Mixed Reality, the Disruptive Technology to Increase Exercise Realism, Improve Live Training Efficiency and Shorten Exercise Preparation

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ABSTRACT

Augmented/mixed reality (AR/MR) is part of those recent technological advancements that could take M&S applications one great step further. By providing some of the keys enabling technologies to support interactions between simulated and real worlds such as precise 3D localization, spatial mapping or head mounted display, AR has the potential not only to effectively make Live, Virtual and Constructive (LVC) training solutions happen, but also to increase significantly the realism of training, particularly in situations that are either too dangerous or too expensive to be exercised in real.

This paper deals with the use of AR for dismounted soldiers training, which involves solving many issues, ranging from determining the soldiers' exact location at any time to ensuring correct display in various luminosity environments, but also handling occlusions between real and virtual objects which are critical for the trainee's efficient immersion.

It also introduces a prototype based on Microsoft's HoloLens AR-glasses to locate the trainee, to rebuild the 3D environment and to display the virtual characters, a constructive simulation for modelling opponent Forces, and an instrumented FAMAS assault rifle replica allowing to fire on virtual enemies.

The lessons learned collected during experimentations at the French urban combat training centre (CENZUB) that involved three dismounted soldiers fully equipped with AR devices are shared and discussed in order to provide future envisioned use-cases and technological gaps to overcome before any operational deployment.

1.0 PROBLEM STATEMENT

The forces readiness effectiveness must comply with the “train as you fight” dogma : it is reasonable to think that the more the training conditions are close to the real conditions of the war fighting, the more effective the training is. Acknowledging this, “live training”, where all players are real, is probably the most suitable form of training. Unfortunately, for reasons of cost or implementation complexity, it is often difficult to reproduce realistic combat environments where a large number of threats are involved. This is particularly the case for the training of dismounted soldiers who have to face with numerous threats on the battlefield.

For training purposes, simulation has been used for many years. The behaviours of the enemy forces (and/or friendly forces in some cases) are simulated, and the trainees fight against computers, in virtual reality for example. Although it allows the implementation of more complex combat environments, the use of simulation to train soldiers, for whom the realism of elementary gestures is essential, can nevertheless lead to negative training, since it introduces constraints that take the trainee away from the “train as you fight” dogma. Moving around with a joystick in a virtual world while remaining static and wearing a virtual reality headset is a significantly different experience than executing same tasks on real terrain.

The work addressed within this paper deals with the training of dismounted soldiers through the implementation of what is called “dismounted simulation”. The objective is to get closer to the “train as you fight” dogma. Dismounted simulation consists of immersing a dismounted soldier trainee into an environment mixing virtual and real units. The stated “operational” objective is not about instructing elementary or reflex actions, which can already be done using various existing settled simulators (e.g. firing simulators), but rather about instructing tactical missions.

Expected benefits of dismounted simulation range from improving the quality of the training in providing more realistic simulated environments, in allowing future scenarios execution where new devices could be assessed, in reducing costs and environmental footprint by minimizing the exercises’ animation crew (e.g. hostile forces could be partly virtual) as well as the infrastructures required by the training means.

Finally, the training of dismounted soldiers must also be considered within the broader context of battalion forces readiness, which implies the involvement of combined arms. Thus, beyond the sole training of dismounted soldiers, and although this aspect is scarcely mentioned in this paper, the consistency of the simulated environment shared between dismounted soldiers and other armed services, and particularly the continuity of the mounted/dismounted phases of the soldiers training need to be given careful consideration too.

2.0 PREVIOUS WORK

2.1 Live training

Nowadays, NATO countries own combat training centres (CTC) where “live training” is performed. The battlefield in which the trainees operate and execute real missions is often reconstructed in its smallest details, while the enemy force is played by real actors. The immersion of the trainees during the scenario execution is therefore maximum, which guarantees a very efficient training. The trainees generally use legacy weapon systems, but these latter are instrumented to allow "virtual" firing. This concept is called “Live Simulation”.

