G-Spacing: a Gyro Sensor Based Relative 3D Space Positioning Scheme

Kai-Wen Liu[a], I-Peng Lin[a], Shih-Wei Sun[a,b]*, Wen-Huang Cheng[c], and Xiaoniu Su-Chu Hsu[a]
[a]Department of New Media Art and [b]Center for Art and Technology, Taipei National University of the Arts, Taiwan
[c]Research Center for Information Technology Innovation, Academia Sinica, Taiwan

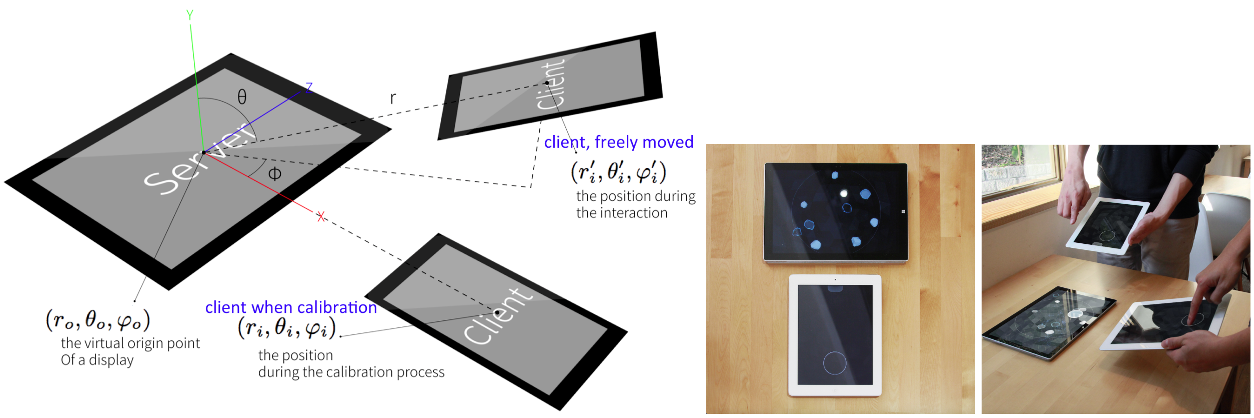

Figure 1: *The proposed 3D space positioning scheme, the calibration process, and the multiple users interaction.*

1 Introduction

Interaction with virtual objects among different devices attracts lots of attention recently. LuminAR [Linder and Maes] was developed for a portable and compact projector-camera system for interactive displaying. THAW [Leigh et al.] was proposed to use a back-facing camera of a smartphone to assist the interactive displaying. RealSense [Lin et al.] was adopted the built-in compass sensor on a mobile device to calibrate the relative position among different mobile devices. However, the complex calibration process of LuminAR [Linder and Maes] and THAW [Leigh et al.] limited the applications. On the other hand, as addressed by the authors, once the users with mobile devices using RealSense [Lin et al.] move larger than 15°, the positioning relationship cannot be kept stable. Therefore, in this paper, a 3D positioning scheme is proposed based on the built-in gyro sensor on a mobile device for effective and intuitive calibration and allow users to freely move the mobile devices with a natural user experience.

2 Gyro Sensor Based 3D Space Positioning

As shown in Fig. 1, during the calibration phase, users can intuitively hold the mobile devices heading to the center of a display, which is a virtual origin point $(r_o, \theta_o, \varphi_o)$ of a spherical coordinate system, and press a button on the user interface of a mobile device (client) to send a calibration signal to the server. Meanwhile, the attitude values in the spherical coordinate and the corresponding user ID will be stored at the server, e.g., $(r_i, \theta_i, \varphi_i)$ in the left part of Fig. 1 represents the 3d position of the heading direction belonging to the held mobile device of the i-th user to the virtual origin. When the user is freely moved to another position and holds the mobile device, the gyro sensor value converted to the spherical coordinate system $(r'_i, \theta'_i, \varphi'_i)$ is used to calculate the relative position from the calibration position. Therefore, the heading vector from the mobile device to the virtual origin point $(r_o, \theta_o, \varphi_o)$ can be calculated and the 3D position of the mobile device can be obtained.

*e-mail:swsun@newmedia.tnua.edu.tw

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3 Implementation and Applications

A tech-art work called,“Sound Space”, a virtual social space via sound interactions based on physically relative positions of social members, is proposed as a demonstrative application of the proposed G-Spacing. The snapshot of multiple users interaction is shown in the right part of Fig. 1. In the implementation of a prototype, the calibration process of each client mobile device (the white iPad in the middle of Fig. 1) to the server mobile (the black Windows Surface pad), with a Wifi device as the access point. After the calibration process, users can freely move around the mobile device in the center and obtain natural user experiences. During the onsite demo of “Sound Space” (presented in a tech-art gallery at the mid January, 2015), about 80% of 15 users responded satisfactory user experiences. In the near future, the proposed prototype will be extended to a larger display, e.g., an interactive wall/ball, to allow users to interact from the mobile device to the displayed objects.

References

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