Interactive Simulator

Simulating the Birth to Death of a Star

By Group 4

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ABSTRACT
This document corresponds to the group report of the course "Principles of visualization (2I1711)". The aim was to develop an interactive visual presentation that portrays the life cycle of a particular star. The present paper can be considered as a theoretical analysis of the design decisions made during the make of the artifact called "The Sun Simulator".

Keywords
Interactivity, entity-relation based classification.

INTRODUCTION
Interactive simulation is a special kind of physical simulation which theoretically constructs and represents many natural systems. In our case study of simulating the birth to death of a star, we have chosen the SUN as our subject of focus. The prime reason for this is that SUN is one of the stars about which we have ample amount of information, statistics and hypothesis's. This wealth of information has allowed us to more accurately design the simulator that achieves its real visual occurrence.

Furthermore, the paper elaborates on one of the theoretical findings of [1]: entity-relationship based classification. Based on this elaboration the present design can be evaluated.

Since the visualization course book provides us with a wide variety of theories and practical know-how, we have decided to select one of the most important theoretical aspects of this book: the classification of data. In an attempt to classify the data, we have adopted the entity-relationship model that is described in ([1], pp.23-26). The importance of data classification in the area of visualization techniques is argued for below:

The goal of visualization is "to transform data into a perceptually efficient visual format" ([1], p.23). Unfortunately, classifying data is not as simple as it seems. Therefore, we cannot claim that our classification scheme is all-encompassing. Nevertheless, it is important to be aware of the exact types of data that are described. By explicitly identifying these types, the designer gets a clear overview of his problem situation and is forced to deliberately reflect upon his / her design decisions. Therefore in this paper we consecutively elaborate on the concepts of entities, relationships, attributes and operations.

The program is developed using Macromedia Flash v8 Professional Edition and most of the graphic editing done in Macromedia Fireworks v8. (See Appendix A for screen - shots)

DISCUSSION ON THE THEORITICAL PRESPECTIVE
Our design choices have been based on firm theoretical discussions which we have gathered during the study of this course. As mentioned earlier, we try to base the entity-relationship based classification scheme to argue for our design preferences. We characterize four types of elements that have been utilized. They are – entities, relationships, attributes and operations. Each of them has been described further below.

Entities
Entities can be considered generally as "objects of interest". To further clarify this to our creation Appendix A (Section B) provides a screenshot with the identified entities highlighted in frames. The following entities can be separated:

- Four Functional Buttons: Start, Pause, Info, Exit.
- One Functional Slider (Zoom function)
- One Timeline
- One Details Frame (set of data on the right, showing radius, age, temperature, etc.)
- One Header (right upper corner, including application name)
- One "Stage", including Sun-animation, static and dynamic details respectively in left and right lower corner of it.

Some entities listed above can be divided into sub entities (like Stage into Sun-animation, details, etc.). Oppositely, some entities can also be grouped into whole entities. For example, everything together can be named the entity "Star Simulator" in case the whole is considered an entity too or when performing an analysis that goes beyond or prototype (e.g. when implementing it in an existing website and analyzing this site). Anyway, the classification of Entities as used above will be used throughout the rest of this paper.

Relationships

According to our reading materials, we can understand that - “Relationships form the structures that relate entities. They can be structural and physical, as in defining the way a house is made of its many component parts, or they can be conceptual, as in defining the relationship between a store and its customers. Relationships can be causal, as when one event causes another, and they can be purely temporal, defining an interval between two events.” ([1], pp.23-24).

Structural

Our Sun Simulator consists of a number of graphics and GUI elements. Some of these are predefined Flash GUI components, like the slider and buttons. The reasons for choosing the predefined components is that they have a proper “look and feel”, users are familiar with them and they are relatively easy to implement.

Physical

Since our prototype is not physically embodied, there are no physical relationships.

Conceptual

A conceptual relationship between the Sun Simulator and its users can be identified. More precisely, there is a relationship between the user and the interface (display / interactive controls) of our prototype. The user manipulates (the interactive controls of) our prototype and the system provides feedback by means of the changes in the display. Next to that,even though not very relevant in our simulation, there is a conceptual relationship between the sun and the other surrounding stars, e.g. gravitational processes.

Causal

Relationship between Slider and Stage: When a user drags the Slider along its horizontal axis, changes on the stage occur (size of sun animation and zoom factor in lower right corner).

Relationship between on the one hand the Start and Pause Button and on the other hand the Stage, Details Frame and Timeline. When the Start Button is pressed, the animated lifecycle simulation is started (or resumed).

Relationship between the Info Button and the Animation: When the animation is in phase X (indicated by Stage Name, as part of the Details Frame entity), pressing the Info Button provides the user with extra information about that phase X (displayed in a new browser window).

Relationship between the whole application and the Exit Button: when the Exit Button is pressed, the application (our Sun Simulator) is terminated..

