professionals. In integrated classes combined both methods and educational means traditional and classical education and new educational and information and communication technology. Review the role and place of students and teachers in the system of modern education. Optimized technologies and techniques and the efficient functioning of the joint interaction of students and teachers based on their cooperation. The efficiency of the use of integrated studies that combine the disciplines of basic, professional and practical blindings as a means of forming a high level of professional competence of students.

Keywords: *integration, integrated employment, professional competence, education, science, change, innovation, cooperation model, mathematics, design.*

УДК 373.6:52]:004

Hristova R. P.

AN EXAMPLE OF USING COMPUTER ANIMATION IN ASTRONOMY LESSONS (IN SECONDARY SCHOOL)[1]

The article refers to the lesson Illustration tools. It is definitely the place of Computer Animation in the Astronomy lesson. An example is an interactive three-dimensional model of the solar system created with the tools of the the event-driven programming. The model allows interactive observation the movement of a separate planet according to the Sun and a change of observer's point of view. It is possible to visualize the simultaneous movement of some or all planets and also to demonstrate the sunlight reflection of the planets and their satellites. The model can be used in studying the solar system in secondary schools.

Keywords: *Lesson Illustration Tools, Computer Animation, 3D interactive model, Solar System, Event-driven programming,*

Introduction. The contemporary children grow and study in a saturated audio-visual environment. To keep the attention of today's digital generation students, narrative and displaying images is not enough. One approach is to use the modern information and communication technologies (ICT) to create and display more attractive visual materials. Other approaches that are gaining popularity in Europe are based on a revived constructivist approach such as Problem-Based Learning (PBL) [7], Inquiry Based Science Teaching (IBST) [8], Inquiry-Based Learning (IBL) [9] and others. Most trends in science education are interrelated, overlapping to some extent and complementary each other.

The illustration is one of the most important principles of didactics. It requires that it be trained on the basis of perception of the objects and phenomen a studied or their visual correspondence. One of the significant advantages of digital learning tools is to increase the visibility of the learning process using a variety of methods and solutions. Visual means for training or illustrative material are drawings, diagrams, photographs and other graphic images. But only the familiarity with the appearance of the objects studied does not reveal their essence. Knowledge is best absorbed if objects and processes in development are displayed in relation to other objects and processes, ie. Using visual means with dynamics included [1]. Such are educational films and multimedia presentations.

An especially attractive way of dynamic illustration is animation – this is a computer program implementation of the movement effect of the illustrated object. Animations are used primarily to

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illustrate the dynamics of processes. They show transitions of a chronological and logical nature and helping to reveal causal links [1].

The Computer animation has practically unlimited possibilities for imitation of situations and demonstration of object movement.For this, it is particularly useful in illustrating processes and phenomena that can not be directly observed, for example due to their duration in the time, the size of the objects or other reasons. Such are the processes and phenomena in the Astronomy.

Chapter. The tools, that areused to create the model

This article describes an interactive three-dimensional (3D) model of the Solar system. For this purpose we use the capabilities of the graphic libraries OpenGL (Open Graphics Library) [10], GLUT (Open GLUtility Toolkit) [14]and GLU (OpenGL Utility Library) [15], the C++ language and the event-driven programming approach [3].

Two concepts are important for organizing interactive graphics:

- the graphical window in which the graph is displayed,
- the mechanism by which information coming from outside, called a message / event, is processed by the program.

