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The Development of a VR Teaching Aid for Use by Middle School Students Studying the Diurnal Motion of Stars

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Abstract.

Utilizing the VR functionality of a tablet, which today is becoming an increasingly prevalent device in learning environments as part of the broader trend towards incorporating Information and Communication Technology, we developed a teaching aid that would help middle school students learn about the diurnal motion of stars. The concept of a celestial sphere is used in textbooks as a method for teaching diurnal motion. Taking this concept, we developed VR software which would allow the user to switch between perspectives from inside and outside of the sphere.

1. Introduction

The utilization of Information and Communication Technology (ICT) has quickly begun to spread within the sphere of education [1]. In Japan, the Government is aiming for the availability of one tablet per student for all compulsory education units by the year 2020. One method of tablet utilization in education is through Virtual Reality (VR), which uses a tablet's gyro sensor. The use of VR in education is not restricted to science classes. It is also used increasingly for subjects in the humanities [2]. A characteristic of VR used in education is the ability to explore a virtual 3D space.

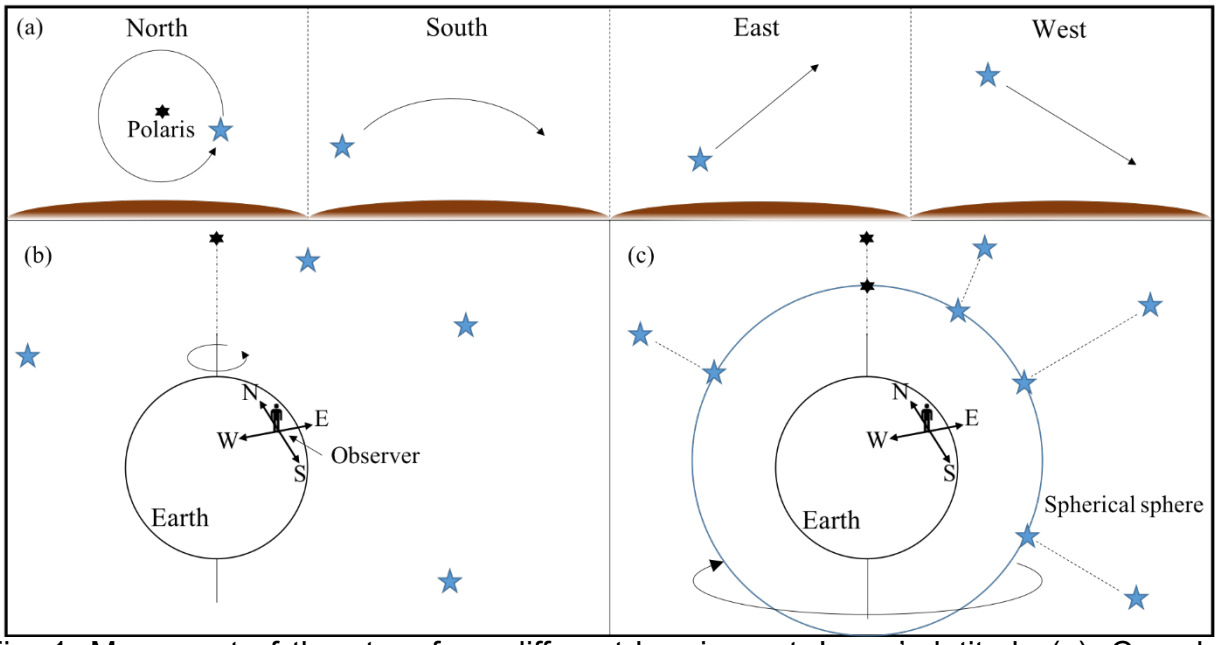

Fig. 1. Movement of the stars from different bearings at Japan's latitude (a). Complex thinking of the diurnal motion (b). Simple thinking of the diurnal motion using a celestial sphere (c)

This makes it extremely valuable for studying celestial bodies and other such distant phenomena that cannot be changed in terms of the scale of space or time, making experimentation and observation difficult [3].

