Final Report Summary

Feasibility Study: Haptic Interface for IRIS3D Display

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Executive Summary

Iris3D is an innovative spin-out company from the University of Strathclyde making 3D displays with very high levels of image quality and user comfort. An important market sector for the company is oil and gas and they have deployed displays with a major Petrochemical company. Users have commented on the high quality and comfort of the display but also expressed frustration at the lack of 3D interaction. This project provides a demonstration of 3D haptic interaction using the Iris3D display. Meetings with the client company established that two approaches to demonstrate the value of 3D interaction would be followed. The client company would outline a simple workflow with a 3D mouse. Meanwhile the HandsOn team at Edinburgh College of Art would create a standalone 3D haptic volumetric visualization tool. The client company completed a specification for the 3D mouse workflow demonstrator but it was not possible, in the short time frame of the project, for the client to implement this workflow. The standalone 3D haptic visualization tool was implemented and provides a powerful demonstration of the potential of integrating 3D haptic interaction with a state of the art 3D imaging device.

Background

The Project History

Iris3d have been trialing their display systems with a world leading petrochemical company for some time. The displays themselves have been generating significant user interest. However, despite the many positive aspects of this new display technology users have become frustrated with the lack of 3D input. Iris3D arranged to pursue this issue through a small innovation award (TTOM) and brought Hands-On in as 'haptic consultants'.

Participating Organisations

- Iris3D:

Iris 3D are a spin-out company from the University of Strathclyde. They are a display hardware company specialising in the design and manufacture of advanced 3D visualisation tools for professional end users and their glasses-free 3D display workstations offer the highest resolution in their class (dual UXGA projection). The displays have also been highly praised for their exceptional user comfort.

- Hands-On:

Hands-On are in the final stages of forming a spin-out company from Edinburgh College of Art and the University of Edinburgh. Currently they are funded by a Scottish Enterprise 'Proof of Concept Award' (soon to be followed by a 'Proof of Concept Plus' award). The group specialise in the development of novel haptic interaction techniques and software applications particularly for use in the creative fields of Design, Arts, Applied Art, Computer Games and Animation.

- Client:

A major petrochemical company, the client manages the research, development and the deployment of technology for their global exploration and production businesses.

Objectives:

The main objective of the project is to demonstrate the potential of including 3D interaction in some area of a typical Exploration and Production workflow. An additional objective is to demonstrate the

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potential of including force feedback (from a haptic interface device) as a mechanism to increase usability, accuracy or productivity. It has been agreed that to meet these objectives two separate approaches will be followed. The first application will be developed in conjunction with the client company. This application will extend the capabilities of the existing primary visualization tool used within the client company by adding a simple 3D cursor which will, in the first instance, be controlled via the Phantom Omni haptic device. This device does allow force feedback. However, it is anticipated that this functionality will not be utilized by this simple application. The primary value of this application is as an initial talking point for users within the client company as to the value of 3D interaction.

The second application will be developed by Hands-On at Edinburgh College of Art as a standalone demo. The aim of this application is to demonstrate a potential 3D interface where force feedback is closely coupled with the interface itself. The timeframe of the project does not allow for this application to be integrated with the client's visualization package. Therefore, a standalone demo will be used to demonstrate the concept.

Scope:

It is not necessary for the project to deliver industrial strength solutions for general distribution as this will not be possible in the given timeframe. Rather, the project goal is to demonstrate the potential of developing such solutions given additional time and investment.

Deliverables:

- A Workflow the for client's visualization tool with the integrated 3D cursor (Client)
- A standalone demo showing a novel haptic interface of 3D visualization (HandsOn)
- Final Project Report (HandsOn)

Timeline:

The timeline for the project was very short with a total length of only 2 months or 8 weeks. It also took a great deal of time to engage with the client which is a very large and busy company.

Initial Discussions with Iris 3D

From Iris3D's point of view the project's value would be greatly reduced if does not involve significant engagement with the client. More specifically, the demo should be linked to the client's in house viewer/manipulator for volumetric data. Although a stand alone application could potentially be of some use for demonstrating the potential of the Iris3D display, it would have significantly less impact than integration with the software which has already been deployed. However, the client was unable to provide support for integration within the time frame of the project. Discussions with the client concluded that a standalone demonstrator would be of value as a discussion point and so this was taken forward by researchers at Edinburgh College of Art.