One of the most accomplished and efficient live training facility for dismounted soldiers is located in Sissonne, in the East of France. The French urban combat training centre (CENZUB) is a huge military camp grouping together several areas representing different urban combat terrain in which dismounted soldiers might intervene: a village, a slum area, a defensive hamlet, a campsite, and even a small town with a capacity of about 5000 inhabitants made up of buildings, residential areas, a city centre, a place of worship, commercial zones, etc.

It is manned by hundred people, among which instructors, but also military personnel organized in companies, and whose role is to play the enemy force (conventional forces, militias, insurgents, civilians, ...) or supporting units of the trainees (command, logistics, engineering, ...).

The dismounted soldiers are equipped with a FAMAS assault rifle fitted with a laser emitter to simulate the trajectory of the virtual ammunition, and a receiver vest reacting to these laser signals to warn them of hits. Exercise control monitors and records in real time geolocated trainees and virtual shots to perform systematically after action review analysis.

Figure 1 : Dismounted soldiers training at CENZUB

Source : http://www.defense-lyon.fr/des-reservistes-du-503e-rt-au-cenzub/

At the French CTC, the concept of "train as you fight" is thus pushed to its climax. The effectiveness of the training performed at CENZUB is well recognized, since troops from European NATO Nations use also the facility.

2.2 Virtual training

Since many years, simulation systems implementing virtual reality technology, which immerse the trainee in a completely virtual environment, were developed mainly to educate elementary gestures (e. g. combat firing simulators). For example, the “Entraineur aux techniques de tourelle” (ETT) and “Simulateur d’entrainement d’équipage” (SEE), provided in the 1990s, were realized in order to teach Leclerc Tank individuals and crew to execute collective actions. Coupling these virtual simulations together allowed Leclerc tank platoons to execute tactical missions enhancing the cohesion and achieving higher degree of training. This concept is called “Virtual simulation”.

Since a decade, the delivery over the market of Head Mounted Display (HMD) led to the realization of simulators using virtual reality (VR) to address dismounted soldiers training and not only education goal like it was the case in the past. Launched in the late 2000s, the US Department of Defence’s Future Immersive

Training Environment (FITE) research program aimed to assess the potential of an immersive training system for dismounted soldiers. The system developed under this program was demonstrated during a Joint Capability Technology Demonstration (JCTD), resulting in the realization and deployment in 2012 of several Dismounted Soldier Training Systems (DSTS) for the training of US infantry combatants. This system is also regularly used during demonstrations carried out during the annual Bold Quest exercises since 2011. In France, the DGA's SECDEB project (Simulateur pour l'Entraînement au Combat DÉBarqué) resulted in a demonstrator also implementing VR. It was notably demonstrated at Eurosatory 2014.

Figure 2 : The US Dismounted Soldier Training System (DSTS)

Source: http://breakingdefense.com/2013/08/09/the-army-gets-unreal-the-pros-cons-of-video-games-for-combat-training/

Those VR training systems have undeniable advantages, not only in terms of cost but also in terms of flexibility to generate multiple situations (terrain, mission, devices, threats …) where trainees are immersed.

However, those systems introduce such constraints for the individual that the "train as you fight" dogma is not achieved. Once the display device up and running, the trainee can't see anymore the real-world surrounding his environment and act as usual. Most of these training systems thus need the trainee to be static. Moving into the virtual world implies using a joystick, and in some cases it is simply not possible. These training conditions limit the trainee's behaviour. They mostly can't react with same celerity and accuracy like they will do in the real life. Hence, what is the real effectiveness of VR simulators for dismounted soldiers training? Mostly, the user's feedback is generally rather mitigated regarding the added value of such training systems.

