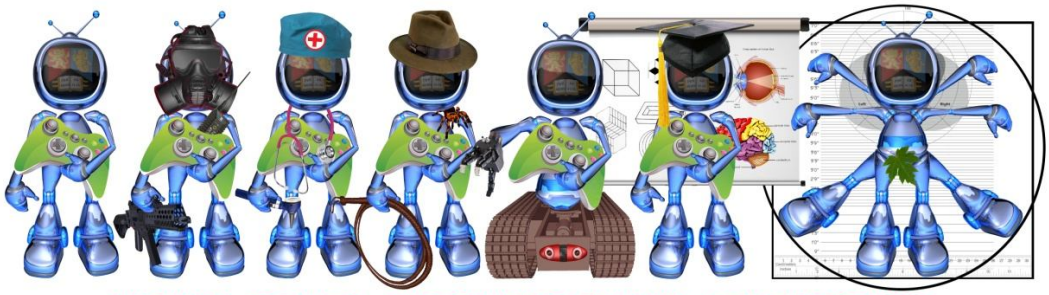
UNIVERSITY OF BIRMINGHAM

HUMAN INTERFACE TECHNOLOGIES TEAM



VIRTUAL REALITY - AUGMENTED REALITY - TELEPRESENCE
DEFENCE - HEALTHCARE - HERITAGE - EDUCATION - HUMAN FACTORS

The University of Birmingham's ***Human Interface Technologies (HIT) Team***, based within the School of Electronic, Electrical & Systems Engineering (EESE) has been pioneering the research and development into interactive media and robotic technologies in the UK since 2003, building on over 28 years of experience in the domains of **Virtual Reality** (VR), **Augmented Reality** (AR), **Mixed Reality** (MxR), **Simulation** and **Telerobotics/Telepresence**. The Team's award-winning research is helping to avoid the "technology push" failures evident in the Advanced Robotics and VR "eras" of the 1980s and 1990s, by developing and evaluating demonstrators that emphasise the importance of exploiting **Human Factors** knowledge when specifying issues such as task and context sensory fidelity (the need for realistic visuals, sounds, haptics, smell, etc.), learning content, human performance evaluation metrics and appropriate interactive technologies, from wearable devices to games controllers.

Defence

The Team's participation within the UK's Human Factors Integration Defence Technology Centre (HFI DTC) and the Haldane-Spearman Consortium between 2003 and 2012 provided excellent opportunities to work closely with military stakeholders and end users in the development of methodologies supporting human-centred design for "serious games" and VR-based part-task trainers and novel human interface concepts for simulation and telerobotic systems. Just some of the projects successfully delivered during this time include a desktop Minigun simulator, an Interactive Trauma Trainer for defence medics, *EODSim* – an urban planning tool for counter-IED activities, *RORSIM* – a training package for RN "rules of the road", and *SubSafe*, a submarine safety spatial awareness trainer, the results of which have been influential in setting up the *Astute* Class submarine and similar training facilities for Canadian and Australian vessels. One of the Team's publications, *Human Factors Guidance for Designers of Interactive 3D and Games-Based Training Systems*, has been distributed internationally, is used for teaching and contains a distillation of over a quarter of a century of Human Factors lessons learned from projects such as those described above. As well as involvement with other defence consortia, such as the DHC STC (Defence Human Capabilities Science & Technology Centre), MarCE (Maritime Collaborative Enterprise) and ASUR (Autonomous Systems Underpinning Research), the HIT Team has undertaken further projects for Dstl, including the use of simulation to support the design of future submarine command spaces and evaluations of specialised remote manipulation devices, including haptic feedback systems and anthropomorphic (human hand-like) end effectors. In 2012, the Team was responsible for developing a unique high-fidelity remote driving and manipulation simulator for the British explosive ordnance disposal (EOD) telerobot system *CUTLASS*, and for coordinating a small consortium that delivered 42 complete simulator units to the MoD, ready for deployment within EOD Squadrons in Northern Ireland, Cyprus, Gibraltar and mainland UK. The Team also works closely with BAE Systems, investigating advanced Mixed Reality interfaces for future Command & Control and next-generation cockpit concepts.

