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Abstract

A considerable interest has emerged in the development of virtual reality applications due to the acceptance of VRML 2.0 as the de facto standard for these applications over the Internet. In this study, we examine and discuss the application of virtual reality for abstract data applications. As a problem domain, we consider monitoring equity stock - a domain that is characterized by abstract data.

There are several reasons why this study is important. First, while virtual reality has been applied to domains that are easy to visualize or scientific visualization e.g., building layouts, part assemblies, human anatomy, etc. (Poston and Serra 1996, Byarri et al. 1996, Bryson 1996), little work has been done on applications that are abstract in nature. Stock monitoring is an abstract application wherein it is difficult to visualize various facets of a stock for the purpose of monitoring it. Many business applications share this similar level of abstraction. Thus, a research on this application will provide pointers to develop other virtual reality business applications.

Stock Monitoring VRML 2.0 World Application

The following is an implementation of VRML 2.0 for monitoring selected securities from two industries –"Airline" with 4 firms and "Semiconductors" with 6 firms. Each firm is represented as a visual stock-object, the object has several visual/audio attributes. Virtual reality stock-objects for each of the two industries are placed on separate locations in the world. The following are depicted in the world for each stock-object instance:

- Percent weekly gain. Depicted as a thin, fixed radius red cylinder with the base located on the 0 of the Y axis. The height provides a visual measure of the value of the gain. Positive gains appear on the positive Y axis. Negative gains (losses) appear on the negative Y axis.
- Percent intraday gain. Depicted as a variable radius cylinder with the base located on the 0 of the Y axis. The height provides a visual measure of the value of the gain.
- Percent invested in portfolio (only applicable to portfolios). Radius of cylinder provides visual measure.
- Intraday price volatility. Color of cylinder provides measure of volatility. Red is most volatile, blue is least volatile.
- Weekly abnormal trading volume. A blue square revolving around the -Y local axis of the stock-object. The faster the revolution, the larger is the weekly abnormal volume.
- Intraday abnormal trading volume. A red sphere revolving around the +Y local axis of the stock-object. The faster the revolution, the larger is the intraday abnormal volume.
- Last four trading ticks. An aluminum arrow-head depicts the fourth previous trading tick. Bronze arrow-heads depict the next three successive trading ticks. These arrow-heads are horizontal, upwards facing or downwards facing depending upon the price trend.
- Weekly high/low percent. A thin cone (spire) with the base on the 0 of the local Y axis extending either to the +Y or the -Y local axis. The height of the spire provides a visual measure of the percent. This extends to the positive Y (negative Y) local axis when the weekly percentage gain is positive (negative).

Additional support provided:

- Alarm. Alarm sounds when last three trading ticks are down
- Basic fundamentals. Touching the Intraday Gain Cylinder activates a billboard that shows the basic fundamentals: Price, Beta, EPS, P/E , Dividend Yield, and Dividend Amount

Decision Support for Trading

The VRML world provides two important benefits to dealers/investors:

- it facilitates in building a complex mental model of the interaction of various attributes e.g., intraday volume and intraday gain are not correlated when weekly high/low ratio is close to the weekly gain. This complex model can now be acquired because VRML provides a tightly integrated picture—much more integrated compared to other existing tools e.g., multiple screens/windows with 2D and non-interactive 3D charts. This results in three benefits. First, opportunities and threats can be identified in a timely manner -timing is critical to stock trading. Second, the complex mental models can be used to finetune the analytical models developed by the research department. Finally, this tool can be used to train dealers. Moreover, this visual representation scheme allows mental models to be formed without the need to query the database as in visual dynamic queries.

- it allows the dealer to monitor the selected stocks effectively. A sophisticated monitoring system mandates comparison of the stock performance with other stocks in the industry, and inter-industry stocks. VRML possesses two advantages over traditional tools. First, all the critical information in encoded in the stock-object. Second, other fully encoded stock-objects are visible either through 3D navigation or by placing the camera (viewpoint) at a suitable location in the world.

