Augmented Reality maintenance demonstrator and associated modelling

V. Havard, D. Baudry, A. Louis, B. Mazari

LUSINE and IRISE laboratories, CESI

ABSTRACT

Augmented reality allows to add virtual object in real scene. It has an increasing interest last years since mobile device becomes performant and cheap. The augmented reality is used in different domains, like maintenance, training, education, entertainment or medicine. The demonstrator we show is focused on maintenance operations. A step by step process is presented to the operator in order to maintain an element of a system. Based on this demonstration, we will explain the modelling we propose allowing describing an entire maintenance process with augmented reality. Indeed it is still difficult creating augmented reality application without computer programming skills. The proposed model will allow to create an authoring tool - or to plug to an existing one - in order to create augmented reality process without deep computer programming skills.

Keywords: Augmented Reality, modelling, maintenance, training.

1 INTRODUCTION

Several definition have been proposed for Augmented Reality (AR). Azuma proposed a commonly accepted one in the 90s [1]. Augmented reality must follow this characteristics:

1. Combines real and virtual
2. Interactive in real time
3. Registered in 3-D

This definition allows not limiting the augmented reality to specific device, like tablet or smart glasses. Indeed, the augmented reality can be haptic or acoustic. Augmented reality becomes more and more used in several domains like maintenance, training, education, entertainment and medicine. The ability to add digital information to the real world allows users to be more aware of their environment is an interesting feature, since it gives more sense to what the user sees.

Several work focus on maintenance with augmented reality. For example, Henderson [2] studies how augmented reality improves the maintenance process in **guided configuration**. That configuration means that the operator is only guided by the displayer; no expert assists him during the maintenance process. It compares 3 means of maintenance displays inside a turret: a Head-Mounted Display (HMD) with augmented reality, a HMD with a virtual representation of system to maintain and a screen put on a seat. The performance is measured in terms of task localization time and task completion time. He shows that the localization time is improved with augmented reality displayer whereas the task completion is quite the same between augmented reality and the Screen on the seat.

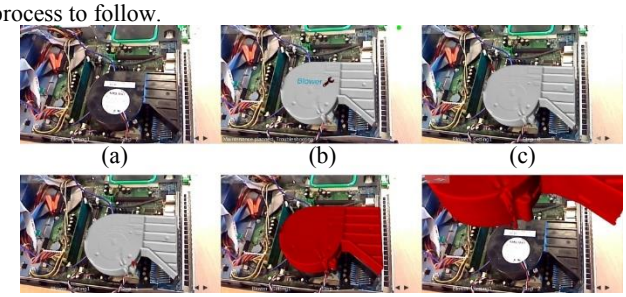
Bottechia [3] studies the remote collaboration between expert and operator with augmented reality. We will called that, the **assisted configuration**. He compares 3 means of communication: expert gives his instructions by phone (TEL) or with augmented reality displayed on a screen put near to the system to maintain (VISIO) or with augmented reality displayed on a smart glasses worn by the operator (TAC). The result shows that the task is executed 10% faster with the TAC system.

In the context of maintenance, several points must be taken into account. The first one is that systems are complex. Therefore, each maintenance operation must be well documented by the system expert in order to guide the operator on the process to follow. Currently such processes are put on paper or on tablet for the more advanced company. So operator must read the process then mentally project what he has read to the system he is maintaining. That mental projection can be a source of error. Moreover, for each new process or each new person in the company, operator must be trained before doing it on the real system. The operator's training time is cost consuming for an industry, even more for industry with high employee turnover rate. Lastly, when the operator goes on maintenance site, the company must be sure that the operation is correctly done. If we take the example of the off-shore wind farm maintenance, operator takes around 1 hour to go on site. So the maintenance shall be made without any mistake. That is why augmented reality is a key subject in maintenance because augmented reality is able to answer to those problematic. In this works, we first present how the augmented reality for maintenance demonstrator works. Then we will explain on which model the demonstrator is based.

2 DEMONSTRATORS

2.1 Tablet maintenance demonstrator

The demonstrator, uses augmented reality to show a step by step maintenance process. The process consists in dismounting a blower of a PC. The user uses the tablet to see what he must do for the maintenance process. The tablet is the display mean to mix the reality scene and the augmented reality objects. Fig. 1 shows what the user can see on the tablet. Each maintenance is composed of a list of actions. Each action is an animation (in red) that shows the process to follow.



(a) (b) (c)

(d) (e) (f)

Figure 1: Step by step process in augmented reality. (a) blower, (b) blower with augmented reality, (c) animation "Unscrew 1", (d) animation "Unscrew 2", (e,f) animation "dismount blower".

* Vincent Havard: vhavard@cesi.fr

* David Baudry: dbaudry@cesi.fr

IEEE Virtual Reality Conference 2015
23 - 27 March, Arles, France
978-1-4799-1727-3/15/$31.00 ©2015 IEEE

The demonstrator is working on an "Asus transformer pad" tablet, with Android 4.4.2. We are using a Tronsmart plug (Miracast) to display the demo on a TV. The demonstration video is accessible at this URL: http://youtu.be/8ZjDGC7hXCY

2.2 Espon Moverio BT-200 smart glasses demonstrator

As the tablet is not a hand free device, we are developing another demonstrator on Espon Moverio BT-200. This demonstrator is currently showing the virtual blower registered with the real one. This demonstration could be tested by each interested person during the conference too.