These observations were published more than 10 years ago by Bruce W. Knerr in [1] and [2]. He wrote then:

> « Virtual immersive simulators necessarily do limit how some tasks can be performed, particularly those involving locomotion and touch. This limits training effectiveness only if those actions that cannot be performed in the simulator are not trained by other means.(…) Virtual simulations possess a number of advantages relative to the use of live simulation for dismounted Soldier training. They can represent any terrain or environment that has been modelled, weather, and other environmental conditions. Use of immersive virtual simulation is likely to reduce the amount of time required by a

unit to conduct a training exercise relative to live training. Fewer human role players should be required to fill the positions of enemy units, other friendly units, and civilians in virtual simulations than in live simulations. The reduced risk of accident or injury makes it possible to more realistically depict the effects of demolitions or indirect fire than is possible in live simulations. Virtual simulations require less physical space than a live simulation facility, and reduce the need for use of actual equipment. »

2.3 Augmented/mixed training

When it comes to train a dismounted soldier, getting closer to the “train as you fight” dogma means, before anything else, preserving his ability to move freely in his real-world and to perform the gesture required to execute the tasks.

Simulators such as VIRTSIM (Small Unit Virtual Immersion System) from MotionReality, its successor DAUNTLESS, RE-liON’s BLACKSUIT, or Omnideck from Omnifinity provide innovative solutions to allow the trainees to move inside the virtual world. The first is an arena, size of a basketball court, in which the trainees, equipped with HMD, move as they wish. Their avatar then moves through the virtual world in accordance with their movements in the arena thanks to a tracking system. An immediate consequence is that playable scenarios are therefore limited in space. Omnideck solves this issue in offering an omni-directional treadmill on which the trainee can move infinitely... but only one soldier can use it at a time.

Despite these worthy and interesting attempts, it is clear that the VR technology introduces drawbacks not enabling to reach the "train as you fight" dogma. Augmented reality (AR) technology is more promising to achieve such goal. AR enriches the real world with virtual elements (i.e. display additional information, traditionally in semantic context about real-world objects) in the field of view of the user. As an example, aircraft head-up display systems, which overlay the pilot’s viewpoint with navigation data (airspeed, altitude, heading, horizon line ...), implement augmented reality techniques. Regarding dismounted soldiers training, it is not required to display textual or graphical data. The needs are to display virtual characters (i.e. the soldier’s enemies) according to his own point of view. To some extent, doing so requires to merge the real world and a three-dimensional virtual world to produce a mixed world where real and digital objects co-exist and even interact with each other in real time. This is usually referred to as Mixed Reality (MR), which is a specific case of augmented reality.

Augmented/mixed reality has been well known to specialists for many years, but it is only recently that technologies (hardware and software) have become mature enough to expect an operational use. Hence, prototypes have been developed over the last few years. The Augmented Immersive Team Training (AITT) developed by the Office of Naval Research in 2015, which uses an optical see-through display system made by SA Photonics to superimpose virtual soldiers and the effects of virtual weapons on the field of view of the trainee, is the most significant demonstrator in this field.

3.0 MOTIVATION

One of DGA’s main missions is to support the future French Defense System. It is achieved in stimulating innovation and smart investment for technological and industrial capacities to get ready. Regarding Augmented/Mixed Reality area, Technology watch has identified the recent emergence of promising technologies, such as Google Tango or Microsoft HoloLens. Hence, in order to assess benefits of such devices, DGA launched in 2014 an R&T study named SIMBA with the objective to enhance the training of dismounted soldiers in using “augmented” dismounted simulation to equip units from levels 6 to 8 (section, group and soldier).

Base on technical and operational constraints and limitations collected as lessons learned, the output of this study would be a medium- and long-term roadmap to procure a targeted "mixed reality" architecture that provides the best "overall cost-benefit-operational risk" pay-off.

Considering the maturity of current technologies that it would be necessary to implement, it is likely that such architecture won't exist in a very near future, at least in a sufficiently advanced state to consider an operational deployment. Nonetheless, the aim is also to develop a prototype to experiment in order to ease the collection of end-users requirements, to capture the limitations inherent to the current technologies, and eventually to identify possible constraints related to human factors.