This url of the implementation was given to two domain experts for their critique. While, the experts agreed that virtual reality systems will possess the advantages as discussed above, the current implementation model falls short of their needs due to the inability of the current system to map the mental model with the abstract visual objects. In view of the discussions, further research needs to be conducted to determine the appropriate human-computer interface design as discussed next.

Research and Design Issues

Three research issued emerged after the implementation of the VRML system.

I) When is VRML beneficial compared to traditional means for monitoring applications? An important criterion for monitoring is the application data-richness (number of attributes/fields, average value, standard deviation, number of visual instances of each of these attributes. As an example, if the decision-maker requires the trend of a stock price over the past 365 days, a 2-D graph will probably be the most effective solution. However, if the decision-maker requires a plethora of data, then VRML may be an effective tool. Research done previously on data type tasks should be especially helpful in determining an appropriate application of VRML (Shneiderman, 1996).

II) What is a good design (shape, placement, motion, and activation rules) of a given VRML visual node in the world? Extensive research needs to be conducted in order to identify the best possible visual representation of nodes based on the data-type, and its data-richness (average value, standard deviation, number of visual instances in the world). The necessity of mapping the mental objects to visual objects imply that the VRML objects must be a representation of the reality, whether abstract or not. We propose a representation model based on a base object, where the base object is considered a good mapping to the mental object (Table 1). Low Value and High Value are the relative values of the abstract data type and are morphed based on the relative value. The differentiation object serves to differentiate base objects in an object-instance of the virtual world.

There are two disadvantages of morphing a base object directly. First, morphing a object may lead to object representations that are difficult to comprehend. Second, morphing of objects may fundamentally change the spatial relationship between the morphed object and other objects. As an example, while a low volatility may be represented by a coin toss (low risk) and a high volatility may be represented by a dice toss (more risk), the morphing of a coin into a dice

Table 1. Example of Visual Object Representation with Morphing

	Base Object	Low Value	High Value	Differentiation	
				Object	Visual Shape
Gain:	$	With Icicle	With Fire		
Daily				Watch	Circle
Monthly				Calendar	Rectangle
Volatility:	Heart	Low Beat	High Beat		
Monthly				Calendar	Rectangle
Yearly				Birthday Candle	Cylinder

will lead to instances that are neither dice nor coins and thus loose the meaning attached to the object. Thus, a good design would require that the visual object be represented as a base object, parts of which may be morphed. Three major differentiation schemes can be applied to a base object: a) base texture: an image of the differentiation object is applied as a texture to the base object, b) base object manipulation: the base and the differentiation objects are merged to form a new object where the merged object must be visually closer to the base object. Daily returns may be represented by "$" symbol with two hands (hours and minutes) of a watch inserted into the object, c) differentiation object insertion: an image of the differentiation object is applied as a texture to the differentiation shape. The virtual reality object design also requires that the differentiation object have a consistent representation e.g., daily should always be represented as a watch.

III) What is the optimal architecture of the VRML System? Should pre-processors be placed on the client? What should be the relative computational burden of pre-processors vs. the VRML world? What is the optimal manner to re-load the world on the client? Many of these issues have been addressed in the design of distributed Object-Oriented Databases.

References

Bayarri, S., Fernandez, M., Perez, M. (1996) "Virtual reality for Driving Simulation," *Communications of the ACM,* Vol. 39, No. 5, 72-76.

Bryson, S. (1996) "Virtual Reality in Scientific Visualization," *Communications of the ACM*, Vol. 39, No. 5, 62-71.

Poston., T., and Serra, L. (1996) "Dextrous Virtual Work," *Communications of the ACM,* Vol. 39, No. 5, 37-45.

Shneiderman, B. (1996) "The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations," *Proceedings of the 1996 IEEE Conference on Visual Languages* (Boulder, CO, Sept.3-6,1996) 336-343.

Song, D., and Norman, M.L. (1993) "Cosmic Explorer: A Vrtual Rality Evironment for Eploring Csmic Data," *Proceedings of the IEEE Symposium on Research Frontiers in Virtual Reality* (San Jose, Calif., Oct. 1993).