SPACE ... THE FINAL FRONTIER FOR CONTROLS

Interactive holographic controls may offer glimpse of heavy equipment future

By R. Douglas McPheters

Wouldn't it seem logical that safety and comfort would be increased significantly if a heavy equipment or vehicle operator didn't have to fiddle with buttons and gadgets while driving? What if that operator could just pass his/her finger through the air to activate control features?

HoloTouch, Inc. has introduced a control technology, HoloTouch, which allows operators of heavy equipment and vehicles to control a wide variety of components by simply passing a finger through floating holographic images of control surfaces. Equipment manageable by HoloTouch includes cockpit and cab instrumentation, as well as all sorts of engines, power plants and other industrial applications where corrosion, dirt, moisture, shock and temperature currently limit the utility of control panels, keyboards and key pads.

For example, all of a truck's cab electronics, such as cell phone, climate control, entertainment systems and GPS can be controlled by interacting with a single composite holographic image, floating in the air in the lower rim of the driver's field of vision, without looking away from the road ahead. These holographic images are colorful and easy to see. Since they are also translucent, operator distraction and fatigue are significantly reduced.

R. Douglas McPheters is president of HoloTouch, Inc., Darien, Conn.

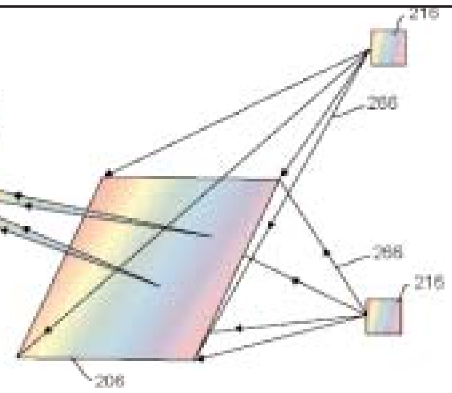
A new control technology, HoloTouch, is designed to allow operators of heavy equipment and vehicles to control a wide variety of components by simply passing a finger through holographic images of control surfaces, floating in the air. Equipment manageable by HoloTouch includes cab or cockpit instrumentation, as well as all sorts of engines, powerplants and other industrial applications.

Because these human-machine interfaces have no moving parts, they are virtually indestructible and operate smoothly in wide ranges of temperatures, industrial environments and weather conditions.

The HoloTouch system combines two well-known and well-developed technologies — holograms and wave source sensors such as infra-red emitters and detectors — to allow the precision operation of many types of electronic and electromechanical equipment by passing a finger or other solid object through holographic images of what would otherwise be the keys or buttons of that equipment, positioned in the air at a location convenient to the operator.

A schematic of the principles of the patented HoloTouch technology involved in projecting into space holographic images of what would otherwise be the keys of the HMI to be controlled is shown in Figure 1. In Figure 1, 207 represents the holographic image of the "keys" of the HMI, projected from hologram 206. If hologram 206 is a transmission hologram, the illumination source 216, providing reconstruction beam 266 for holographic image 207, is positioned behind hologram 206 relative to the

Fig. 1. A schematic of the principles of the HoloTouch technology involved in projecting into space holographic images of what would otherwise be the keys of the HMI to be controlled. Area 207 represents the holographic image of the "keys" of the HMI, projected from hologram 206. If hologram 206 is a transmission hologram, the illumination source 216, providing reconstruction beam 266 for holographic image 207, is positioned behind hologram 206 relative to the operator. However, if hologram 206 is a reflection hologram, the illumination source 216, providing reconstruction beam 266, is positioned on the same side of hologram 206 as the operator.



operator. However, if hologram 206 is a reflection hologram, the illumination source 216, providing reconstruction beam 266, is positioned on the same side of hologram 206 as the operator.