4.0 APPROACH

4.1 Theoretical study

The dismounted simulation system architecture introduced hereby is the result of a paper analysis to satisfy the need driven both by the operational requirements for training as expressed by the forces, and by the constraints induced by the limitations of the technologies and products available at the targeted deployment timeframe. The resulting architecture takes also into account the FELIN system equipping the infantry soldiers and made by Safran Defence & Security in order to reach an optimal integration with existing systems.

The system architecture is split into several functional modules, to draw up an inventory of the existing and/or upcoming technologies allowing to cover the needs for each of these modules, and to evaluate them independently. Consequently, technical solutions were selected for each of these modules based on objective comparison criteria (cost, performance, maturity, etc.) and, in some cases, based on experiments outputs.

Different technical architectures have been defined and evaluated in order to finally keep an architecture providing the best "overall cost - operational benefit - risk" compromise.

4.2 Prototype and experimentations

The resulting architecture has been developed targeting a deployment by 2025. The technologies that were proposed are those that is believed to be mature and to provide the appropriate performance for this timeframe. Today, creating a prototype illustrating this architecture with current technologies should ease to measure the benefits that are expected to improve the operational readiness of combatants.

In addition, this prototype allowed assessing the issues of integrating AR devices with the existing soldier's equipment. The dismounted simulator is intended to be deployed both in the French army training centres (e.g. CENZUB), but also in regiments, which already own "mounted" combat simulators. The coupling with existing simulations is therefore critical.

These evaluations were carried out as part of 4 experimentations whose stated objectives were:

- Experimentation #1 : demonstrate the feasibility about the continuity of mounted/dismounted MR, by connecting them together ;
- Experimentation #2 : demonstrate the capability within CENZUB to perform an urban terrain exercise in using MR ;
- Experimentation #3 : demonstrate the ability to handle a mixed opposing force (real + virtual) ;
- Experimentation #4 : evaluate the use of dismounted simulation to execute an outdoor CAS.

5.0 RESULTS

Performing mixed reality requires solving many issues. First, it is mandatory to find/build a display system able to superimpose a virtual 3D scene on the trainee’s real-world point of view. To that end, it is required to capture the exact location and head orientation of the user at any time. In addition, occlusions between real and virtual objects are critical to the trainee's efficient immersion (e.g. a virtual enemy hiding behind wall shouldn’t be visible to the trainee). Thus, it is needed to find a way to capture the real world to handle these occlusions correctly. Furthermore to interact with the virtual characters, it is critical to focus on the dismounted soldier’s ability to shoot on virtual characters, which requires acquiring precise location and orientation of his assault rifle at the time he pulls the trigger. Finally, preserving the trainee’s ability to move freely involves him wearing autonomous and non-invasive devices to perform his tasks.

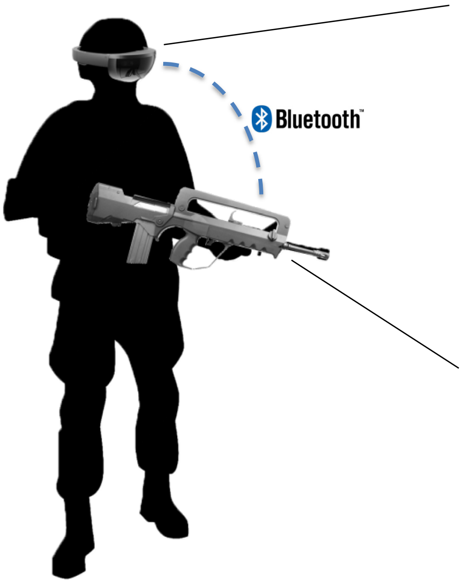
5.1 Prototype

The prototype was realized with the objective of addressing each of these issues, at a "reasonable" cost. When the study started, the technologies addressing these issues existed at different technology readiness level (TRL), but no "off-the-shelf" system integrated them all. Solution came from Microsoft, which released the HoloLens glasses. More than a simple display system, these glasses embed the sensors required to answer all the problems raised by mixed reality, and for an affordable cost:

