

# **The God-like Interaction Framework: tools and techniques for communicating in mixed-space collaboration**

Research Thesis for the Degree of Doctor of Philosophy

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# Declaration

I declare that:

- this thesis presents work carried out by myself and does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university;
- to the best of my knowledge it does not contain any materials previously published or written by another person except where due reference is made in the text; and all substantive contributions by others to the work presented, including jointly authored publications, is clearly acknowledged.

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Adelaide, November 2008

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# Abstract

This dissertation presents techniques for remote communication of situational and navigational information. Outdoor augmented reality is a technology that facilitates viewing and generating geospatially registered virtual objects outdoors. In the future, emergency workers, law enforcers and military personnel may benefit from using outdoor augmented reality to help describe situational information to assist with safe and efficient completion of tasks. Situational information is constantly changing, what was true a minute ago may no longer be the case. These workers currently rely on a central command centre to keep them up to date with the larger picture.

This dissertation describes a new approach to communication of navigational and situational information between people in command centres, and people working in the field using outdoor augmented reality. This dissertation introduces the god-like interaction metaphor that describes a new approach to remote communication. The metaphor utilises a person's current perception about how an interventionist god influences the world through the hand of god. Command centre personnel visualise the remote workers on a large display, showing their position and orientation with respect to the real world. The command centre personnel use hand gestures and tangible prop interaction to provide navigation and situational information. A 3D capture system above a display captures the gestures and interactions, which are then presented to the remote field worker through the outdoor augmented reality system. To remote workers, the animated interactions appear to originate from the sky. Using this approach, command centre personnel can use their hands to point, make gestures, and represent objects and numbers. Tangible props can be used as virtual landmarks, virtual rally points and area of interest markers. Post-It notes can be used to create persistent information without the need for traditional input devices. To facilitate this form of interaction a 3D reconstruction tabletop display system was developed. The system has a number of cameras around the outside looking in that capture the interaction above a display surface.

3D capture systems have previously been developed to work over high-bandwidth reliable networks, but this system extends a well know video-based rendering algorithm to enable transmission of 3D content over an unreliable low-bandwidth network.

The practicalities and limitations of the god-like interaction techniques are explored in two studies. The first examines outdoor AR experiences, revealing problems with users estimating distance, particularly when the scale of the virtual objects is altered. However, participants are able to recognise objects and interpret intentions. The second study examines the comparative usefulness of gestures for providing visual cues for collaborative navigation. The results show that gesture-based cues are as effective as using a mouse to generate the cues. However, using gestures reduces the cognitive load on participants and facilitates experimentation of ways to convey intention, which is not possible using a mouse-based approach.

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# Abbreviations and Definitions

**AR** Augmented Reality.

**CCD** Charge-Coupled Device.

**FPGA** Field-programmable gate array.

**FOV** Field of View.

**GPS** Global Positioning System.

**GPU** Graphics Processing Unit.

**HOG** Hand of god.

**HOG table** The 3D capture tabletop display.

**HOG user** A person operating the HOG table.

**HOG object** A 3D reconstructed virtual object generated using the capture technology of the HOG table.

**HMD** Head Mounted Display.

**RGB** Red, green and blue. A common colour space used in many graphics applications.

**VBR** Video-Based Rendering.

**VR** Virtual Reality.

**Working volume** The area on the HOG table in which all cameras can see.



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