Temporal

The Start and Pause Button control the progression of the the Sun animation. Regarding the (temporal) order: first the Start Button needs to be pressed to get the animation started. When the user wants to pause it, the Pause button needs to be pressed. Resuming the animation can be done by pressing the Start button again.

Attributes

Both entities and relationships can have attributes, or properties.

Attribute quality

The visualization techniques that we have applied in our prototype can be described by the quality of the attributes that they convey. In relation to this, [1] identifies 3 main data classes, described in the following 3 sub-sections:

Category data

This category encompasses nominal data, used to distinguish between several objects or groups of objects. In our prototype, this is done by for example by using color and labels to distinguish between the several button functions.

Integer data

Zoom factor (in right lower corner of the Stage) and some of the information in the Details Frame (e.g. Star Age) is displayed as integer data. In these cases we preferred integer data over real-number (floating point values) since:

- Extreme (floating point) accuracy is not required
- Continuously updated floating point values may give the user the sense of a high interactive and accurate system, but can also be considered as too distracting.

Real-number data

It is rather impossible to simulate the life cycle of the sun using precise numbers. We do not exactly know how much time it will take for the sun e.g. to explode, so using precise real-number data would be rather misleading. However, we did make the timeline and the size of the sun animation look analog. This was done to give the user a sense of continuity. Even though we agree that the values are a rather inaccurate reflection of the facts (e.g. the process concerning the changes in size of the sun may not be linearly with the time, as displayed in certain phases), this is not our aim. Apart from being impossible, providing the user with the exact data would be useless. We'd rather want to give the user an overall sense of the dynamics.

Attribute dimensions

One-, two- and three-dimensional attributes are respectively called *scalar, vector and tensor.*

Examples of scalar attributes are the information in the Details frame (age, temperature, radius, etc.) and Timeline. The only vector attribute that we identified is the zoom factor in the right lower corner of the Stage. In case this zoom factor is adjusted through the Slider, the size of the displayed sun animation is increased in both X- and Y-direction (rather than being stretched in one direction only). The gravitational field of the sun can be considered a tensor and is relevant regarding its life cycle. Nevertheless, it is not explicitly used in our Sun Simulator. The shape of the sun is another 3-D attribute. Even though it is modeled using a 2-D tool (Flash), by means of illumination “tricks” it looks as if it were a 3-D object.

Operations

By dragging the Slider along its horizontal axis, the zoom factor is changed accordingly. When dragging the Slider X pixels to the left or right of its initial position, the animation size is respectively decreased or increased to Y percent. The value of Y lies between 50% (Slider completely to the left) and 150% (Slider completely to the right).

The star temperature and other details (radius, etc.) are changed based on the timeline and estimated events to happen; this is not just linearly but depends per phase.

CONCLUSION

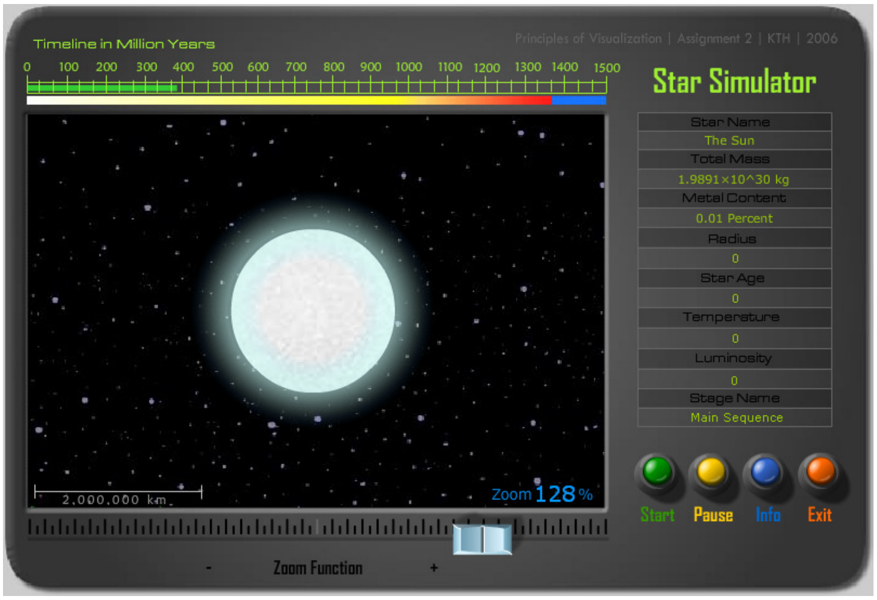
This paper has reviewed the development process of the SUN Simulator in details and the theoretical viewpoints behind each design choice. The SUN simulator can be readily perceived as a furnished product that completes the requirement of this course.

REFERENCES

1. Ware, C. *Information Visualization, Perception for Design, 2nd edition.* Morgan Kaufman, San Francisco, CA, 2004

Appendix A

SECTION A: Screenshot of our prototype



SECTION B: Entities identified.