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RZECZYWISTOŚĆ ROZSZERZONA W NAUCZANIU ASTRONOMII

Streszczenie: Rozważane są nowoczesne narzędzia programowe wykorzystujące elementy rozszerzonej i wirtualnej rzeczywistości, możliwości wykorzystania zasobów internetowych, takich jak darmowe teleskopy z możliwością zdalnego sterowania, a także bazy danych obrazów kosmicznych do nauczania astronomii. Wykazano, że nowoczesne narzędzia multimedialne mogą znacząco poprawić jakość percepcji wzrokowej i pogłębić przyswajanie wiedzy z zakresu astronomii i kosmologii.

Słowa kluczowe: Edukacja astronomiczna, multimedia, rzeczywistość rozszerzona, rzeczywistość wirtualna

AUGMENTED REALITY IN ASTRONOMY LEARNING

Summary: Modern software using elements of augmented and virtual reality, possibilities of using Internet resources, such as free telescopes with remote control, as well as databases of space images for astronomy teaching are considered. It is shown that modern multimedia tools can significantly improve the quality of visual perception and deeper learning of astronomy and cosmology knowledge.

Keywords: Astronomy teaching, multimedia tools, augmented reality, virtual reality

1. Introduction

With the development of technological progress, there are more and more new opportunities to present educational material in a more visual and interesting way. In ancient times, teachers used to draw in the sand or on stones for their students. With the appearance of papyrus, parchment, and later paper, as well as different

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methods of drawing images on them (paint, ink, and then typographic methods), visual illustration became more and more perfect, complex, and colorful. However, this was all the era of static pictures, when any movement or change could be demonstrated either in several phases, or the student had to be imaginative and the described phenomena had to be visualized mentally. Of course, this also had a certain pedagogical value, as it developed children's imagination. But there was also a specific uncertainty caused by the different levels of development of pupils' thinking abilities. One child's imagination is stronger, another's is weaker, and there are children who cannot imagine not only changing pictures but even static images. The advent of cinematography in the last century provided a new tool for creating dynamic learning content, but the creative process was very labor-intensive. It was necessary either to find the described phenomenon in nature and shoot it on the film or to draw it in the form of animation on paper and then transfer it to the film. With the advent of computer technology, the creation of dynamic learning content has undergone a real revolution. Modern computer means, both hardware and software have removed all restrictions from the creative process, and only the imagination of a person (teacher, editor, etc.) stands in the way of limitless opportunities to visualize the phenomena of nature or certain patterns that we want to present in a more understandable form to their students. Different implementations of artificial intelligence can now be used to create dynamic content, so it is only necessary to describe the desired video or animation. Especially important are the described opportunities in the field of astronomy, because although mankind has learned a lot about the laws of the cosmos, many of them are not available for direct observation, and can only be simulated (especially the cosmological development of the universe, the behavior of black holes, etc.). It is true that in terms of visualization, astronomy is one of the most striking and impressive areas of modern physics. Millions of photographs of distant planets, moons, galaxies, or nebulae, taken both with the most powerful space and ground-based telescopes and with automated spacecraft (such as Pioneer 1 and 2, New Horizon, Mars Observer, etc.) give us a pretty accurate picture of what is happening on distant planets, in our solar system, galaxy, and the universe. And although night hikes with children to observe the sky with a telescope or the naked eye cannot be replaced by anything, modern means greatly facilitate the study of astronomy. The fact is that the general illumination of the night sky, especially in large cities, bad weather, cloudiness, etc. does not allow for conducting observations at any time, especially synchronously with the curriculum. And here modern multimedia is ideal for replacing direct observations. Let's consider some software and hardware tools that significantly simplify and facilitate the process of teaching astronomy.

2. Using NASA photo databases

No matter how well-equipped an astronomy laboratory in an educational institution is, it can never compare to the capabilities of modern telescopes with a diameter of 4x8.2 m (Atacama Very Large Telescope) installed on Earth, let alone the James Webb Space Telescope 6.5 m or the Hubble Space Telescope 2.5 m. However, teachers and students alike have a great opportunity to utilize the huge database of space photos taken by these instruments. Just go to *science.nasa.gov/mission/hubble*, *webbtelescope.org/*, or *esawebb.org/*. Those who are interested in astronomy can spend hours here, and teachers can always find the necessary photos for the next lesson in the highest quality. For a more interactive search, you can use one of the free programs from NASA available at https://www.nasa.gov/apps/, including programs for learning about the solar system, the universe, the space station, or Shuttle missions. For students, it would be fun to take a photo as an astronaut against the backdrop of one of the space objects using the NASA Selfies program.