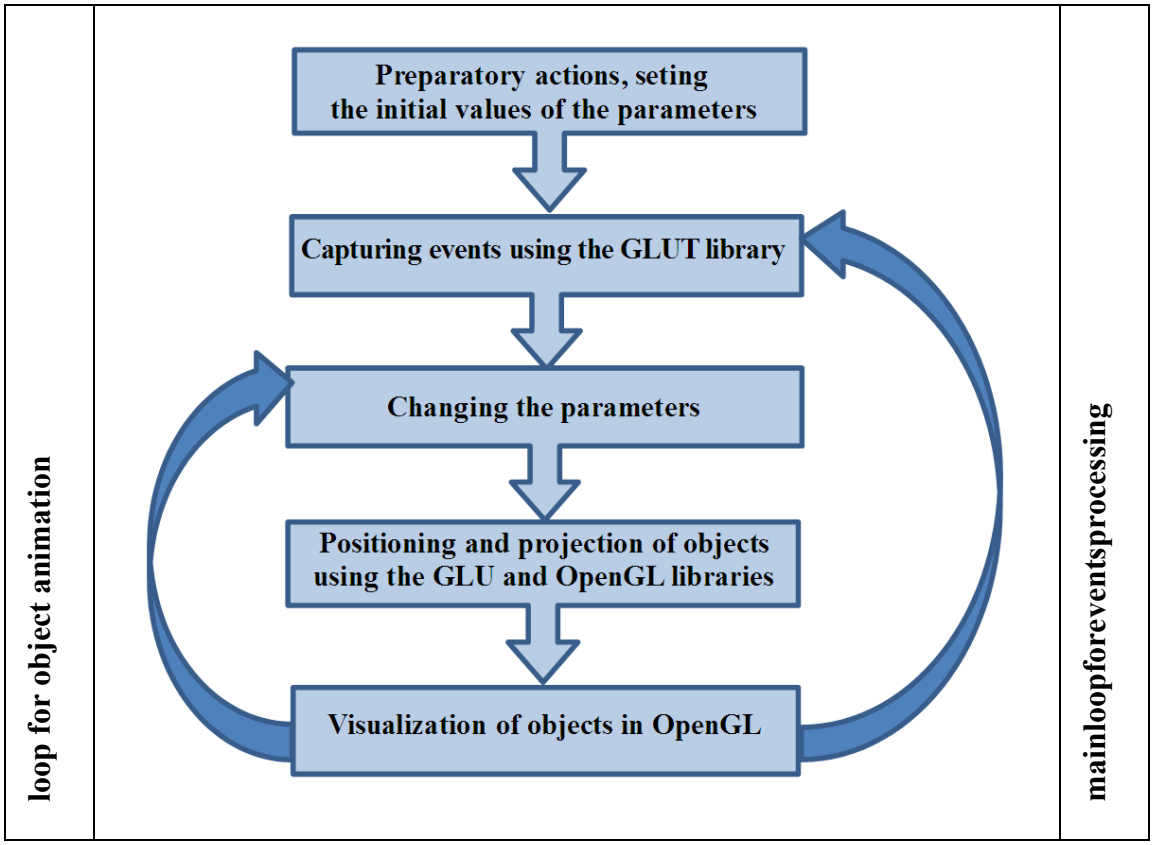

Fig. 1. General scheme of theprogram

The GLUT library creates the graphical window and organizes the main program cycle through which the messages are intercepted. Messages are external events (keystrokes or mouse clicks, mouse movements, etc.) that cause different actions of the program in the graphical window. The visualization of the objects in the graphical window is done with the tools of the OpenGL and GLU libraries.

The diagram (Fig. 1) gives a generalized algorithm of action of the program that implements the animated 3D model of the Solar System. At the start, the only object that is visible and moving is the Sun. By pressing a suitable key (triggering an event), the movement of the planet or group of planets, along with their / their satellites, is visualized. Changing the observation point is also seen

as a keystroke event.

Chapter Description of the Model

The model is heliocentric and includes the Sun, the planets of the Solar System, some of the planets' satellites (those that can be seen with a small telescope from Earth), and the asteroid belt between Mars and Jupiter [2].

When creating the model, the real relationship between the size of the planets and their satellites (except the Sun for obvious reasons) is retained. The orbit size of the planets is respected [4, 5, 6]. All elements of the system are moving in their orbits, taking into account the direction of motion of the planet and the ratio between the periods of planetary rotation around the sun.