- the fusion of data from the integrated sensors (an inertial measurement unit, an infrared depth camera, and four RGB cameras) using SLAM algorithms allows the HoloLens to both determine the viewpoint of the user (position and orientation of the head) in a local earth frame (where gravity is the “down” axis), and to rebuild in real time the real environment in which the user moves to handle the occlusions of virtual elements by real elements ;
- thanks to this data, the holograms computation is then performed directly by the integrated computer, according to the point of view and the real surrounding environment as it was captured. An application designed to run on the HoloLens has been developed specifically for this purpose ;
- finally, the holograms are displayed to the user thanks to a holographic waveguide-based projection system, and accordingly to the point of view of the user.

In order for the trainee to shoot the virtual enemies displayed in the glasses, an assault rifle replica (FAMAS airsoft) was equipped with sensors to capture the event when the soldier pulls the trigger, and the rifle’s orientation. The sensors used are a piezoelectric sensor for detecting the trigger’s activation, and an inertial measurement unit combined with a magnetometer for capturing the rifle’s orientation relative to the magnetic north.

This data are transmitted in real time via Bluetooth to the application that computes the holograms on the HoloLens. Squeezing the trigger thus launches the calculation of the trajectory of a virtual bullet (which is assumed to be rectilinear), to determine whether the virtual enemies have been hit or not.



Optical see-through display system : Microsoft HoloLens

- Displays holograms on transparent glasses
- Integrated sensors :
  - IMU
  - 1 IR depth camera
  - 4 RGB cameras
  - SLAM algorithms

→ Capture the environment in real-time for simultaneous localization andf spatial mapping

Virtual firing : Airsoft FAMAS assault rifle (plastic balls propulsion)

- Firing on virtual enemies
- Instrumentation :
  - IMU + magnetometer
  - Bluetooth module
  - Arduino interfaced with the rifle's shooting mechanism to get the firing events

→ Retrieves the rifle's orientation (relatively to magnetic North) at the time the user pulls the trigger

Figure 3 : The SIMBA prototype

5.2 Experimentations

Several experimentations were performed to assess the prototype. The main objective was to refine requirements and constraints related to the human factor in order to enrich the specifications elaborated during the paper study. This was done by collecting, at the end of each experimentation, the feedback of the soldiers who wore the prototype (operational added value, degree of acceptance of the device, thresholds of tolerance, level of realism reached ...).

5.2.1 Experimentation #1

Besides evaluating the pros and cons of the prototype, the first experimentation was to connect it with another training simulator, a prototype of a "mounted" combat training simulator carried out as part of a study managed in parallel by the DGA. The experimentation involved a real troop-transport vehicle (VBCI) and crew, facing a threat consisting of several virtual fighters who were displayed in augmented reality inside the turret episcope. The two simulators shared the same tactical situation, generated by a simulation (DirectCGF). The crew of the vehicle visualized through its episcopes the same virtual threats as the dismounted soldiers. Figure 4 shows the overall architecture.

