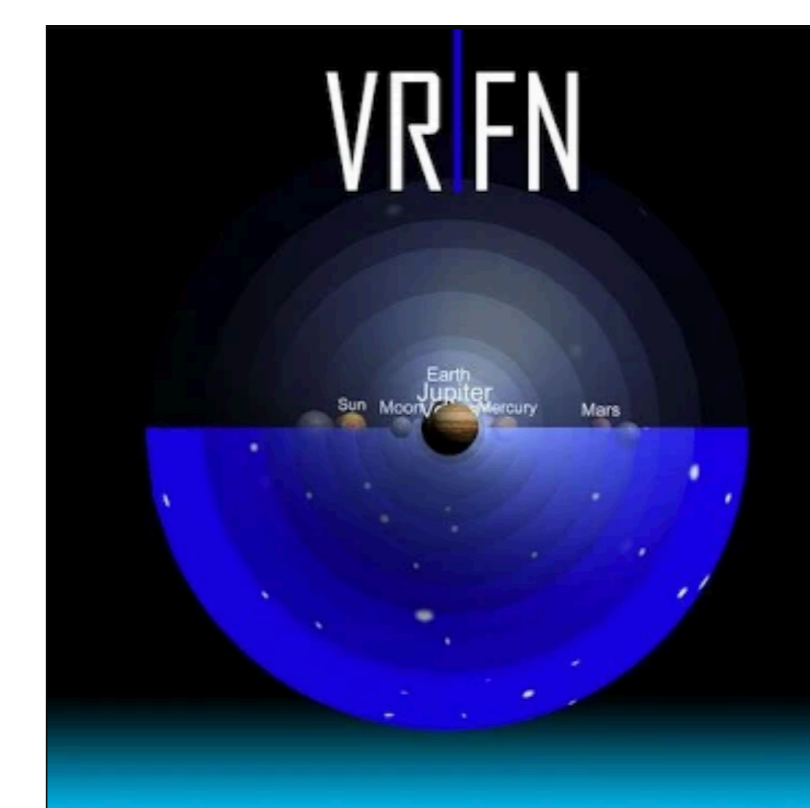


Explanation of difficult concepts in science classics using Virtual Reality (VR) technology

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Introduction

In Dialogue with Nature (UGFN1000) is a foundation course in the General Education Foundation (GEF) Programme that requires all undergraduate students from various disciplines to read and discuss science classics. Thorough understanding of concepts from texts is indispensable to in-depth discussions during tutorial classes. However, some students might find it difficult to visualize concepts that are too remote from their own studies or daily lives. According to our experience, the cosmology of Aristotle and Newtonian mechanics are two of the most difficult concepts in part I of the course. Visualizing Aristotle's model and Newton's idea can help students to understand these concepts and learn better in this course. In light of this, we have developed a mobile app **VR|FN** using VR technology to enhance students' understanding of difficult scientific concepts through a VR immersive environment.