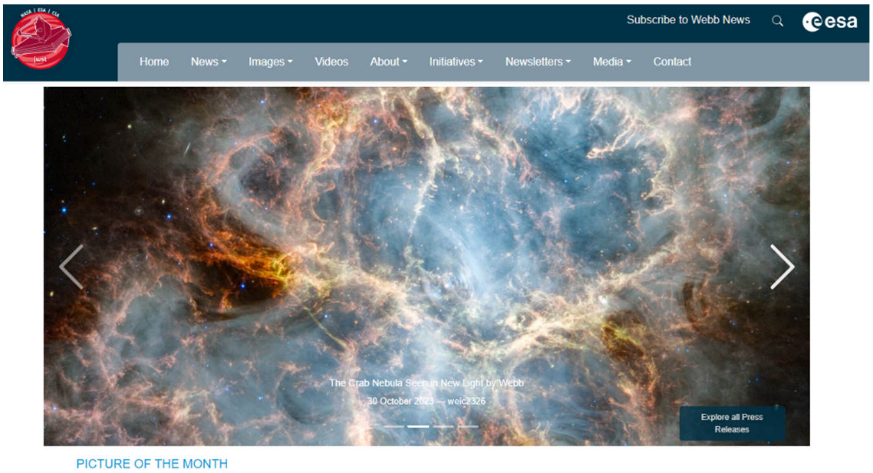

Figure 1. Photo from https://esawebb.org/

3. Automated telescopes with remote control

Modern electronics make it possible to create automated telescopes with remote control. They are equipped with a GPS positioning system, which greatly simplifies setup. Once the telescope is set up in an open area, it automatically determines its location (latitude and longitude), and the system synchronizes the exact time using GPS as well. A motorized control system automatically points the telescope to the desired object in the sky. Many of them are equipped with high-resolution cameras, the image from which is also transmitted remotely via Wi-Fi or local network. A program installed on a tablet or phone (such as SkySafari 7) contains the coordinates of 100 million stars, 3 million galaxies up to 18th magnitude, and 750,000 solar system objects. One of them is the MEADE LX 90 ACF, with GPS, WI-FI, and remote control.

However, not all educational institutions have the opportunity to purchase and place such telescopes, especially since, as mentioned earlier, not all cities have the possibility of night observations. Therefore, when teaching astronomy, it is possible to use free Internet telescopes with remote control, for example, *www.telescope.org/*, *www.virtualtelescope.eu/*, or *telescope.live/home*. It is also possible to connect to virtual telescopes, e.g., *worldwidetelescope.org/webclient/*.

Figure 2. Telescope with remote control/

4. Augmented reality programs for astronomy

Most cell phones are equipped with GPS receivers, high-resolution cameras, and position sensors. And if you consider the latest models of phones in the upper price segment, one of their distinctive features is night photography (including of astronomical objects) and the ability to zoom in (ZOOM). This means that when using suitable augmented reality programs, when pointing them at the night sky, they can determine their coordinates and pointing direction, get the exact time from the operator's network, and based on this identify space objects that fall within the camera's field of view. This real image can be overlaid with information about visible objects (planets, stars), a drawing of visible constellations, and a pointer to the estimated location of the desired object (this is augmented reality when virtual, auxiliary objects are superimposed on the "live" picture) [1]. All these functions greatly simplify the study of elements of the night sky and can be successfully used in the study of astronomy [2,3].