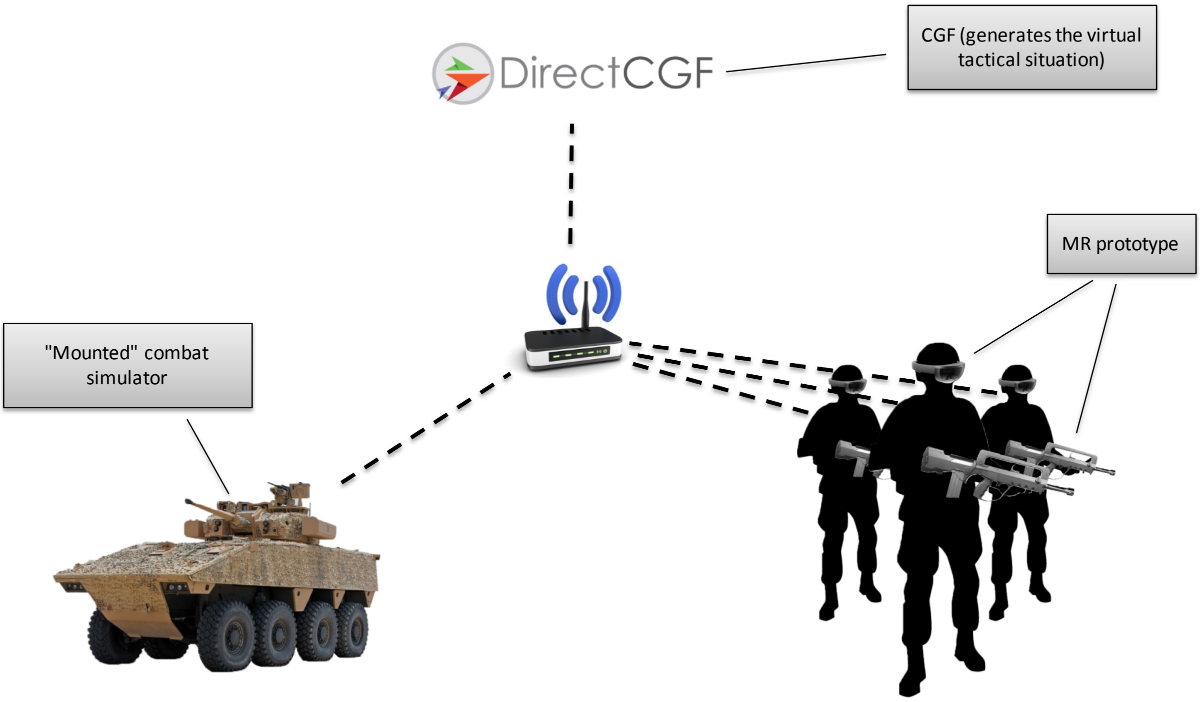


Figure 4 : First experimentation overall architecture

The immersion of the trainee in the "mixed" world was unanimously considered very positive. Holograms turned out to be well anchored in the real environment, and above all, occlusions of these holograms by real elements contribute in a very efficient way to the impression that virtual opposing forces are real. The possibility of engaging them with the FAMAS replica, which looks exactly like the real one, reinforced this impression.

The interviews performed at the end of the experimentation also showed that the system itself is rather well accepted by the trainees. Its size and weight do not seem to be an obstacle to its use on the battlefield.

Finally, the experimentation was also a success regarding the mounted/dismounted combat continuity. The VBCI crew and the dismounted soldiers equipped with the prototype both perceived the virtual enemies at the same location. They were able to follow the virtual characters movements and to display the effects when the threat had been engaged. However, the visuals displayed to both parties were not strictly identical. The HoloLens 3D engine being different, the 3D database used for displaying the virtual elements was not shared between the two simulators.

Regarding the limitations and issues, it was noticed that the field of view of the HoloLens is rather narrow. The TRL of this technology makes holograms only appear in a 35° cone, in the direction of the orientation of the head (and not the eyes) of the user. The trainee is therefore "blind" in his peripheral vision. Moreover, this leads to visibility problems when shooting in a shoulder-fire position. As shown in Figure 5, in such position, the holograms are located outside Microsoft’s glasses field of view. The trainee will naturally move his head to align the glasses with the line of fire, to be able to visualize the virtual target. But this compensation is not desired since it necessarily introduces a negative behaviour.