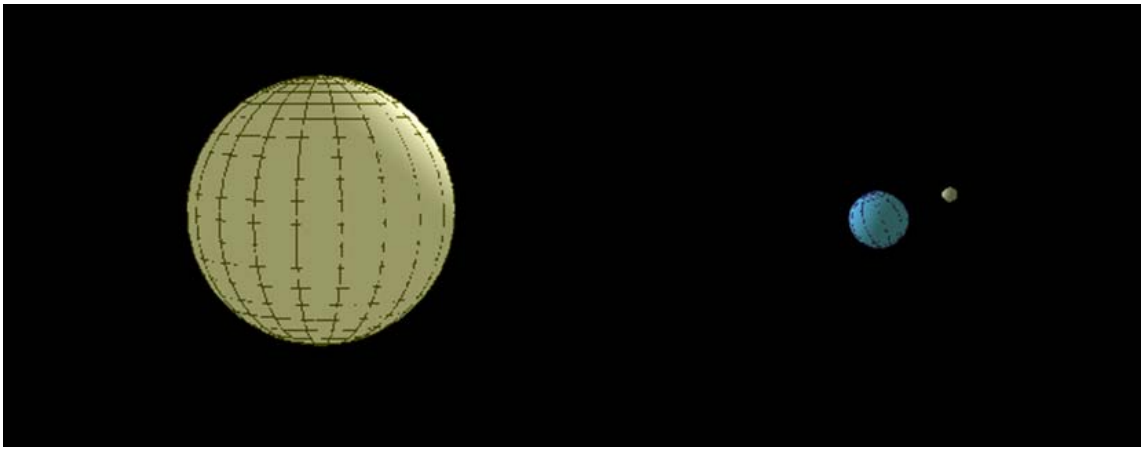

Fig. 2. The Sun, the Earth and the Moon

For each planetary systema real inclination of the axis of the planet and orbits of the visible satellites is shown. The movement of the planet around it saxis and the speed of movement of the satellites in their orbits are synced with the other planetary system speeds. It is possible to accelerate ordelay the movement of the whole solar system.

The model all owsus to observe:

- the movement of a separate planet according to the Sun (see Fig. 2);
- the simultaneous movement of the planet and its satellites to the Sun;
- the simultaneous movement of several random chosen planets and their satellites (see Fig. 3);
- the simultaneous movement of Terrestrial planet/innerplanets;
- the simultaneous movement of all planets.

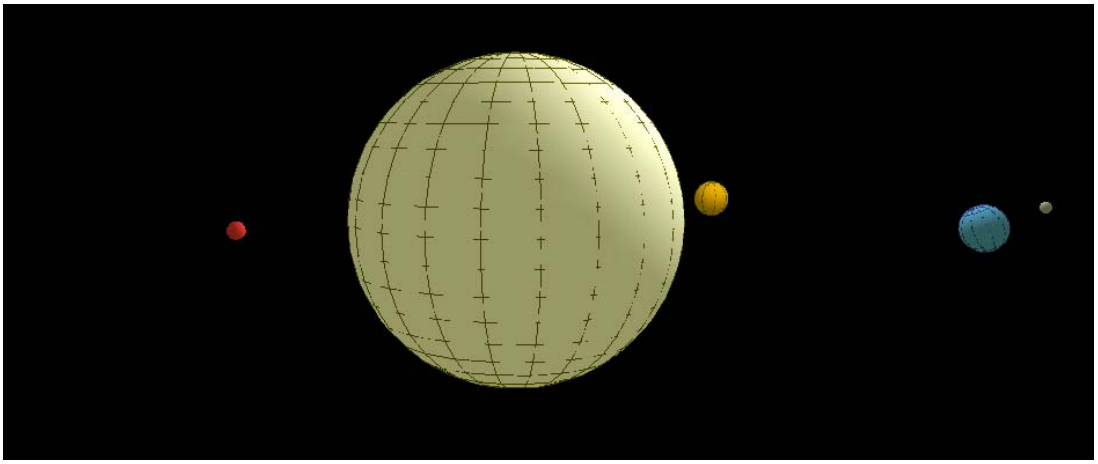

Fig. 3. Mercury, Venus, Earth and Moon

The program allows the viewer to change the point of monitoring by approaching and receding from the center of the solar system or moving it (see Fig. 3, Fig. 4, Fig. 5).

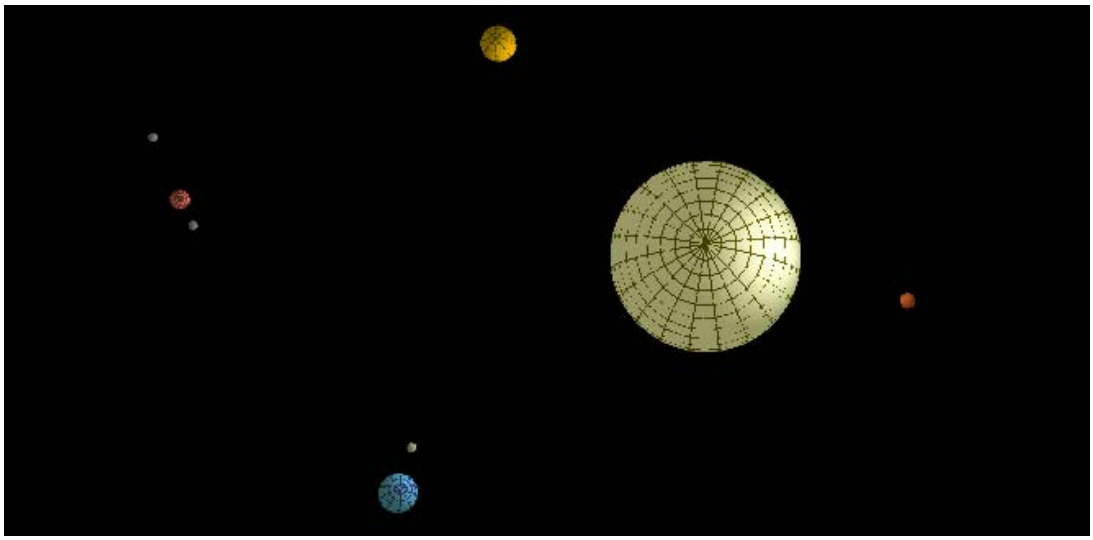

Fig. 4. Terrestrial planet, another point of observation

Additional possibility is the demonstration of sunlight reflection from the planets and their satellites [3].

