HeroX - Untethered VR Training in Sync'ed Physical Spaces

Above and Beyond - Integrating Robotics

In previous research work I experimented with multiple robots remotely controlled by people over the Internet in modelled physical game like environments. The participants logged into a web site and selected a robot, through which they could see the physical arena and other robots through a digital camera, hear through a microphone and speak through a speaker [1]. Extensions to the system would have involved touch/force sensors on the robots providing haptic feedback to operators, augmented reality graphics and audio overlaid over the audio-video feed and eventually 3D vision through stereo cameras. The objective was to test whether low cost robot hardware and web software could support people anywhere in the world playing immersive games involving real, physical robot avatars, and we found indeed this was the case.

The immersive training system created by NIST for first responders could also incorporate automation elements and robotics in all three levels of control; fully human remote controlled, semi-autonomous with shared human and robot AI control, and fully autonomous robots. Some first responders already use robots for police, security, rescue and other use cases, typically of the fully human remote control or semi-autonomous control varieties. Efforts are underway to expand the capabilities of robots in first responder situations [2]. These robotic elements (or more simply automation elements without mobility for instance) could be first class participants in the merged VR and physical training scenes and scenarios, reflecting the existing and future collaboration of first responders with such

active machine participants. With cameras and other position and orientation tracking sensors and motion control actuator elements these machine participants can be an integrated part of first responder teams with their own specialize roles, activities and capabilities. In the training scenario hypothesized above with the goal of rescuing a person trapped under a vehicle as quickly as possible with as little harm to them as possible, instead of a human responder jacking up the vehicle, a robot participant may be involved to lift the vehicle under semi-autonomous command from the human first responders. Just as there are millions of training scenario variations the system proposed here can support, there are millions more variations which can incorporate intelligent machine automation and robot elements.

Table 1: Summary of Content for Judging Criteria

Section	Description	Proposal's Support
Reality	How well does the design emulate a real first responder experience?	High fidelity emulation: Participants are untethered and can move unencumbered. They wear gear (helmet, vests, backpack carried equipment) much as they would in real life. They move, see, hear, smell, and feel thermal, moisture and digitally created haptics, much as they would in real life. They use tools, instruments, equipment and devices much as they would in real life.
Availability	Is the technology proposed currently available?	Much of it is currently available. For example, the Unity 3D game engine can support all the immersive 3D software elements. Companies like The VOID and others coming soon can provide the entire merged VR and physical platform to extend for this challenge. Additional IoT like sensing modules can easily be created and integrated with existing technologies. Optional AR hardware is readily available in developer editions.

Section	Description	Proposal's Support
Versatility	Ability to accommodate multiple and variety of scenes/scenarios.	Highly adaptable: Proposed solution can work for every type of first responder and a huge variety of training scenarios.
Metrics Collection	How well does the design enable the collection of measurements and data from the first responder?	Supports massive collection of data for each training session and first responder. Data from equipment used can be time synchronized to the activity in the training session for post analysis and review. Anything carried or moved during the session can be tracked by multiple parameters, such as position, orientation, acceleration, touches and applied forces and synchronized for analysis and review post session. Data from automated or robot machine participants can be captured and presented as additional participants. Actions taken during the training session can be sensed, captured and incorporated into the overall time synchronized record.
Replicability	How replicable is your design for future labs to recreate?	Highly replicable: The physical environment is modelled in digital 3D and staff can use this data for guided and accurate recreation of any scene/ scenario, including the optional use of AR HMDs to make this work simple and rapid.
Repeatability	How long does it take the operator to reset the scene in between simulations?	Highly repeatable: The beginning of the physical scene is modelled in 3D so staff can rapidly and accurately reposition all elements. The physical scene is built using easily assembled moveable and modular components (walls, doors, stairs, furniture, vehicles, etc) built using inspiration from the theatre and film set industry. Consumables such as water, smoke, and materials for smelling can be designed for quick restocking.

Section	Description	Proposal's Support
Interoperability	How many different technologies and/or interfaces can your design accommodate for testing?	Highly interoperable: Any digital equipment with realtime data feeds through an API can have the data integrated with the VR scenario for modelling any displays or interfaces in VR, and the data time stamped and recorded. For those without, mockups which mimic the physical interaction and capture the interaction using standardized interaction elements, sensors, and electronic data communication nodes can feed data to a software simulation of the equipment in VR. Supporting these two approaches accommodates any device, instrument, tool or technology into the training scenario.
Safety	How safe is your design for the end-users?	High safety: The proposal incorporates HMDs with padded helmets for face and head protection. Physical hazards can be reduced by subtle modifications that don't take away from realism, such as sharp edges can be removed, heat can be kept just below skin burning level, etc.

Section	Description	Proposal's Support
Above and Beyond	How does your submission go above and beyond the listed criteria?	The proposal enables tools, instruments and even intelligent machines such as robots to be effectively incorporated as part of the human first responder team. Mobile robots with intelligent elements can be represented much the same as human participants, with the same tracking and realtime synchronized VR avatars. All instruments, tools and devices can be digitally tracked, including all interface interactions by the participants, for accurate represented in realtime in the VR scene, so physical manipulations and digital elements can be synchronized and merged for ultimate realism and for later analysis and review. All team communications can be captured for playback during session analysis and review.

REFERENCES

[1] http://www.cloudyrobotics.com/
[2] https://en.wikipedia.org/wiki/DARPA_Robotics_Challenge