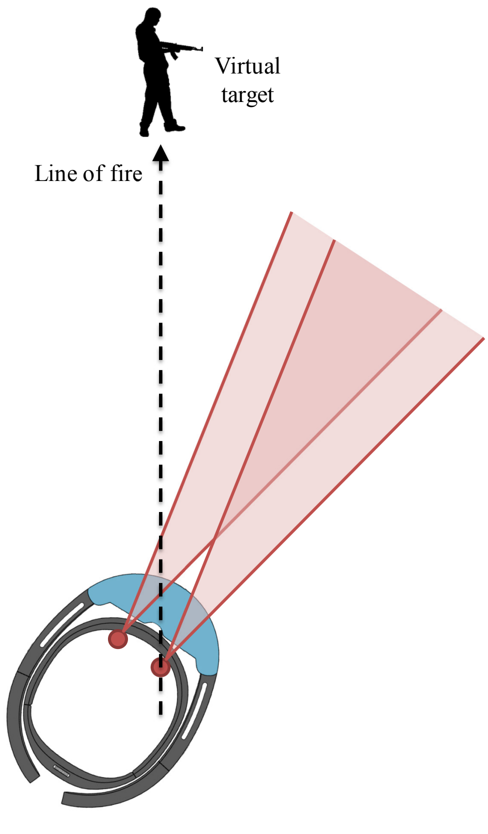


Figure 5 : On the left, normal firing position ; on the right, glasses aligned with the line of fire to visualize the virtual target

Before considering any operational deployment, other issues will have to be solved, particularly concerning the occlusions (virtual elements being hidden by real ones). Although it worked pretty well during prototype execution in a known environment, the 3D reconstruction of the real environment in which the trainee evolves, and which is used to compute the occlusions, suffers from several defects: the reconstructed model is too coarse, the reconstruction takes too long (2 to 3 seconds latency), the acquisition range is too short (about 3 meters). These issues are due to the limited capabilities of the HoloLens sensors, and its processor's low computing power. In use, the impression remains that occlusions due to immobile elements of the real environment are relatively convincing. Those due to mobile elements are clearly ineffective or even worse disturbing.

Finally, the direction of the virtual firing showed a noteworthy error, compared to the real orientation and position of the rifle at the time the user pulls the trigger. This error is variable, but can rise to several degrees, which at a distance of a few meters can represent a several dozen centimetres offset. Causes of this error are multiple. First, only the orientation of the weapon is captured. The rifle's position is assumed to be fixed relative to the HoloLens, which is a very rough approximation, and which forces the soldiers to fire always in the expected position, namely a "shoulder-fire" position (this instruction was given to them during the experimentation), with the consequences on the holograms' visibility described earlier. Furthermore, the orientation of the rifle is estimated using an inertial measurement unit with magnetometer fixed under the barrel of the weapon. This type of sensor is sensitive to external factors, such as metallic objects in its vicinity (the metal structure of the rifle itself, for example) or shocks, which can disturb the measurements.

5.2.2 Experimentations #2 and #3

These experimentations were carried out at CENZUB. The prototype was coupled with the in house training system allowing to monitor every trainees location, actions and status within the urban terrain. The goal was to engage a mixed opposing force (i.e. consisting of both real and virtual opposing forces). The experimentation involved a team of three soldiers equipped with the prototype and coming into contact against a threat made of three virtual characters and one real soldier, during the search inside a building.

Several modifications were made to the prototype for these experimentations. First, connection with the CENZUB training system was achieved. Second, to be able to engage a mixed opposing force, the FAMAS replica was modified to embed a laser emitter of the firing simulator in use at CENZUB. Pulling the rifle's trigger thus started both the laser emitter fixed in the axis of the rifle's barrel for firing on real targets, and the calculation of the trajectory of a virtual projectile for firing on virtual targets.

The various limitations of the prototype noticed during the first experimentation were solved. Software modifications to improve the integration of holograms in the real environment were made. The inertial measurement unit was changed to capture the rifle's orientation with a higher quality, in the expectation of lower capture error. The rifle's metallic barrel has been replaced with an aluminium rod, to cause as little disturbance as possible to the inertial unit.

