Coast Guard
USMC	United States Marine Corps

USN United States Navy
VR virtual reality