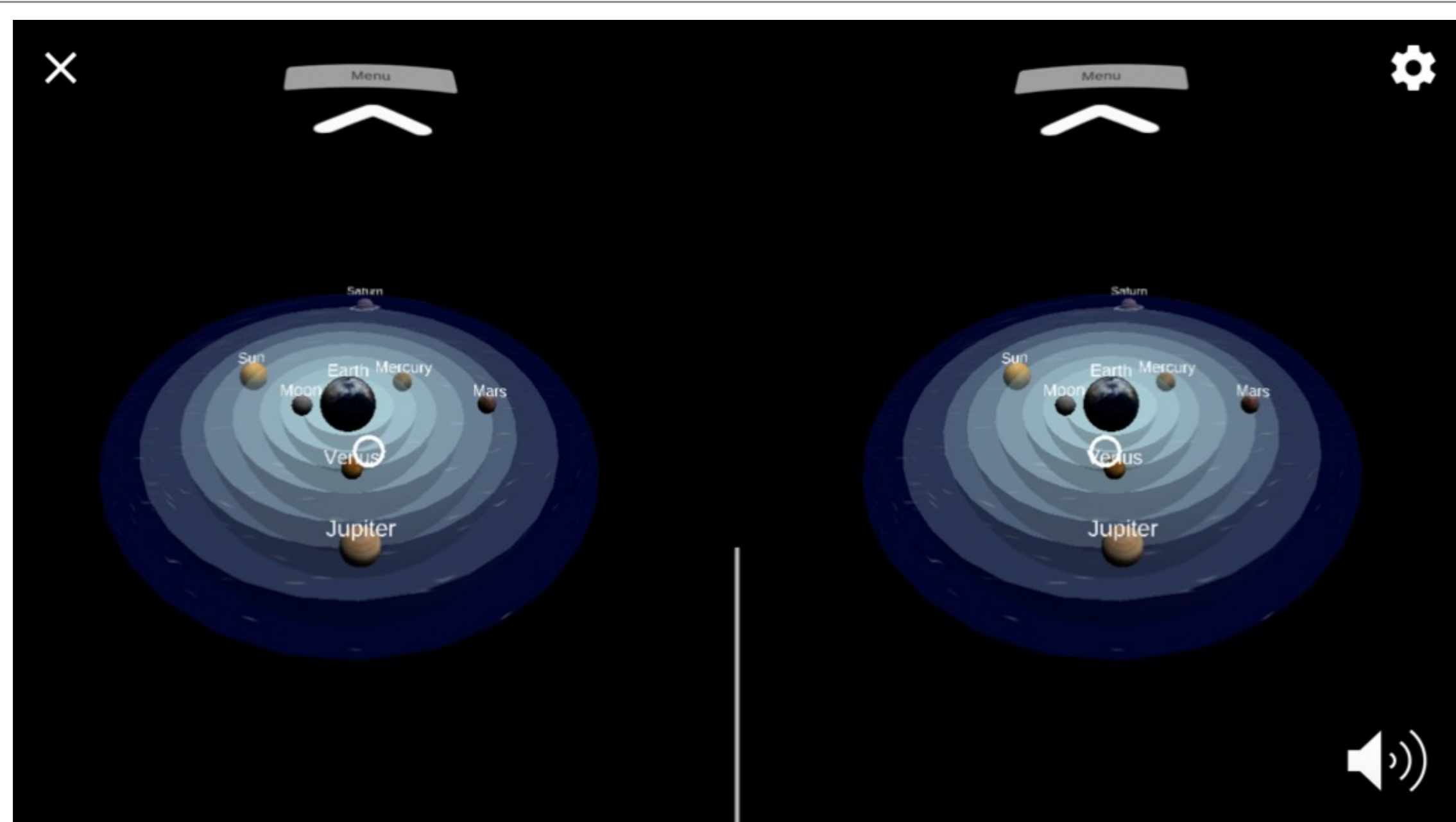
Aristotelian Cosmology

When students first learn about Aristotle's cosmology,

- 1) they often **superficially disregard it as an obsolete model** accepted by ancient people due to lack of modern knowledge
- 2) they **do not realize the agreement between empirical observation and Aristotle's model.**

The VR micro-modules help them to:

- 1) understand the **credibility of Aristotle's theory**,
- 2) help them **discuss worldview-related issues** and
- 3) appreciate the **transition from a geocentric model to a heliocentric model.**

