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Potential of multimodal and multiuser interaction with virtual holography

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ABSTRACT

Virtual holography is a disruptive technology that can inspire innovations in variety of fields through blending the physical world with sensory-rich virtual world. The technology enables users to naturally and intuitively manipulate objects and navigate in 3D space. The zSpace virtual holography platform is described. The platform provides a 3D display and head-tracking technology that transforms PCs into virtual-holographic computing facility using a stereoscopic user interface with an interactive stylus. The major components of the platform and its potential benefits, along with some of the current applications are briefly described.

The use of the zSpace platform to explore and manipulate a number of space system models is outlined. The models considered include Titan Saturn system, a joint NASA/ESA mission; Mars Science Lab concept; James Webb Telescope; and a Lunar Lander concept. In each of the applications considered, the platform is enhanced by using multimodal interactions, and providing support for multiuser collaboration. The multimodal interactions, which enable more engaging, enhanced accessibility, are achieved by fusing information from a set of stylus input, 3D gestures, and neural input. Simultaneous and collaborative multiuser interactions are described, which support both local and distributed teams, using variety of displays.

Emerging and future enhancements of the zSpace platform are outlined, along with novel future applications.

1. Introduction

In recent years, there has been an increasing interest in 3D experience, including, 3D imaging and display systems, 3D stereoscopy, 3D TV, 3D movies, 3D wearable devices, holographic 3D monitors, holographic telepresence, and the glasses-free 3D projector recently developed by researchers at the MIT media lab (see, for example, [1–6]). This may be attributed to the fact that a lot of significant information gets lost by looking at 2D views of 3D objects. By contrast, a true 3D stereo visualization platform allows a user to see objects as 3D objects by imitating eyes' natural 3D perception pipeline, the binocular parallax. The interactive stereo displays enable the user to manipulate and interact with the 3D stereo images depicted on the display.

2. 3D virtual holographic zSpace platform

The zSpace virtual holography platform, developed by a California-based company, is a game changer for 3D stereo and interactive visualization. It enables new level of realism in the creation of virtual prototypes, real-time interaction with photo-realistic 3D objects, as well as representing complex ideas more effectively, through viewing and manipulating 3D objects, and navigating in 3D space. It provides a portable, interactive immersive 3D environment. The major components of the platform are described subsequently [7,8].

2.1. System overview and major components

The zSpace platform combines a number of hardware and software technologies for blending the physical world with sensory-rich virtual world in an interactive immersive experience. It consists of three components: a 24 in., 1920×1080 LCD monitor (tablet display) running at 120 Hz, a laser-based wired six-degree-of-freedom stylus device, and a pair of lightweight polarized passive glasses. The monitor is mounted on a stand that tilts it up about 30° ([7] and Fig. 1).

The stylus has optical and inertial sensors, such as an accelerometer and a gyroscope, for determining the location relative to the screen. The stylus has three buttons, one for selecting the

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objects, and the other two are user definable. It is like a ballpoint pen that enables a user to "pick up" an object and place it anywhere within the plane (see Fig. 2). Also, there is functionality for a user to look completely around a particular object, examine it from all angles, and zoom in and out. The user can zoom down to the smallest scale and explore the object in ways that cannot be experienced with physical objects. This capability is particularly significant for certain applications, like medical training.

The glasses are not shuttered LCD glasses, and do not need wires or batteries. The tablet has a pair of widely spaced sensors that track the glasses, and then re-renders the 3D geometry with respect to the user's updated perspective in real time as the user looks around the model. 3D models can appear to be floating in the screen, or pop out of the screen, beyond simple binocular parallax. The new immersive depth information is called the motion parallax, which can be augmented to the binocular parallax already present in the display in order to amplify the depth perception of the user.

The software platform provides simple, low-level access to all the aforementioned features. An SDK is provided for integrating existing applications with, and developing new ones for, the platform.

The zSpace platform offers a combination of three elements that create an immersive 3D environment:

- *Stereoscopy*, which provides depth perception.
- *Head tracking*, which allows the user to look around objects; and
- *Proprioception*, or the ability to actually manipulate and interact with virtual holographic objects.

A fourth element, which is important in applications, is the development of an appropriate protocol to take advantage of the open visual space. Allowing the user to manipulate virtual objects enables the creation of a sense of spatial relations among the elements in the display via proprioception, which can augment the two distinctive parallax cues. The congruence among binocular parallax, motion parallax, and proprioception can increase both the sense of depth in the display and the viewing comfort. It can also enhance the user's ability to make sense out of the incoming perceptual information.

The major benefits of the zSpace platform include [9].

- Providing a sense of realism, where virtual-holographic images are projected in an open space above the display, and the images appearing in full color as real physical objects.
- Deeply engaging the user's cognitive and intuitive powers in scenarios involving complex objects, concepts, and interaction with data.

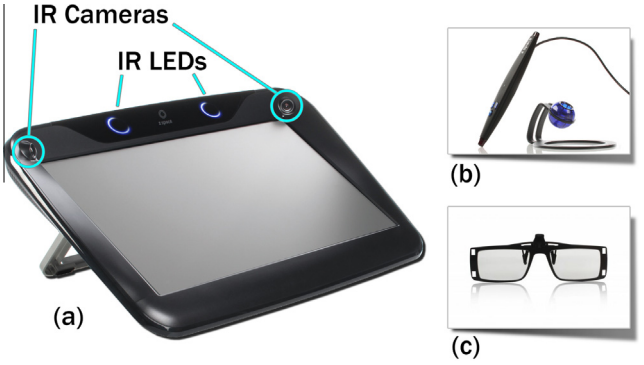

Fig. 1. Major components of the zSpace platform, (a) 24 in. LCD monitor (physical display), (b) gyroscope-based wired six-degree-of freedom stylus device and (c) polarized passive glasses with IR markers.

Fig. 2. Using the stylus and head tracking to interact with the orbiter of the Titan Saturn System mission (a joint NASA/ESA proposed mission).

- An intuitive, natural and comfortable easy-to-use 3D interface.
- Fast, accurate and flexible interaction with three dimensional objects and data.
- Quick and insightful understanding of abstract concepts and discovery of hidden information.

2.2. EON Ibench Mobile

The zSpace platform described in the preceding section has been integrated with the high-end 3D software developed by EON Reality, a large provider of virtual reality software, systems and applications. The resulting integrated hardware/software platform is called EON Ibench Mobile. It provides a table-top stereoscopic 3D display solution that fully immerses users within the digital environment.

The EON Ibench Mobile platform enables easy conversion of 3D data, scenario creation, and creation of advanced interactivity. It supports several CAD and 3D model formats, as well as content from the EON Experience portal [10].

3. Some examples of current applications

The applications of the zSpace platform span several industries including CAD/CAM/CAE, manufacturing, virtual product creation, architecture, big data visualization, immersive learning, healthcare, and entertainment. Also, zSpace organizes conferences and webinars to provide an educational environment for stimulating communication and collaboration among developers of 3D applications, hardware and content, interested in immersive, lifelike and interactive technologies. Some of the recent 3D applications developed using the zSpace platform are described subsequently.

A zSpace immersive 3D interface was developed for Siemens' Teamcenter life cycle management software [11]. The interface enables users to achieve a higher level of realism and interactive collaboration throughout the product manufacturing process from their desktop.

Autodesk's 3D visualization and virtual prototyping software (VRED), enable automotive designers and engineers to visualize product presentations, design reviews, and virtual prototypes with highly realistic materials, physical camera settings, engineering tools, and even surface analysis modes using an interactive desktop environment [12]. The use of the zSpace platform as an interface to VRED added interactive realism for training and product presentations.