Designing Virtual Trailblazing for Battlespace Visualisation

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SUMMARY

In order to maximize the Common Operational Picture, interactive displays of large-scale complex computer-rendered environments must allow for effective navigational techniques. This is no small challenge, given the current state of virtual environment technology, 3D input devices, and limited knowledge regarding human factors-based best practices for human way-finding and navigation. In theory, integrating 3D computer renderings of the real world allows command personnel to plan and simulate battlespace tactics from the perspective of both ground and air. However, change in viewpoints without proper reference points or landmarks can lead to disorientation for the human user. Human factors issues pertaining to navigation in virtual environments and the need to extend the scientific knowledge base concerning ways of effectively improving human navigation in complex or landmark-sparse environments are discussed. In addition, conceptual designs for virtual trailblazing techniques are proposed.

1.0 INTRODUCTION

Taylor defines a visualisation system as "a system for presenting interactively some part of a dataspace in such a way that a user with some purpose in mind can visualise the import of the data for that purpose", [1]. The task of the human operator is to perceive, process, and interpret the data in order to make timely decisions. The data need not be limited to visual displays (e.g. may include auditory and haptic feedback). As well the data may not be complete, and as such system designers must acknowledge the limitations of human information processing capabilities in order to best support complex data visualisation.

One approach to displaying images of the battlespace is to present modified renderings of the real world in the form of virtual environments (VE). In the broadest sense, a VE allows the user to move and interact through a computer-generated simulation of 3D space. An advantage of a VE is that it can be designed to allow for route planning from the perspective of ground and air personnel. Often virtual environments are detail-sparse so as to keep the rendering of interactions to time frames acceptable to the human operator. Renderings that are slow impact on a user's sense of presence in the environment and contribute to simulator sickness [2, 3]. However, limiting visual detail can contribute to user disorientation – a frequent complaint with complex virtual environments [4]. Promising approaches for countering such disorientation include allowing for change in viewpoints through visual momentum [5] and providing trailblazing techniques [4]. VEs allow for the combination of egocentric and exocentric frames of reference (FOR) leading to improved situational

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awareness compared to using a single FOR [6]. This paper will focus on the design and development of virtual trailblazing techniques that can be used effectively to aid battlespace visualisation.

2.0 TRAILBLAZING IN VIRTUAL ENVIRONMENTS

The commander may need to lay out the strategic plan in terms of troop navigation through the battle space (i.e. land, air, sea). Navigation can be parsed into two main components: the strategic component of planning the route from point A to point B (wayfinding); and the tactical component of translation through the space from point A to point B (movement) [7]. To successfully navigate through battle terrain it is important to understand one's position relative to others (friend or foe). To this end VEs may serve as collaborative environments for strategic planning and tactical movements. On a 2D map the perspective is exocentric and one might use markers or overlays to identify routes and points of interest. In 3D space, one is more likely to trailblaze while moving through the space with an egocentric perspective. Trailblazing should be distinguished from landmarks. Landmarks are features embedded in the landscape by the designer of the environment, while trailblazing is the act of placing physical markers in the environment by the user so as to remember particular trails or to mark routes for others [7]. Recommendations have been made in terms of guidelines for constructing landmarks in virtual environments [8]. Such recommendations are most suitable when the design of the virtual environment allows for the inclusion of distinct landmarks. However, many real world tasks involve navigation in environments that allow for alternative paths, changes in path efficiency depending on circumstance (e.g. finding alternate routes if a bridge has been washed out), and strategic and permit-oriented markings (i.e. dropping of virtual anchors or markers that can be detected by authorized followers only). Our proposed research extend how best to design and deploy configurable markers for trailblazing in virtual environments.

To date software-based techniques that support active trailblazing in virtual environments are limited. Researched methods have ranged from having users actively drop simple cubes in breadcrumb-like fashion to mark routes [4] to automatically marking routes with footprints [9]. Darken and colleagues found the effectiveness of the breadcrumb trail to be limited by the non-directionality of the cubes [4]; and the footprint technique was found to confuse users if more than one route had been travelled or more than one user had left behind footprints [9].

3.0 STICKY VIRTUAL TRAILBLAZING MARKERS

A proposed alternative to breadcrumbs and footprints are *sticky virtual markers* (*VTrail markers*) for use in 3D space. The user will be able to place VTrail markers in the VE to trailblaze routes. Unlike virtual breadcrumbs and footprints, VTrail markers will consist of simple shapes created to communicate directionality whether viewed from an egocentric or exocentric perspective. Like 2D sticky notes for desktop applications, VTrail markers will be easily moved and repositioned until the trailblazer "locks" the VTrails into place. The proposed VTrail application will allow commanders to configure distinct virtual marker sets for strategic planning and tactical simulation. In addition, VTrail markers will be embedded with configurable behaviours that will allow users to move along the marked route by teleporting (i.e. move immediately from one location to another location without intervening scenes) or rubber-banding (i.e. move backwards or forwards along the marked trail with continuous movement). Conceptual design of the VTrail markers and preliminary user-testing is underway. The presentation will report progress on the VTrail Project, as well as recommendations for continued design development for virtual trailblazing.

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