The appearance of the diurnal motion of the stars varies depending on one's observational latitude and observational bearing on Earth. In Japan, third-year middle school students study the diurnal motion of the stars. However, as indicated in Fig. 1(a), the principle goal for students is to understand the movement of the stars from different bearings at Japan's latitude. Complex thinking is required in order to understand how the autorotation of the Earth changes the appearance of diurnal motion. This is because, as shown in Fig. 1(b), it is necessary to consider how, from the perspective of an observer who is standing on a rotating planet, stars that appear still are actually moving. In order to simplify this complex thinking for the purpose of teaching the principles of diurnal rotation to middle school students, we have utilized the concept of the celestial sphere [4]. As shown in Fig. 1(c), a celestial sphere is a globe that concentrically covers the earth that has the stars attached to it. By using a celestial sphere, the viewpoint of the observer, which is always rotating as a result of the rotation of the globe, can be kept still. Furthermore, as the movement of the stars represents at the same time the rotation of the Earth's surface in the opposite direction, the observation of the phenomenon is simplified.

Many VR teaching aids have been created for the purpose of studying celestial objects [5]. However, there are not many that utilize the celestial sphere concept found in textbooks. This is why in this research we developed a VR teaching aid for use by third-year middle school students: to help them learn about the diurnal motion of the stars by way of the concept of the celestial sphere.

2. Teaching aid development

For this teaching aid, we used the Android OS-equipped NEXUS7 (2013), made by ASUS, which comes with an internal gyro sensor. The software was developed in Unity. Below is an overview of the developed teaching aid.

When the student holds the tablet and moves themselves in a rotation, that rotation is picked up by the gyro sensor, and the observational perspective used within the software is also rotated to match the student's body movement (Fig. 2(a)). Using a check box, the student can switch between an observer view and an overhead view. With the observer view the movement of the stars at each bearing can be seen. With the overhead view, meanwhile, the observer's location can be seen from space, with the direction the observer is facing made visible, along with the stars that are moving on the celestial sphere covering the surrounding area (Fig. 2(b)).

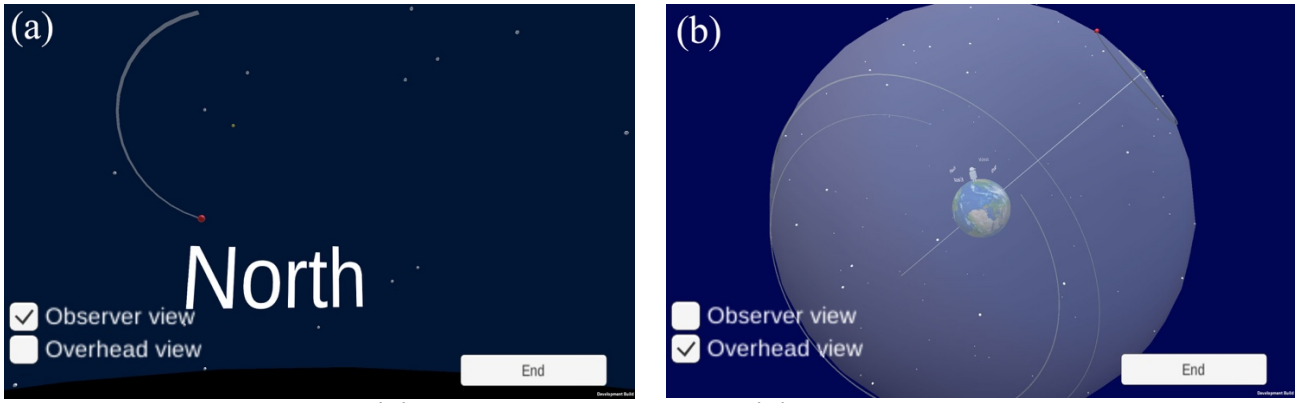

Fig. 2. The observer view (a) and the overhead view (b)

3. Conclusion

In order to help third-year middle school students, who were learning about the diurnal movement of the stars for the first time, we developed a VR teaching aid using a tablet. What is characteristic about our research is that we utilized the concept of a celestial sphere as found in textbooks, providing students with the ability to switch between viewing the celestial sphere from the inside (as an observer on the surface of the Earth), and from the outside. Our intention was to thereby make it easier for students to grasp the concept of diurnal motion. Going forward, we wish to conduct testing of the teaching aid in actual middle school classes in order to verify its educational effectiveness.

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