The client has already indicated that haptics have, in the past, been fully integrated with their Volume visualization package. However, lack of user interest has led to the removal of this code from the core package. Iris3D suggest that this could have been related to the legacy 3D displays which were used at the time. Their own display has recently been deployed to the client. The new display has been praised for is comfort and high resolution. However, the users are continually frustrated by the limited 2D input device (standard mouse) and this suggests that integration of some 3D input device with the clients visualization package could potentially be of great benefit.

Haptic Tool Kit Survey and Linux Compatibility

A survey of available haptic tool kits was undertaken and the results given in Appendix 1. The market leader in Haptic devices in Sensable and they provide a toolkit called Open Haptics. It is recommended that this tool is used for future development. However, there was an outstanding technical issue which is whether this toolkit runs on the Linux operating system used by some client users. We therefore decided to perform a compatibility test. The initial compatibility test of the OpenHaptics toolkit was carried out on RedHat EW3 u7 and was successful.

Client Work Flow Application

The client produced a workflow for a typical oil production application. The workflow consists of a detailed sequential list of interactions with the visualization tool during an oil exploration exercise. The workflow includes the mouse and keyboard buttons that would normally be used to create the interaction. A key comment by the HandsOn team is that the number of keyboard and mouse button interactions could be significantly reduced using a 6D haptic input device.
The client was unable to integrate the workflow into their visualization package in the very short time frame of the project but will consider further development. A demonstration of the final application would be arranged with the client user groups.

HandsOn Stand Alone Haptic Demonstrator

The HandsOn Team at Edinburgh College of Art were tasked with creating a stand alone 3D interactive haptic demonstrator for the manipulation of geological data.

EuroHaptics

It was decided to send a member of the project team to Eurohaptics, which is the leading meeting for research into haptic interaction techniques in Europe. The purpose of this visit was to assess the latest state of the art in haptic interaction and to see if some of these new approaches could be adapted for use in a 3D haptic visualization tool for the oil industry using the Iris3D display.
A relatively new innovation in haptic API's is the provision of volume rendering. This is particularly relevant to oil exploration as geological data sets are 3D volumes. At Eurohaptics there were demonstrations of the use of volume rendering for visualization of medical data such as CAT scans. It was decided to adapt these approaches to geological datasets.

An Application: Geological Fault and Boundary Visualization

One relevant application in the Oil industry is the tracing of geological faults and boundaries through rock strata. We see such faults at the surface as 2D lines but below the surface they can form complex 3D structures. Geologists look for particular configurations of faults and boundaries between porous oil bearing rocks and impervious rocks which can trap oil or gas. It was decided to make a 3D Haptic interactive visualization tool with the fault/boundary application as a focus.

Figure 1 shows a screen shot of the HandsOn stand alone demonstrator. The wire-frame box outlines the limits of a 3D volumetric data set of rock strata. Within the box there are three orthogonal clip planes. The clip planes show textured images of a planar slice through the volume. The clip planes can be moved through the volume to display other slices of data. The pen is a proxy for the haptic device which can pull the clip planes through the data volume. It is also possible to draw faults or rock boundaries. The demonstrator was created using Sensegraphics H3D API and its Volumetric extension.

3D Interaction

Firstly we note ways in which this tool differs from a conventional tool:

- Scaling and Positioning: It is possible to scale, place and rotate the entire volume within the display's workspace. Because the haptic device is a true 6D input device it is possible to perform translation and rotation actions simultaneously which greatly speeds up the process.
- Clip Plane Movement: It is possible to use the haptic device to drag the clip planes through the data. Again, because of the 6D input device it is possible to move all three planes at once with great efficiency.