Conclusion

The program can be used instudying the Solar System in the subjects classes of "Physics and Astronomy" [12] and "Man and Nature" [13], in extracurricular forms of education, as well as inpreparation for the National Astronomy Olympiad [11] to illustrate:

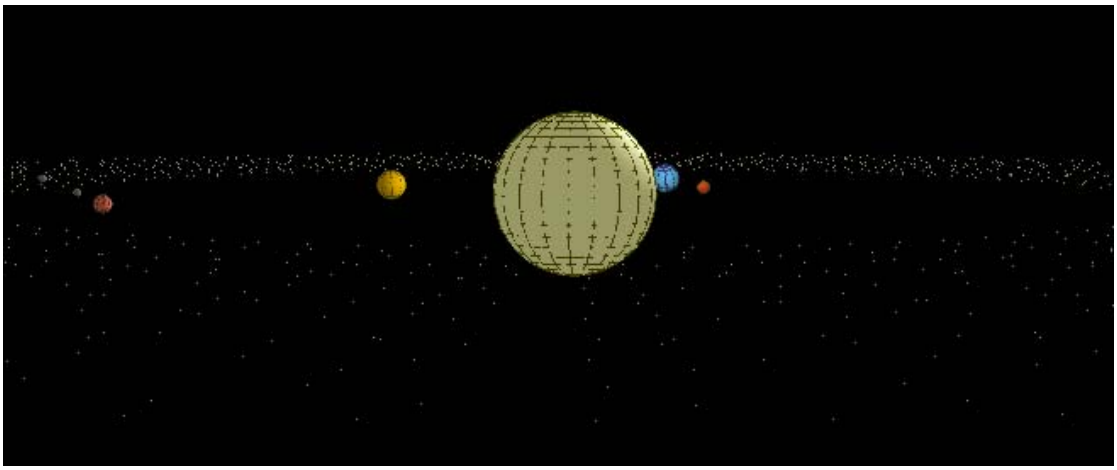

Fig. 5. Terrestrial planet and asteroid belt

- The movement of the planets in the Solar system.
- The movement of each planet and its satellites in relation to the Sun.
- The size and location of each planet according to the other.
- The location of the asteroid belt.
- The type and movement of the ring of Saturn.

The advantage of the application is that the programis compact, unpretentious in terms of computer resources and has no specific hard ware requirements, does not install and does not require constant Internet access.

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Христова Р. П. Приклад використання комп'ютерної анімації на уроках астрономії (в середній школі).

У статті розглядаються засоби для візуалізації навчального матеріалу. Визначено місце комп'ютерної анімації на уроках астрономії. "Профіль" є прикладом інтерактивної тривимірної моделі Сонячної системи, створеної за допомогою подієвого програмування. Модель дозволяє в інтерактивному режимі спостерігати рух окремої планети навколо Сонця і змінювати перспективу спостерігача. Можна відтворити одночасний рух окремих або всіх планет, а також продемонструвати відображення сонячного світла від планет і їх супутників. Модель може бути використана при вивченні Сонячної системи в середніх школах.

Ключові слова: *засобів, що ілюструють уроки, комп'ютерної анімації, тривимірна інтерактивна модель, Сонячна система, керованої подіями програмування.*

Христова Р. П. Пример использования компьютерной анимации на уроках астрономии (в средней школе).

В статье рассматриваются средства для визуализации учебного материала. Определенно место компьютерной анимации на уроках Астрономии. "Профиль" является примером интерактивной трехмерной модели Солнечной системы, созданной с помощью событийного программирования. Модель позволяет в интерактивном режиме наблюдать движение отдельной планеты около Солнца и изменять перспективу наблюдателя. Можно воспроизвести одновременное движение отдельных или всех планет, а также продемонстрировать отражение солнечного света от планет и их спутников. Модель может быть использована при изучении Солнечной системы в средних школах.

Ключевые слова: *средств, иллюстрирующих уроки, компьютерной анимации, трехмерная интерактивная модель, Солнечная система, управляемой событиями программирования.*