Technical issues which should be addressed before beginning the process of actually making a hologram intended for use in an HMI include:

■ Selecting a "look and feel" of the holographic images of the HMI that will best convey the HMI's functional characteristics, which involves careful attention to how the color, detail and size of the images to be displayed appear to the operator

■ Determining how far the holographic images will appear from the hologram itself in order to achieve optimum visual effects which, for example, in high-traffic consumer HMI's can substantially affect how well customers are drawn to the end-user's business

■ Selecting the angle at which the operator can view the holographic images in order to yield optimum image resolution, which is intertwined with the physical characteristics of the location where the holographic HMI will be used and the relationship of those locations to the HMI's potential operator

■ Selecting the range of angles across the horizontal and vertical axes at which the holographic images can be clearly seen by the operator of the holographic HMI which, to cite just one example, in kiosk applications such as ATM's, should be very narrow to prevent anyone other than the operator from seeing personal information entered by the operator

■ Determining which of the increasingly sophisticated holographic design and production techniques will best accomplish all of those objectives.

In order to create a hologram, two beams of laser light emitted by separate transmitters are recorded on film. Those transmitters are usually mounted on a shock-isolated platform to eliminate distortions caused by even the slightest movement of the equipment that might occur while those lasers are active, from factors such as vibrations caused by traffic in the street outside the holographic laboratory. Fixtures holding the holographic film and the object or graphics to be replicated in the final holographic image are also mounted on the same shock-isolated bed must be precisely positioned in relation to each other in order to achieve an accurate rendition of the object or graphics.

One laser produces the object beam, so-called because, on its way to the holographic film, it illuminates the object or graphics to be replicated in the final holographic image, in our case what would otherwise be the keys or buttons of the electronic device to be controlled. The second laser, called the reference beam, does not illuminate the object but is instead aimed directly at the holographic film, by a different path than the object beam.

Arriving at the holographic film by separate paths, the two beams create an interference pattern on the holographic film, which acts as a diffraction pattern. The resulting holographic image is developed in a process analogous to developing ordinary film. The finished hologram can be laminated onto glass, acrylic or another translucent material for durability and ease of handling and use in the laboratory as well as in practical applications such as holographic HMIs.

When a completed hologram is illuminated by a light source similar to the reference beam with which it was created, that light is refracted by the recorded hologram in such a way that when you look into that light, you can see a reconstructed image of the object. In order to make most effective use of a holographic HMI, its completed hologram must be precisely aligned in relation to its reconstructing light source in order to achieve optimum image resolution, both in distance and at the proper angle from the light source to the hologram itself. How these factors affect the mechanics of the holographic HMI depend on the distances and angles involved in the positioning of the reference and object beams in relation to the object or graphics during the process of making its hologram.

A wide variety of wave source sensors is readily available in the commercial market for use in scanning the plane of the holographic image of a holographic HMI, the selection of which depends upon the configuration and size of those images as well as the location of those images in relation to the HMI and the number of selections which those images are meant to offer operators of the HMI.

A schematic of the principles of HoloTouch technology involved in detecting the insertion of a finger into holographic images of what would otherwise be the keys of the holographic HMI to be controlled is shown in

