Enabling Physical Telework with Spatial Augmented Reality

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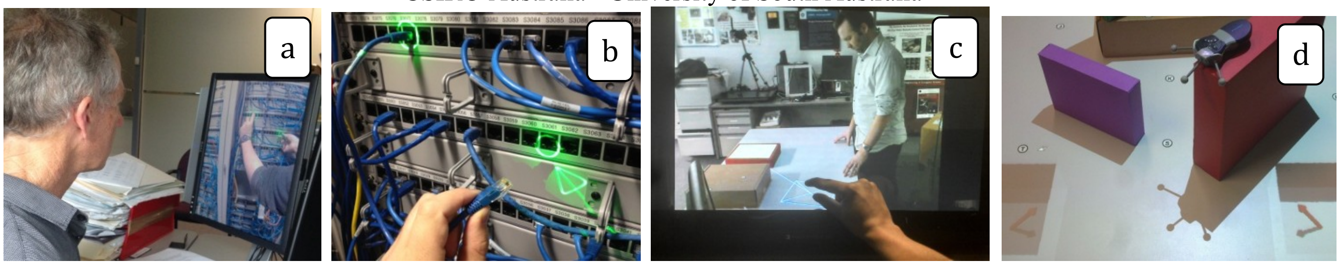

Figure 1. *A remote expert (a) troubleshoots with an on-site worker (b). The hand of a remote expert directly manipulating a target for a worker (c). Projected visual cues point to an off-surface object (d).*

1. Physical Telework

When you think of the professions most likely to telecommute, it is common to envision a white collar knowledge worker, remotely accessing their computer desktop applications and services. While in reality, telework benefits are not limited to knowledge workers.

We are investigating and developing technologies that can empower a skilled individual in one location, to complete a physical task in another location. Our approach has been to investigate systems that have a relatively unskilled human collaborator local to the task. Here, we present systems that explore this collaborative form of physical telework using applications of Spatial Augmented Reality (SAR).

2. Applications of Sketching With Light

Telemedicine The Remote Immersive Diagnostic Examination System (RIDES), was a partnership between CSIRO and the Royal Children's Hospital, Melbourne (RCH) [Palmer et al. 2007]. Where previous telehealth systems had used only a 'talking heads' style videoconference, RIDES enables a specialist conducting an examination to effectively 'reach through' the screen. When the specialist draws on the video showing on a computer screen, a laser projector at the patient's location displays the sketch directly on the patient's skin, guiding a local nurse or General Practitioner in the precise way to attend to the patient. By ensuring a common physical frame of reference for communication between specialist, nurse and patient, RIDES can enable a specialist to conduct medical examinations across large distances. A clinical pilot study at the RCH indicated that as many as 88% of consultations could be conducted without the need for a patient to travel.

Maintenance Inspired by fly-in-fly-out maintenance workers in the mining industry, a wearable version of the laser projection system using commodity hardware was developed [Gunn and Adcock 2011]. The system is called "Sticky Light" because it compensates for any movement of the head-mounted projector, effectively 'sticking' the remote specialist's laser annotations to objects in the physical world. By overcoming the "left a bit, left a bit, no, no, the other way" problem, this system enables a city-based maintenance expert, with the help of a local generalist, to trouble-shoot problems at a distant mine site.

Quarantine The Australian Animal Health Laboratory (AAHL), is a research facility that houses some of the world's most dangerous diseases. To cross the biological containment barrier at the facility, scientists expose themselves to significant risk. It is therefore important to reduce the number of people who need to enter the lab. A tool-trolley-mounted camera/projector system has been developed that can be wheeled up to lab benches and other equipment, thereby lessoning the need for some AAHL staff to physically enter. Figure 1 (a&b) shows an example.

3. Beyond Sketching With Light

Object Based Manipulation The techniques mentioned above allowed free-hand input but do not make use of any semantic information about the physical properties of the environment. A prototype system was developed to introduce a level of abstraction for the remote expert, allowing them to directly specify the object movements required of a local worker [Adcock et al. 2013b]. We use 3D tracking to create a hidden virtual reality scene, mirroring the real world, with which the remote expert interacts while viewing a camera feed of the physical workspace (see Figure 1 (c)). The intended manipulations are then rendered to the local worker using SAR.

RemoteFusion In an effort to explore alternatives to the single-camera, RemoteFusion was developed [Adcock et al. 2013c]. It performs a volumetric fusion of commodity depth camera data and enables an unrestricted 3D viewpoint for the remote expert. Dynamic objects are detected and placed into a separate volumetric representation. The dynamic volume is then rendered together with the static one, optionally with the dynamic objects displayed transparently. This new technique allows objects in the scene to defuse and fuse as they move and stop within the scene.

Off-Surface Visual Cues While a freely controllable 3D viewpoint is great for the remote expert, it creates an issue for the local worker—from which direction is the remote expert viewing the workspace? A selection of different SAR visual cues were created that, while only projected onto a 2D tabletop, conveyed (1) an off-surface 3D location and/or (2) which of the objects can be seen by the remote expert [Adcock et al. 2013a]. See, for example, Figure 1 (d).

This poster showcases techniques that represent steps toward our ultimate goal of versatile, portable, and expressive SAR-based tools that enable technicians to quickly carryout complex tasks while under the guidance of a remote expert.

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SIGGRAPH 2014, August 10 – 14, 2014, Vancouver, British Columbia, Canada.

ACM 978-1-4503-2958-3/14/08

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