Digital Astronomy in Education

S. Boutiche
Bechar University/Physics Dept., Bechar, Algeria

***Abstract*— What causes seasons? Why day and night durations are so different with seasons? Why the position of the full moon seems directed to the south in summer while it seems directed to the north in winter?**

It is the purpose of this computer simulation to provide an interactive application, programmed in Java language to explore the issues related to the above questions.

***Index Terms*— Computer animation, Java 3D, graphic representation, cognition digital astronomy, Java 3D**

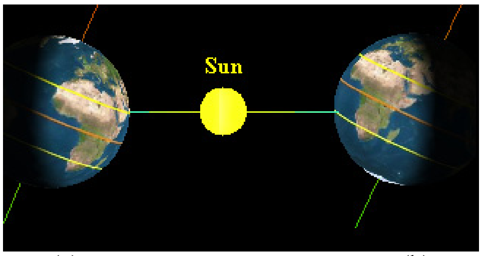
I. INTRODUCTION

Astronomical phenomenons involve often complex concepts and their explanation requires always the development of several levels of representation. It would be indeed difficult to explain for example, the concept of the austral seasons, in absence of representations as shown in Figure 1. Without graphical representations, our understanding would be imperfect since the volume of information provided by the unique textual or verbal explanation is certainly insufficient for us, to construct a perceptive process with which we understand why winter in the northern hemisphere, coincides with summer in the southern hemisphere?

I have explained previously [1] that the graphic representation is a wonderful tool of cognition since it helps to convert data into information. I have also asserted that the carried volume of information is much more important when the graphic representation is animated than when it is not. To support this assertion, I have suggested that any animation may be considered in fact as a superposition of several graphical scenes involving naturally a higher volume of information.

With such cognitive arguments, we understand better why it is necessary to develop exploratory tools to bridge the hiatus that may exist between any subject and its understanding.

In this context, I present an interactive application, in which the motion of the moon is analyzed with respect to the earth position. In astronomy, such tools are welcome since they help for the construction of the understanding process.



(a) (b)

Figure 1. Austral seasons. (a) Summer [winter] in northern [southern] hemisphere. (b) Summer [winter] in southern [northern] hemisphere

II. VISUAL ANALYSIS OF THE MOON PATH AROUND EARTH

I have also discussed [2] in a previous communication what the physical causes of seasons are. To do this, I have developed an interactive application (see Figure 1) written in Java that uses the 3D API of this technology. The results were satisfactory, since it was possible to reproduce the exact motion of earth around the sun. It was also possible to observe in real time some natural phenomenon such as why the day duration is very short in winter, in the Scandinavian countries for example. With the help of our Java animation, we have visually linked and explained this phenomenon to the total North Pole enlightenment.

In the same context we investigate now summarily, with a new Java material, the moon path around earth to explain some aspects of motion that may appear somewhat antagonistic.

A. *Is the moon rise from East or from West?*

The view of the earth-moon system from space reveals that the rotation sense of the moon around earth is counter clock-wise if the observation is made from the North Pole. It is then legitimate to expect the rise of the moon from west. But in reality such a rise occurs as we know from east. So, what goes wrong in our perception?

The rotation velocity of earth (one turn per day) is higher then the one of the moon (one turn per month). So, the relative motion of earth with respect to the moon position gives the illusion of the moon rise from East.

B. *Presentation of the Java 3D solution*

To analyze such relative motions, the visual solution may be very useful, particularly if offers some interactive functionalities. The Java simulation that I present here is also written in Java programming and uses equally its 3D API. This type of programming can be used to represent animated 3D objects, and is characterized by high graphical and interactive outputs. When our application is running, it can be started by clicking the "Start Motion" button. This brings the user to the vicinity of the Earth-Moon system. In order to obtain, an optimal level of perception, I have suggested a highly interactive interface (Figure 2) with very simple functionalities since it is possible to show or hide any parameter such as planes, paths, earth, sun, etc.

