Interactive Visualization of Oil Reservoir Data

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Motivation

- Communication Overhead in Organizations.
  - between domains within one oil field
  - between domains within oil fields

- Different data formats
- Different tools
- Not willing to learn simple tools
- Need IT experts help for data communication

3D data visualization takes time.
- 3D data visualization is a iterative process.
- Can we provide an easier and useful means?
Example

- Geologist:
  I want to see the reservoir Reservoir_LH’s Oil Saturation.

- Geologist:
  In addition, I want to see the wells and their pipes in the reservoir.

- Decision-Maker (High-Level Manager):
  On top of this, I want to see the aggregated water injection rate for each injection location as a cylinder whose volume proportional to its rate.
Example

GoCAD Engineers

Geologists

High-Level Decision Maker

GoCAD Engineers
Example
Example

Show Visualization {

For Reservoir_LH with Geometry, show 3D Volume of Oil Saturation. Show Cube of Well. Show Line of Well Pipe. Show Cylinder of Water Injection Rate.

}
Objectives

- To provide a consistent and ease-to-use interface for inexperienced or occasional users.
- To deal with 3D volume and temporal data sets.
- To provide an Interactive and intuitive manipulation for 3D volume data access and visualization. (Selection/Narrow-down/Clipping/Aggregation/Classification)
Related Works

• **Previous Work: Grammar & User Interaction**
  - Introduced the Phrase-Driven Grammar System for Data Access.

• **Data Model: Map + Multidimensional Database**
  - Algebraic Formalism over Maps [Joao P. C. et al, 2000]

• **Formalism: Geo-Algebra + Data Presentation Algebra**
  - Map Dynamics [Masanao T., 1997]
  - Grammars of Graphics [Leland W., 2005]

• **3D Graphics: Scene Graph + Procedural Modeling**
  - Procedural Modeling of Building [Pascal M., 2006]
Phrase-Driven Grammar System

- A GUI, which facilitates data visualization while working as a middleware between data sources and visualization applications.

- English-Like Sentence using PDG

- Active Menu GUI from NLMenu [H.R. Tennant et al, 1983]

- Procedurality from TABLET [D. W. Stemple, 1978]

- User Interaction: Drag & Drop with Visual Guidance
  GUI: Active Menu, Grammar Editor, and Quick Info.
Data Model

- Reservoir
  - Section
    - Pattern
      - Well
        - Well Pipes
  - Rock Properties
    - Oil Production
    - Water Injection
  - Time
Architecture

Interaction

Processing

Data

3rd Party Application
GIS
Excel
Spotfire

ReMVR

GUI

Event Handler
Query Result
Data Converter

PDGS Engine

PDGS

GIS
XML
DB
...
Excel
Others
Graphical User Interface

- **Object Browser**: major stages (with order)
  - Object
  - Command
  - Operation
  - Operation Parameters
  - Simplified Modifier
  - Source

- **Sub-stages** (without order)
  - Modifier
  - Aggregator
  - Etc

- Eight menu items represent one unique stage.

- **Guide to its next stage**
  (Highlighting + Automatic Proceeding to the next stage)
Visual Guidance
Phrase-Driven Grammar (PDG)

- For selected **data objects**, show their data
- Data Phrase & Command Phrase
- Data Phrase: For selected objects
- Command Phrase: show their data

“**For a selected data set,** show 2D plot of time vs. price onto MS-Excel”
User Interaction

• 3D Volume Visualization
  
  #1
  For Lost Hills, show me **3D Volume** of Clay
  
  #2
  Show Visualization
  {
    For Lost Hills, show me **Cube** of Well ID.
    For Lost Hills, show me **Line** of Well Pipes.
  }
User Interaction

• 3D Bubble Map

#1
For Lost Hills, show me 3D Volume of Clay.
For Previous Result,
show me Bubble Map of Water Injection over 2 years.

#2
For Previous Result,
show me Bubble Map of Oil Production over 2 years.

#3
show Visualization
{
For Lost Hills, show me 3D Volume of Oil Saturation.
For Previous Result, show me Bubble Map of Oil Production.
For Previous Result, show me Cylinder of Water Injection.
}
Conclusion

• Phrase-Driven Grammar (PDG) and GUI form a new graphically guided English-like command system for 3D data visualization.

  • Visually guided, less ambiguous

  • Relatively expressive for complex queries compared to form-based graphical user interface approaches

  • More readable and understandable than formal languages

  • No Specific Training for usage/No Visualization tool training

• Future Works
  • Formalism
  • User Study
  • Extend to 3D volume manipulation & Reasoning
Questions.