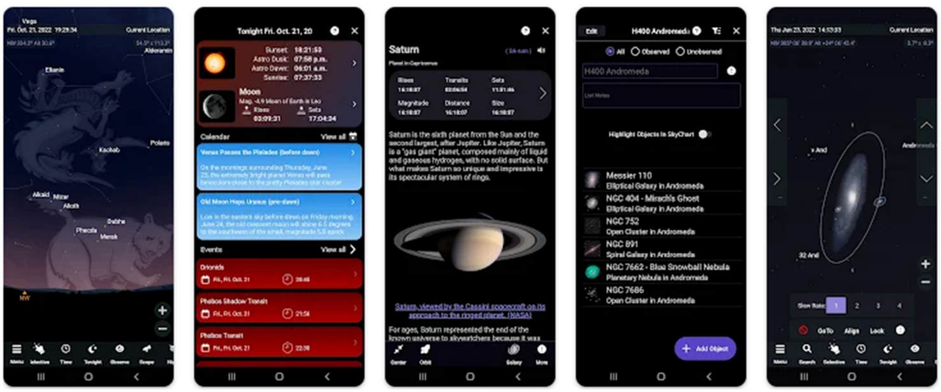

Figure 3. Best astronomy program SkySafari 7 Pro with augmented reality support

As mentioned earlier, the best program for tablet or cell phone is rightly considered to be SkySafari 7 Pro (Fig. 3).

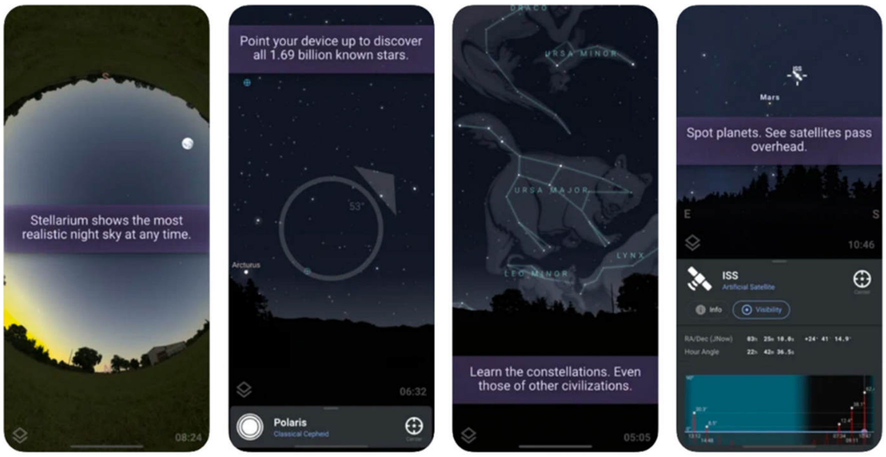

Figure 4. Very realistic application Stellarium Mobile Plus with augmented reality support.

Very realistic application is Stellarium Mobile Plus, which contains an extremely complete map based on the Gaia DR2 database, including more than 1.69 billion stars and all known planets and comets from a catalogue of more than 2 million nebulae and galaxies. The app uses your smartphone's GPS to display a real-time map of the stars above you. The app can also be linked to your telescope via Bluetooth or WiFi, making it a great observing assistant. The software also offers fantastic high-resolution photos of the moon, nebulae, and galaxies that you can zoom in on. An interesting feature of this app is the ability to move through time. This means that you can fast-forward time to see what will be seen later at night or select a specific date to view.

Figure 5. NASA Spacecraft AR software.

There are many augmented reality programs of this kind [4,5,6], and by using special mobile phone holders that are attached to students' heads, many of them allow 3D visualization of space objects in virtual reality mode, with the ability to track head movement, which adds to the feeling of real presence.

For those who like to actively explore the history of learning about our solar system, the free software from NASA Spacecraft AR will be of interest. This stunning educational app uses augmented reality to bring spaceship explorers from across the solar system to wherever you are. It allows you to view interactive 3D models right in front of you, scaled to tabletop size or natural proportions. Especially interesting is the application of AR programs for young children [7].

5. Conclusions

As we have shown, modern possibilities of remote observation of space objects through telescopes, access to inexhaustible photo resources of space missions and observations, as well as the use of programs with elements of augmented reality [8] make the study of astronomy a very exciting activity, which in turn increases the interest of students to learn the laws of development of our universe and improves the quality of memorized information. Our young people are used to audiovisual presentation of the studied material, which can be very successfully used in the study of astronomy.

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