The screen of visualization is conceived to utilize many different views since the user can drag the universe with mouse. In such a way (see Figure 3) the projection of 3D light can be easily observed. I have added other geometrical objects such as the motion planes of earth and moon (Figure 4). With these objects, the motion is best analyzed since it is best tracked and marked

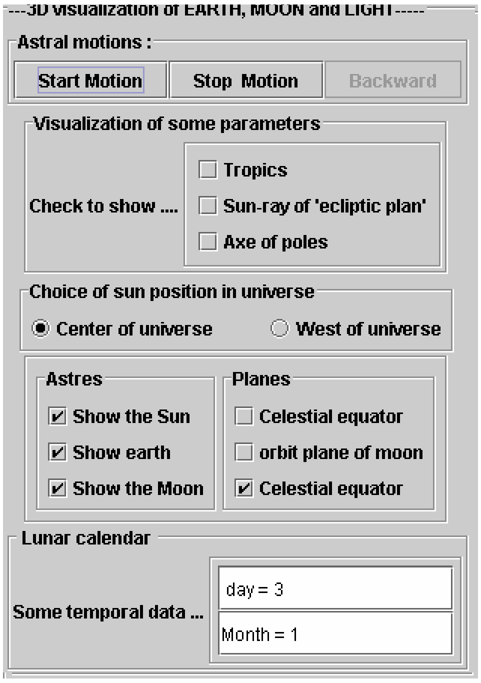


Figure 4. The simulation command panel

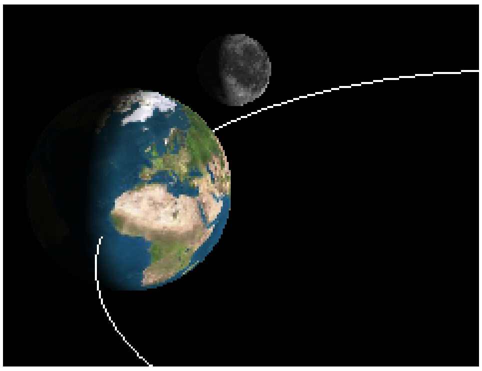


Figure 3. Earth, moon and 3D light

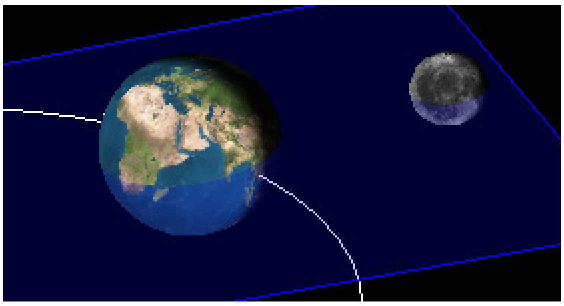


Figure 5. Offered possibilities by Java: Visualization of the moon orbit plan in 3D

III. THE JAVA SOLUTION IN EDUCATION

To teach concepts of astronomy in classroom, the traditional education makes use of classic and ordinary tools of didactics, such as representations (Movies, Books, Images, etc.) where the studied concept is explained with the help of a text. If additional material means are available, the teaching quality would be higher since the studied concept can be simulated and can be in consequence best described and best understood. However, such a material is in general very onerous and might be inaccessible, if the allocated budget to education is not comfortable. In such a situation, Java may be an optimal solution since it can give a high pedagogical output with reduced costs.

IV. CONCLUSION

The purpose of this interactive application is to show that object oriented programming (oop) is useful for the construction of the understanding process. If the oop is Java, then our application can be embedded in a web page and can be accessed via the Internet, from anywhere by everyone, at any time.

ACKNOWLEDGMENT

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AUTHORS

S. Boutiche is with the Dept. of physics at Bechar University, 08000 Bechar Algeria. (e-mail: vizuallearning@hotmail.com).

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