ENHANCING SITUATIONAL AWARENESS USING FISHEYE LENSES

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ABSTRACT

Advances in C4I technology are constantly increasing the amount and quality of information available to command personnel. This brings to the fore the challenge of managing, navigating, and comprehending this information as a requirement for making correct and timely decisions. We discuss the use of fisheye lenses, also known as detail-in-context lenses, to aid in geo-spatial and imagery data presentation and interaction on computer displays with the goal of increasing comprehension, efficiency, and ultimately the quality of decisions. A framework is laid for the use of fisheye lenses, including the fusing of data from multiple sources, and the direct coupling of lenses with data.

1. INTRODUCTION

Detail-in-context visualizations, also known as fisheye lens visualizations (see Fig. 1), have been a research topic of interest for over a decade in the fields of information visualization, scientific visualization, and human-computer interaction. Recently, with the application of detail-in-context visualizations to map viewing systems and other GISs, a natural connection has been made between the benefits offered by fisheyes, and the needs of users of C4I computer systems.

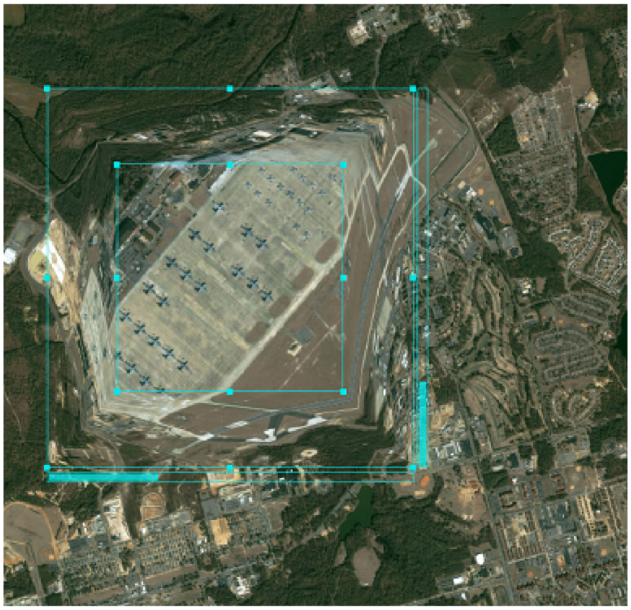

Fig. 1: A fisheye lens applied to a photograph

Fisheye lenses offer several benefits to users of C4I systems. The core strength of such a lens is its ability to display data at multiple scales while maintaining continuity of topography. The focal region of a lens, the central area of constant magnification, provides the user with a detailed view of a region of interest. The base region of the image, the region surrounding the fisheye lens, provides a low-resolution overview of the region. This provides the user with a means of maintaining an awareness of global context, and in the case of systems updating in real time, provides the user with the ability to monitor global changes in state. The shoulder region of the lens, the area of varying scale that connects the focal region with the base region, provides the user with valuable visual cues, and allows for an understanding of the physical relationship between focal region and base region objects.

2. RELATED LITERATURE

A thorough summary of the state of the art in the early years of detail-in-context lens research is available (Leung and Apperley, 1994). A significant advance in the underlying technology of these lenses was also developed (Carpendale et al., 1995). More recently, several studies dealing with the usability benefits of fisheyes have looked at cursor steering tasks (Gutwin and Skopik, 2003), as well as the benefits fisheyes offer for browsing information on small displays (Gutwin and Fedak, 2004), such as those found on handheld devices.

3. A FISHEYE DESIGN FRAMEWORK

We are developing a general design framework that will allow applications such as those under the C4I umbrella to benefit from the use of detail-in-context lenses in the representation of geo-spatial and imagery data. One novel component defined in the framework is the use of fisheye lenses for the display of fused data from multiple sources. A second component is the direct coupling of lenses with data.

IDELIX Software is actively developing technology to achieve these two goals, with the possibility of incorporating the technology into their Pliable Display Technology SDK. This technology, in conjunction with the already developed rendering, user interface, and reverse “undisplace” lensing transform allowing precise lens mediated data interaction, will make possible the realization of this general design framework.

3.1 Sensor Fusion

C4I systems gather data from a wide variety of sources. Geographic data can arrive from satellites, aerial photographs, and archived vector maps. This geographic data can then be correlated with real-time data gathered from a variety of sensors reporting such things as force deployment.

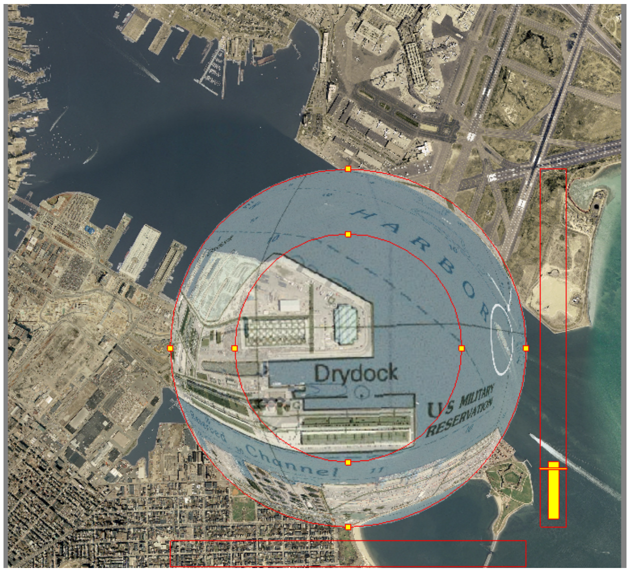

Fig. 2: A screenshot showing a lens with a blended satellite photograph and vector map.

We have developed technology that allows data from different sources to be blended together at varying alpha (transparency) levels selectively in either the lens region or the base image region (see Fig. 2). This allows, for example, for data from sources appropriate for providing contextual awareness to be shown in the base image, while dense information necessary for selective local decision making is shown in the lens.

Not only can data from different sources be blended, but rendering of data from a single source can be made dependent on scale. For example, when showing troop deployments on a map, troops within the lens can be represented at platoon level, whereas in the context troops can be represented at lower resolution, for example at the company level. This provides the detail in the lens required to make accurate decisions, while avoiding excessive clutter outside of the lens.

3.2 Smart Lenses

It is possible for a user to be in direct control of all lens parameters, including position, magnification, and size. It is also possible, however, to design a system in such a way that lens behavior is directly coupled to changes in data elements.

We introduce the concept of a “smart lens.” A smart lens is one that is aware of the atomic data elements (e.g. an individual squad or vehicle) that might exist in a scene. Knowledge of these elements can be acquired from different sources, whether determined through direct reporting from a sensor, reporting from an individual in the field, or through the application of automatic image feature recognition algorithms.

Once a lens is aware of data within a scene, that lens can reconfigure itself for a variety of purposes, including to draw user attention to a change in state of an element at a certain position, to dynamically track a mobile component, or to reshape itself to accommodate a cluster of components, making the scene more comprehensible.

4. FUTURE WORK

The next step in development of Smart Lens technology is to define a communications protocol allowing for synchronization between data and lenses. Once this protocol is defined and implemented, we will incorporate it and the blending technology into a sample system with automatic target recognition capabilities.

IDELIX is also investigating the use of fisheye lenses for use on novel hardware technologies. One such project deals with fisheye lenses applied to collaborative C4I applications on a touch-sensitive tabletop display.

The next quantum leap in detail-in-context lens technology from IDELIX will quite likely involve the application of fisheye lens technology to 3D data, be it 3D models or terrain data.

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