[Poster] Using Augmented Reality to Support Information Exchange of Teams in the Security Domain

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ABSTRACT

For operational units in the security domain that work together in teams it is important to quickly and adequately exchange context related information. This extended abstract investigates the potential of augmented reality (AR) techniques to facilitate information exchange and situational awareness of teams from the security domain. First, different scenarios from the security domain that have been elicited using an end-user-oriented design approach are described. Second, a usability study is briefly presented based on an experiment with experts from operational security units. The results of the study show that the scenarios are well-defined and the AR environment can successfully support information exchange in teams operating in the security domain.

Keywords: Augmented reality, information exchange, usability.

Index Terms: H.1.2: User/Machine Systems; H.5.3 Group and Organization Interfaces; H.5.1 Artificial, augmented, and virtual realities

1 INTRODUCTION

In the security domain, operational units rely on quick and adequate exchange of context-related information. Nowadays, operational units that work together in teams orally exchange information. Oral communication, especially under time pressure, can be understood and interpreted differently by the different team members [1]. As result, wrong decisions or choices may affect the continuation of an operation, the security of the operational units as well as the possibly affected civilians.

Augmented reality systems allow users to see the real world, with virtual objects superimposed upon or composited with the real world [2]. AR systems have, e.g., been used to allow distributed users to spatially collaborate with each others and create a shared understanding in, e.g., the field of crime scene investigation [3], to increase social presence in video-based communication [4] or help in complex assembly tasks [5].

This extended abstract reports on first results of a project that evaluates the usability of AR to support information exchange and situational awareness of teams in security domain. Here, situational awareness is defined as the perception of a given situation, its comprehension and the prediction of its future state [6]. Within the project, the security domain is represented by the Dutch Police and the Netherlands Forensic Institute (NFI). By using an end-user-oriented approach, different scenarios for using AR to exchange information with these partners have been identified. Second, a Unity-based AR environment supporting these scenarios has been developed using state-of-the-art technology for marker-less tracking in AR [7].

The next section describes the scenario identification and design. Subsequently, the main architectural concepts of the framework supporting the collaborative AR system are discussed. Then, the AR environment as well as results of a usability study are briefly presented. The extended abstract closes with conclusions and outlook on future work.

2 SCENARIO DESIGN

Based on earlier positive design experiences with operational units in the security domain [8], we used the triadic game design (TGD) philosophy [9] as the leading design approach to the scenarios. TGD is an end-user oriented design approach distinguishing three equally important game components: *Play*, *Meaning*, and *Reality*. During a half-day workshop in which 12 members of 3 different operational units participated, 3 different scenarios were identified. In all 3 scenarios, AR is used to establish virtual co-location. Virtual co-location entails that people are virtually present at any place of the world and interact with others that are physically present in another location by using AR techniques. The 3 identified scenarios are:

- *Reconnaissance teams*: A policeman, equipped with a headmounted device (HMD) investigates a safe house in which a witness needs to be safely accommodated. This policeman shares the local view as recorded from the HMD camera with a remote colleague. While the local policeman investigates the safe house, the remote agent has the task to highlight suspect objects in the house and point out possible emergency exits.
- *Forensic investigation*: A forensic investigator arrives at a severe crime scene. Wearing an HMD, the investigator shares the local view with a remote colleague. The remote colleague has the task to point the local colleague to possible evidence, take pictures of evidence and support the preparation of 3D laser scans.
- *Domestic violence*: A team of 2 policemen arrives at a scene of domestic violence. One of the policemen wears an HMD and shares the local view with a remote colleague. The remote colleague can provide instructions and information on the case, take pictures and highlight possible evidence. The local policeman wearing the HMD orally shares received information with the second local colleague.

3 DISTRIBUTED COLLABORATIVE AUGMENTED REALITY ENVIRONMENT (DECLARE)

In order to support the above scenarios, DECLARE is developed. DECLARE is a centralized multimodal framework for distributed collaboration in AR. It is developed to support virtual co-location of multiple users simultaneously, through specialized applications serving both local and remote users. The communication is enabled through a shared memory mechanism. The architecture is scalable, distributed and modular, with a range of functional modules e.g. hand tracking and gesture recognition [10]. An essential part of DECLARE is represented by the RDSLAM module [7] which is based on the state-of-the-art marker-less algorithm for mapping the physical environment and for localizing the user

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IEEE International Symposium on Mixed and Augmented Reality 2014
Science and Technology Proceedings
10 - 12 September 2014, Munich, Germany
978-1-4799-6184-9/13/$31.00 ©2014 IEEE

in the environment. The sparse cloud of 3D points generated by RDSLAM provides virtual anchors between the AR and the physical environments (the yellow points in Figure 1) that enable AR annotations by the remote user.

