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Advanced Visualization Techniques for Exploration and Production

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Abstract

During the past few years considerable attention has been given to a collection of high-performance computing and communications technologies--often referred to as "virtual reality" or "virtual environment technology"--directed at enabling enhanced data visualization on the part of scientists and engineers. Not only does this rapidly-evolving group cf technologies support the efficient navigation of large information spaces, it also offers the potential of new and powerful mechanisms for identifying subtle patterns or anomalies in data--patterns or anomalies that may lead to new and crucial discoveries. The use of visual immersion (via a CAVE or head-mounted display) and multi-sensory displays for these large and complex data sets further extends the ability of geophysicists and geologists to use seismic data and well logs, together with powerful modeling techniques, to identify and characterize hydrocarbon reservoirs. Current approaches utilize an immersive, three-dimensional visual display, a three-dimensional acoustic environment, interaction through "gesture" transducers, and one or more haptic display devices for force and tactile sensations to provide new and powerful mechanisms for the discovery and production of oil and gas.

In addition to a description of the technology elements noted above, this paper also presents examples of applications to problems in the oil and gas industry. Oil and gas reserves are distributed in three-dimensional physical space in the Earth. The current understanding of how and why accumulations of hydrocarbons form provides the basis for finding these accumulations. By taking physical measurements and displaying the resulting data in immersive, multi-sensory environments, one can achieve an intuitive understanding of the data and their internal relationships. In this manner, one can map the spatial distribution of production against geologic and reservoir simulation models, against databases of physical measurements, and against other of statistical or mathematical representations. This, the process of building a conceptual geologic model with acceptable risk, using algorithms to simulate this model, interpreting the raw data, comparing the inte9'retation with the simulations, and iteratively optimizing the Interpretation so that the simulation best matches the raw data can occur both faster and more accurately.

Introduction

The Texas oil and gas industry has, over the past decade invested significant funds (e.g., $620,000,000 by Exxon alone [Greenlee, 1994]) in acquiring three-dimensional seismic data for hydrocarbon exploration and development. In spite of this Investment,

the. methods used for its analysis are still largely done on two-dimensional displays. This paper describes the use. of immersive, three-dimensional, multi-sensory virtual environments to support the analysis of three-dimensional seismic data. The benefits are a significant increase in the productivity of geophysical analysts and an enhancement of their ability to locate hydrocarbon deposits that are currently overlooked. The economic benefit to the can be extraordinary. The following objectives are being pursued in this research and development activity:

I. enabling the migration of three dimensional seismic data analysis from two-dimensional computer workstation displays to totally immersive virtual environments (e.g., head-mounted displays or a CAVE);

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Reservoir Characterization, Information Management and Systems, Seismic processing and interpretation

Submitted

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During the past few years considerable attention has been given to a collection of high-performance computing and communications technologies--often referred to as "virtual reality" or "virtual environment technology"--directed at enabling enhanced data visualization on the part of scientists and engineers. Not only does this rapidly-evolving group of technologies support the efficient navigation of large information spaces, it also offers the potential of new and powerful mechanisms for identifying subtle patterns or anomalies in data--patterns or anomalies that may lead to new and crucial discoveries. The use of visual immersion (via a CAVE or head-mounted display) and multi-sensory displays for these large and complex data sets further extends the ability of geophysicists and geologists to use seismic data and well logs, together with powerful modeling techniques, to identify and characterize hydrocarbon reservoirs. Current approaches utilize an immersive, three-dimensional visual display, a three-dimensional acoustic environment, interaction through "gesture" transducers, and one or more haptic display devices for force and tactile sensations to provide new and powerful mechanisms for the discovery and production of oil and gas.

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The recent availability and growing maturity of these technologies offers an extraordinary opportunity to industry for enhanced efficiency in both the discovery and the production of oil and gas.

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