3 AR MAINTENANCE MODELLING

The demonstrator is based on our work on modelling a maintenance process in augmented reality. The aim of the model is to be able to represent the maintenance operation with augmented reality with a standardized file. That model will allow to either create authoring tool or to plug to existing one in order to quickly create or edit augmented reality maintenance operation and export it to that standardized file. Moreover any **AR player** that will respect the model defined could play the maintenance process described with that model. For reaching this aim, we define several concepts presented in Fig. 2.

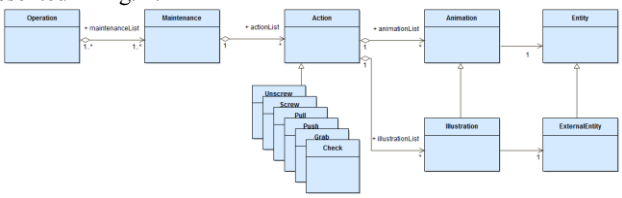


Figure 2: Maintenance UML modelling for augmented reality.

The first concept is the **Entity**. The entity is the smallest part of the system to maintain, for example, a screw, a resistor of an electronic card or a gear box. The entity concept is the virtual object that represents the real one. Entity can contains children entities, allowing to create bigger part of the system. Each entity is represented by a 3D model and/or an Image target that allows to recognize the real object by the AR player. We define a similar concept that is **ExternalEntity**. An external entity has the same properties as the entity, we only semantically distinguished it. An external entity allows to represent an object that is not part of the system, but either an object the operator must use for doing the action, for example a monkey wrench to unbolt a piece. External entity can also represents a clue for guiding the operator, for example an arrow to focus the interesting entity or to illustrate the action to do. The third concept is an **Action**. An action represents what the operator must execute on the system. An action aims to create template action like (pull, push, screw, unscrew). Indeed, the system expert will use those template action to edit the maintenance operation for the operator. An action is composed of **Animation** on entity. An animation is represented by a starting pose (position and orientation) and an ending pose of the entity concerned. The entity and a duration for going from this starting pose to the ending pose. Therefore we can define all necessary movement to execute on the system entity. An **Illustration** is the same concept as animation but on an external entity. The last 2 concepts are container of the concepts describe above. A **Maintenance** represents a series of actions to execute. In the example of the demonstrator, the maintenance is composed of 3 actions: unscrew 1, unscrew 2 and pull blower. The **Operation** represents a list of maintenances to execute by the operator when he moves on the site to maintain. The operation is prepared by a system expert.

4 PRESENTATION OF THE LUSINE RESEARCH LABORATORY

The LUSINE (Laboratoire sur les USages Informatiques et Numériques de l'Entreprise) research laboratory from CESI (Engineering and Computer Sciences Schools) develop research in the fields of ambient intelligence, virtual and augmented environments, modelling and optimization of complex systems and data mining. These research area are mainly focused on the uses and identified from the industry through the work developed in the context of student projects, collaborative research projects and industrial partnerships. The three themes developed are:

- Ambient Intelligence. The research focuses on connected devices, sensor networks, embedded intelligence in products and M2M (Machine to Machine) communications applications for home automation, smart buildings and for the factory of the future.
- Virtual and augmented environments. This theme primarily intended the uses of these environments for the PLM (Product Lifecycle Management), factory of the future and for industrial maintenance activities.
- Uses of Artificial Intelligence (cross Thematic). We address in this cross-thematic modeling and optimization of complex systems and the development of decision support tools for example using multi-agent systems. The research perspectives also cover issues related to BIG Data and specifically machine learning and the search and visualization of large data sets.

Current LUSINE works are carried out within [4][5]:

- Franco-British Mer Innovate Project: maintenance and e-maintenance equipment of offshore wind farms. LUSINE research works focuses on the use of the augmented reality technology and remote communication for maintenance on wind systems. We also develop a decision support tool to schedule maintenance activities based on multi-agent systems.
- Franco-British CREST Project. The research focuses on the modelling and optimization of the implementation and the reliability of wireless sensor networks within a smart building. Additionally, we are working on the exploitation of CREST living lab in the field of ambient intelligence, to design, develop and test new management policies of intelligent lighting based on user behavior.

5 ACKNOWLEDGMENT

Acknowledgement is made to European Union for the support of this research through the European Program INTERREG IVA France-Channel-UK by funding project entitled MER Innovate.

6 RÉFÉRENCES

[1] R. T. Azuma et others, «A survey of augmented reality,» *Presence,* vol. 6, n° %14, pp. 355-385, 1997.

[2] S. Henderson et S. Feiner, «Exploring the benefits of augmented reality documentation for maintenance and repair,» *Visualization and Computer Graphics, IEEE Transactions on,* vol. 17, n° 110, pp. 1355-1368, 2011.

[3] S. Bottecchia, «Système TAC: Télé-Assistance Collaborative. Réalité augmentée et NTIC au service des opérateurs et des experts dans le cadre d'une tâche de maintenance industrielle supervisée.,» thèse, 2010.

[4] M. Sahnoun, P. Godsiff, D. Baudry, A. Louis, B. Mazari, "Modelling of maintenance strategy of offshore wind farms based multi-agent system", CIE44 & IMSS'14 Proceedings, 14-16 October 2014, Istanbul / Turkey, pp. 2406-2420, 2014.

[5] M.A. Benatia, A. Louis, D. Baudry, B. Mazari, A. El Hami, "WSN's Modeling For a Smart Building Application", IEEE Int. Energy Conf. – ENERGYCON 2014, Dubrovnik, Croatia, May 2014.