4 Usability Study

11 policemen and inspectors from 4 operational units of 3 national Dutch security institutions participated in a usability study. In the study, they played the local and remote roles of the 3 scenarios described above. The experiment took place at a training location of SWAT teams. All 3 scenarios were performed as designed with no interruption being necessary at any time. Each scenario was played mostly for up to half an hour, for multiple times, with several participants. In a few cases, the same participants played the local as well as the remote role. Audio communication was set up by using police radio devices.

The user interface, created using the Unity 3D game engine, was customized according to the requirements of each scenario and was adjusted to the role of each user. The local user was wearing an optical see-through HMD (META.01 Developer edition). The grey area in user interface of the remote user (see Figure 1) indicates the augmented part of the view in the HMD.

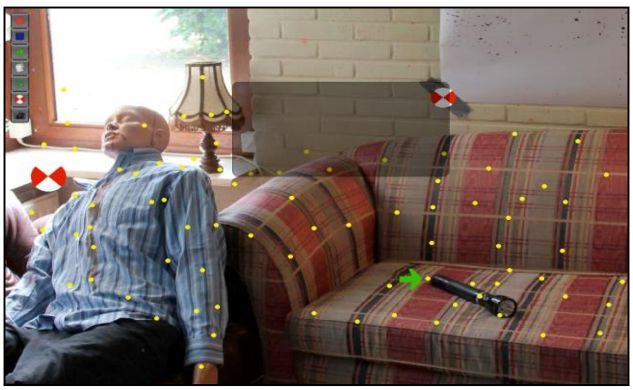

Figure 1: Screenshot of the user interface for the remote investigator during the experiment on crime investigation.

The user interface of the remote user displays the live video captured from the HMD camera of the local user. Additionally, it shows an authoring menu with buttons for handling virtual 2D and 3D objects (see Figure 1). For instance, in the crime investigation scenario (Figure 1), the remote person is able to place 3D objects (spheres, cubes, arrows), to write 3D text messages, to place laser stickers to mark physical areas to be scanned by the local investigator, and to take/load photos from the local scene. In order to accurately place virtual objects, the remote user can freeze the live video feed, place a virtual object and then unfreeze the video transmission to again share the view with the local user.

After the experiment, each participant filled in a questionnaire with 16 closed and 8 open questions on the usability of the system as well as its support with regard to information exchange. The evaluation of the answers indicates that the scenarios were clear and attractively built, with clear instructions and explanations given beforehand.

The location, the setup which included weapons, real handcuffs, visual representations of blood patterns and injuries (on a mannequin in the forensic scenario) contributed to the realism of the scenarios. The participants appreciated the shared visualization, the communication, the directions of the external supervisor, the person profile pictures delivered on the spot and the provided information in AR to determine essential focus points, to increase the situational awareness and to improve the common operation picture. In most cases, the virtual information was easily recognizable and displayed at the right time. The participants pointed out that some actions were slower than in real operations and that this negatively impacted the realism and execution of the scenarios. This was mainly due to the wired connection between the laptop in a backpack of the local user and the rest of the system. Some policemen experienced difficulties due to the temporary loss of visual tracking which was caused by a very high pace of the tasks and to an improper calibration of the marker-less tracking. Others reported that the augmented area in the HMD was too dark and distracting. In case of the forensic investigation, a similar problem was caused by the mask being worn over the mouth which led to fogging of the HMD.

5 Conclusion and Future Work

This extended abstract described 3 scenarios in which AR can be used to support information exchange of teams in the security domain. The usability study showed that the scenarios are well-defined and the used AR environment is suitable for the tasks. As future development of our AR environment, we will focus on enabling interaction for the local users by free-hand gestures (using a depth sensing camera), on the integration of HMD hardware trackers (for measuring orientation) to improve the tracking of local person, and on Wi-Fi communication for the local person to enable a higher mobility of the local user.

6 Acknowledgements

The results of this extended abstract have been achieved as part of a joint project with the Dutch Police and the Netherlands Forensic Institute (NFI) sponsored by the National Coordinator for Security and Counterterrorism (NCTV) of the Netherlands.

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