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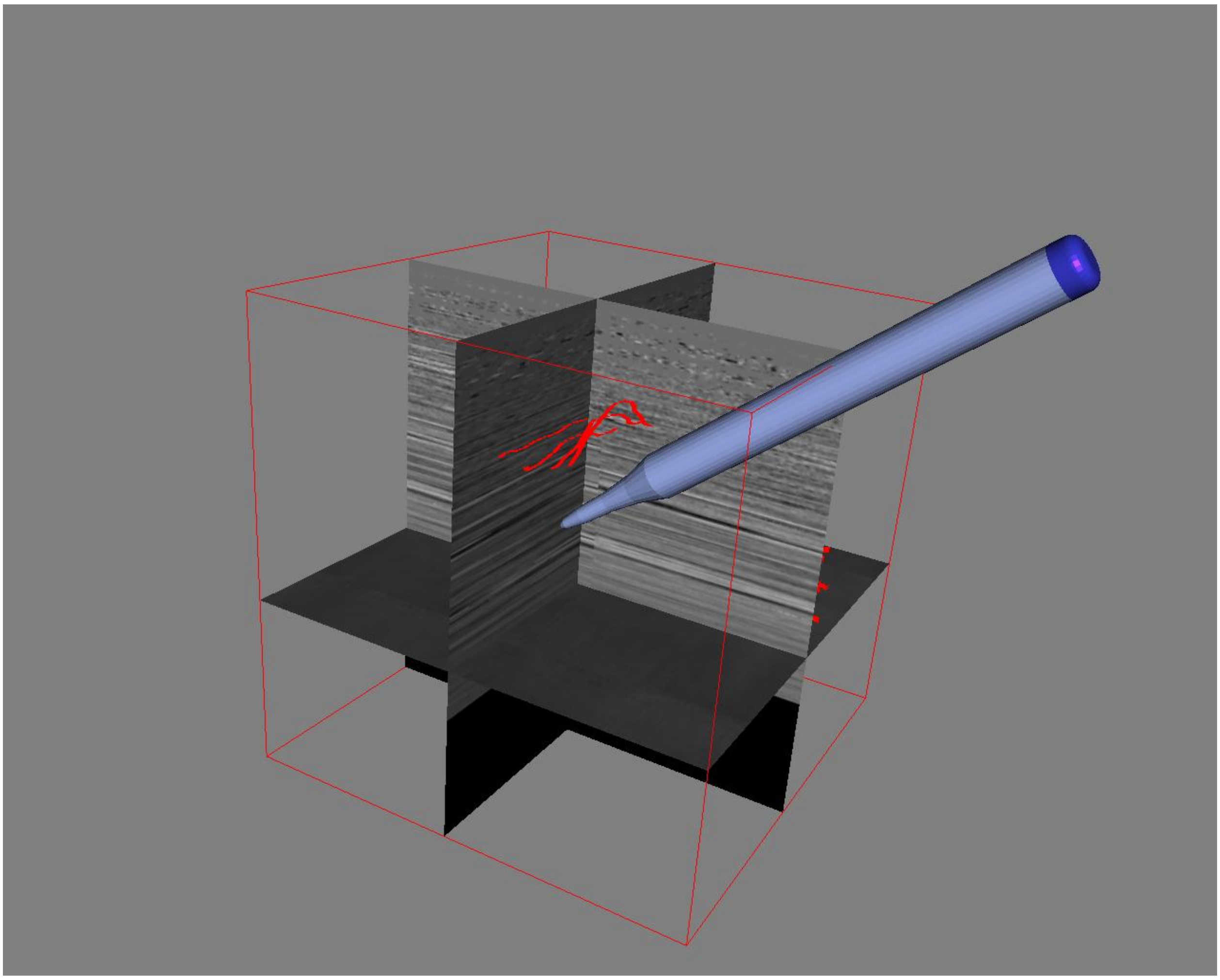

Figure 1: HandsOn Stand Alone 3D Haptic Interaction Demonstration

3D Haptic Interaction
In addition to full 6D input we have included haptic interaction within the demonstration:

- **Haptic Clip Planes** : Each of the clip planes is haptic. This means that they can be touched as if they were three real orthogonal planes in 3D space. This means the planes are easy to select within the 3D display.
- **Haptic Fault/Boundary Drawing**: As well as being able to touch the clip planes it is possible to draw on them. The user can therefore mark the position of a fault or boundary on the clip plane directly. When the clip plane is moved the drawn line remains in its original position in space. It is therefore possible to trace a Fault or Boundary in 3D as a series of 2D contours through the 3D volumetric data set.

Conclusion
A TTOM project has been undertaken to demonstrate the utility of integrating 3D haptic interaction with a state of the art 3D display from Iris3D. This process was necessary to engage with a major Petrochemical company in the important Oil and Gas sector. Users of the display were impressed by

its high level of comfort and quality of images but expressed frustration at the lack of 3D interaction. It was decided to provide a demonstrator of 3D haptic interaction.

A survey of haptic toolkits was undertaken and Sensable OpenHaptics identified as fitting the needs of the user. A compatibility test was undertaken to show that OpenHaptics could run on a version of Linux and this was a success.

A meeting with the client Petrochemical company identified that two approaches should be followed. The client would create a simple workflow of a typical oil exploration application with basic 3D cursor interaction with the purpose of engaging users with the potential of 3D interaction. In parallel a stand alone demonstrator of 3D haptic interaction was developed by researchers at Edinburgh College of Art. The application off marking faults and boundaries in rock strata was chosen as an application. The standalone 3D haptic visualization tool was implemented and provides a powerful demonstration of the potential of integrating 3D haptic interaction with a state of the art 3D imaging device.