Healthcare

The HIT Team collaborates closely with the Royal Centre for Defence Medicine and the nearby Queen Elizabeth Hospital. Although members of the Team have been involved in simulation, VR and robotics for healthcare since the early 1990s, more recently research has been directed to specific issues relating to surgery and post-trauma physical and psychological care, with parallel initiatives to "spin off" research results to the civilian sector. Such research has included studies of VR technologies for training in trauma surgery, psychotherapeutic support for post-traumatic stress disorder (PTSD) and the development of interactive technologies for the investigation of Virtual

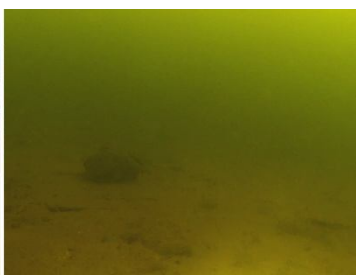
"Restorative Environments" – simulated scenes of nature – and their impact on patient wellbeing (including sleep quality and delirium reduction), especially in Intensive Care. Additional projects are expanding the capabilities of these projects to take advantage of – where appropriate – new interactive devices (such as those emerging from "crowd-funding" sources) and to develop innovative and ergonomically acceptable methods of interfacing with virtual environments. These are being investigated to support motivational rehabilitation for amputees and the design of "incentive spirometry" games supporting respiratory exercises for patients to improve their health, ready for discharge from Intensive Care. The Team is also embarking on a parallel set of activities addressing the use of restorative virtual environments to support the care of dementia patients.

Heritage

One of the key application areas for VR and AR technologies is that of ***Virtual Heritage***. In particular, the HIT Team's interest centres on recreating sites and artefacts relating to *industrial* and *maritime archaeology*, as these fields are in keeping with the engineering focus of the School in which the Team resides and offer the opportunity to interact with real-world rural and sometimes remote communities (fostering strong public engagement and *digital inclusion*). The Team uses a variety of novel technologies to support its heritage site surveys, from small Unmanned Air Vehicles (hexa- and quadcopter platforms) and mini submarines, to image processing software capable of converting images captured from aerial video into geo-referenced 2D mosaics and 3D, fully textured scenes. Just some of the projects conducted by the HIT Team include a VR recreation of the wrecksites of the Frigate *Scylla* and the US Liberty Ship *James Eagan Layne*, plus another based on the *A7* submarine, lost in 1914 with all hands (the focus of an MoD-sponsored survey in 2014). Another innovative project in 2014/2015 delivered a real-time AR visualisation of the 17th Century ship *Anne* from a quadcopter whilst in flight over the site of her wreck near Hastings. The Team's *Virtual Plymouth Sound* project aims to develop a range of interactive underwater 3D scenarios, initially of the area immediately around the Breakwater and, in 2015, included a reconstruction of the UK's first underwater habitat, the *GLAUCUS* (1965).

Telerobotics

Telerobotics is a term used to describe the remote control of semi-autonomous vehicles and manipulators, where the human remains in control of the overall systems, either as a high-level supervisor, or by undertaking direct manual control (as with the *CUTLASS* system, described earlier). Given the synergies between virtual and remote (real-world) environments in terms of human interaction, and with the HIT Team's members' experiences in the human factors of telerobotics and telepresence for underwater, nuclear and space applications, there are many opportunities supporting the successful exploitation of human-centred design and evaluation processes in both real and virtual domains. Since 2010, final year project students, together with academic and EESE technical staff, have come together to design and build a remotely operated vehicle (ROV) from scratch, with the challenge of diving the submersible onto the decks of the scuttled HMS *Scylla* (see previous entry relating to the *Virtual Scylla* project). Students develop their own underwater subsystems and integrate their solutions with those of fellow team members prior to the actual dive. Individual projects have ranged from developing the human-ROV interface to small manipulators, and from building subsea pressure and temperature sensors to onboard communications modules. As well as the ROV project, the HIT Team is constantly experimenting with new technologies to support field surveys of complex heritage sites, especially where they are difficult to access due to plant growth, hazardous terrain or protective measures. The use of telerobotic technologies, such as small unmanned air systems (sUAVs) or "drones" and other remotely operated devices, such as the Team's *Neptune* radio controlled minisub, is delivering an invaluable capability, not only in the collection of data relevant to the future construction of Virtual Heritage sites, but in their subsequent visualisation, using remote AR techniques.



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