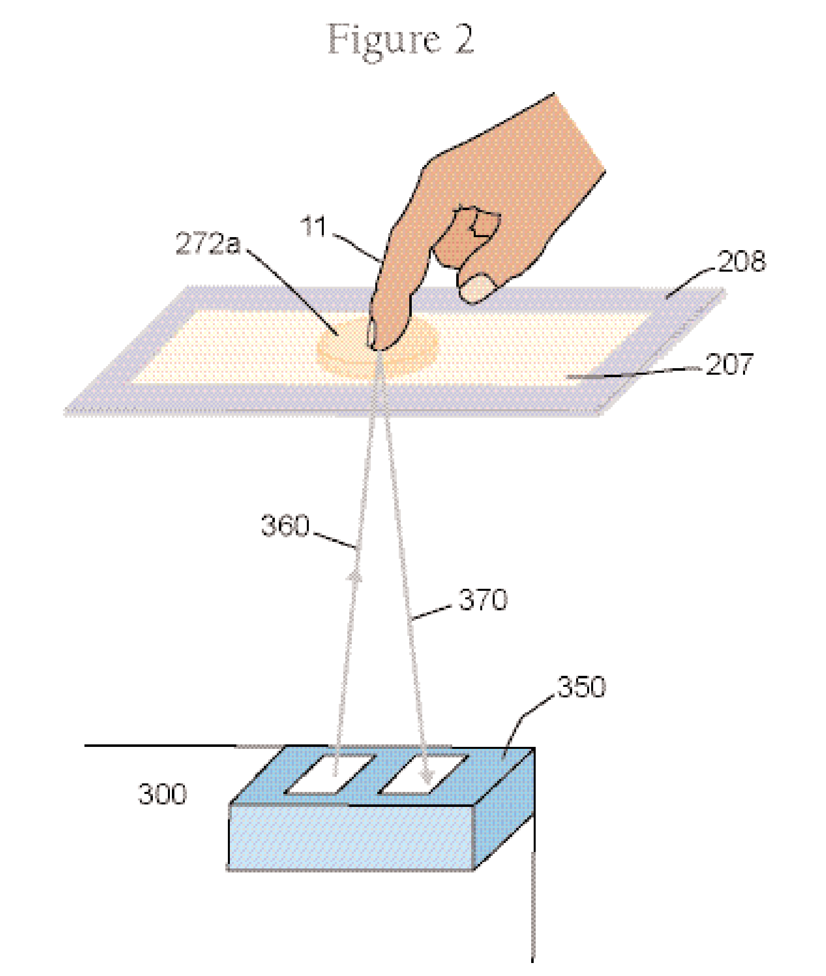


Fig. 2. A schematic of the principles of HoloTouch technology involved in detecting the insertion of a finger into holographic images of what would otherwise be the keys of the holographic HMI to be controlled. Area 300 is an actuation detector, 350 is a wave source which emits scanning beam 360 that senses when finger 11 enters the space where holographic image 272a appears to be, resulting in reflected beam 370's signal to actuation detector 300 that the operator has entered the command represented by holographic image 272a. The resulting command is then transmitted to the equipment controlled by the holographic HMI.

Figure 2. For the sake of simplicity, the schematic shown in Figure 2 assumes that holographic images 207, 208 and 272a, the latter representing a "key" of the holographic HMI, are being generated according to the principles shown in Figure 1. In Figure 2, 300 is an actuation detector. 350 is a wave source which emits scanning beam 360 that senses when finger 11 enters the space where holographic image 272a appears to be, resulting in reflected beam 370's signal to actuation detector 300 that the operator has entered the command represented by holographic image 272a. The resulting command is then transmitted to the equipment controlled by the holographic HMI.

Replicating the characteristics embodied in a hologram as the result of the mechanics of its creation, wave sensors are positioned so as to detect when an operator's finger or some other object such as a pointer enters the space where each holographic image appears in front of the holographic HMI. In the case of a holographic HMI offering an operator one choice, such as a power switch, one potential choice of hardware, for example, might be one diffuse reflection photoelectric sensor emitting infrared having a wavelength of 880 nm, and having the broadest detection range from itself of approximately 50 to 100 mm.

When a tangible object enters that space, which coincides with the apparent location of the HMI's image of what would otherwise be a tactile power switch, the on/off signal is transmitted to the underlying electronic device. Tunable emitter/detectors available on the commercial market allow the designer of a holographic HMI to adjust the position of this "sweet spot" to suit the needs of particular applications.

Where more than one or two choices are to be offered the operator of holographic HMI's, the wave source to be employed is configured to scan the plane of the holographic images of the HMI — an X-Y axis coplanar with the plane of those images created with software analogous to that used to program a computer screen for interaction with a computer mouse. Scanning the plane of those images, the wave source detects the intrusion of a finger or other tangible object into the space, which coincides with the apparent location of one of the choices offered the operator of that holographic HMI, for example, a letter, number or icon. That detection is simultaneously transmitted to the underlying electronic device utilizing electronic circuitry that would otherwise be used to transmit the signal generated by touching the conventional keys or buttons of the electronic device. ★