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Title:

In-Situ Virtual Images and Forces to Augment Image Guided Intervention

Abstract:

Medical imaging modalities such as CT, MRI, and ultrasound have produced fantastic new abilities to visualize beneath the surface of the patient. Confining their display to conventional screens, however, forces the clinician to look away from the patient during the interpretation of such images. A direct view of the actual patient remains crucial to the practice of medicine, especially during interventional procedures. We have developed new techniques for displaying images directly within the patient, using semi-transparent mirrors and holographic optical elements. Such displays permit a clinician to aim an interventional tool, such as a needle or a scalpel, directly at the image in-situ within the patient, aided by familiar visual landmarks on the patient's exterior as well as the clinician's hand and the tool itself. We have given the clinician, in effect, an augmented sense of vision to see through the skin, without any tracking apparatus or head-mounted display, as previously required by so-called augmented reality displays. In related research, we are also augmenting the clinician's sense of touch while using an interventional tool, by sensing forces at the tool's tip and delivering magnified forces through the handle to the operator's hand. Unlike previous systems, which use freestanding robotic arms, our device is completely hand-held, and thus less restricted in its movements. Taken together with the aforementioned in-situ display, these augmented forces may enhance hand-eye coordination in an intuitive and non-intrusive manner, improving the safety and effectiveness of invasive procedures.