Figure 6 : The SIMBA prototype, made of HoloLens glasses (outlined in red), and the FAMAS replica equipped with the laser emitter (outlined in yellow)

The prototype was very well received by the users. The objectives were achieved and the experimentations allowed identifying many other use cases, and improvements regarding the interconnection with existing CENZUB devices. Regarding the performance of the prototype, the replacement of the inertial unit did not have the expected effects. The accuracy of the virtual firing was slightly improved, but disturbances, especially inside the building (most probably because of its metallic structure), were numerous. Tests with this same equipment made outdoors, away from the buildings and any metal structure likely to disturb the magnetometer of the inertial unit, showed much better results. The precision of the shots in this case were excellent.

5.2.3 Experimentation #4

The last experimentation was designed to assess the prototype in a context of a close air support. A Forward Air Controller (FAC) equipped with the prototype had to guide a virtual aircraft to engage a virtual target on a real battlefield. The FAMAS replica was not used, since the FAC doesn't directly engage the target. He only transmits his instructions to the virtual aircraft pilot.

Technically, given the size of the terrain compared to the previous experimentations, the challenges were not the same. HoloLens is a device designed to display and to interact with holograms located in a close environment (2 to 3 meters). In particular, since the real environment acquisition mechanism is limited to a few meters, occlusions due to the terrain relief (e. g. when the virtual aircraft flies behind a real hill) cannot be managed in the same way. To this end, the software application was changed so that occlusions are managed in accordance with a numerical terrain model corresponding to the real terrain. The difficulty lay in the superimposition of the real terrain with the virtual model, which could only be done manually, and which had to be very accurate.

Moreover, unlike the previous experimentations, which took place indoors in controlled lighting conditions, this last experimentation took place during a clear and sunny day, thus in a very bright environment. The low visibility of holograms in this type of lighting conditions had to be compensated for by the addition of a tinted solar film on the HoloLens glasses to attenuate ambient brightness, and allow the FAC to better visualize the virtual aircraft and target.

Figure 7 : The FAC giving instructions to the virtual aircraft he watches in his AR glasses

The feedback was fruitful. The FAC highlighted the realism of the integration of the virtual aircraft into the real environment. Despite the slight deformation of the real environment as seen through the glasses which was due to the poor quality of the solar film, the experimentation showed that the accuracy of the digital terrain model is critical to manage with precision the occlusions. It must be accurate enough to faithfully match with the real terrain and also to comply with constraints imposed by the glasses' low power processor. In addition, vegetation and infrastructures need to be taken into account. Indeed, the elevation data used for the experimentation gave information about the elevation of the terrain in georeferenced locations. In particular, it doesn't deal with the micro relief.

6.0 CONCLUSION

Since many years, the use of simulation, and in particular virtual reality technology, has undoubtedly reduced the costs and improved training efficiency. Unfortunately, use of virtual reality to train dismounted soldiers is not so effective due to motion lack of realism, complex interactions with the environment and limitation regarding the gesture.

Augmented/mixed reality is a promising technology to “train as you fight” and thus to improve the effectiveness of dismounted teams/sections. Although AR/MR tends to become popular, thanks to several applications that are emerging in the civilian world, the experimentations carried out to assess a prototype show that many issues still have to be addressed before considering any operational deployment. In particular, it is required to enlarge the field of view of current AR glasses, and to improve the accuracy of the occlusions between virtual characters and terrain. This will significantly contribute to augment the feeling of individual immersion.

In addition it is critical to perform better integration with the soldier’s equipment. Nowadays, it is not possible to wear simultaneously the AR glasses and the helmet, the autonomy is quite limited, and the devices are especially too fragile.

Technology watch has to address not only MR glasses but also sensors, SLAM algorithms performances and micro relief acquisition in real time.

Nevertheless, the experimentations collected positive and enthusiastic feedbacks leading to move ahead.

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