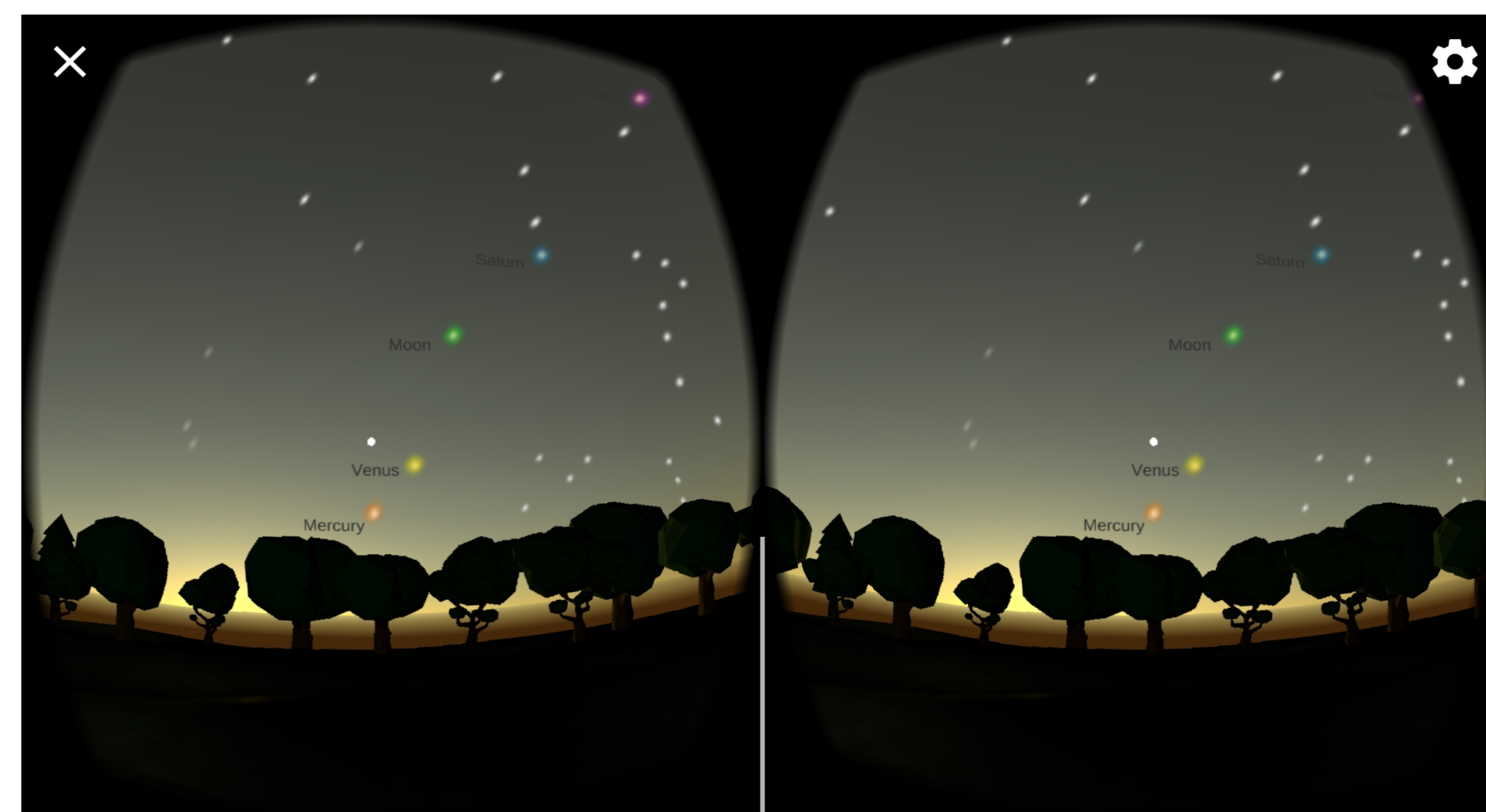


Module 1: Aristotle's Cosmological Model

In the first module, it shows a **3D animated cosmological model proposed by Aristotle**. It is a geocentric model where the earth is located at the center of the universe, while other planets (e.g. sun, moon, mars... etc.) and stars rotate around the earth. User can move freely to examine the model at different perspectives.

Module 2: Empirical Observation on Earth

The second module is **an immersive environment showing the rotating sky from the standpoint of earth**. In this module, user can freely look around and experience the empirical observation of various planets and stars when viewed on earth. The heavenly bodies would appear to be rotating around us (and the earth), thus lending support to the idea of geocentricism.

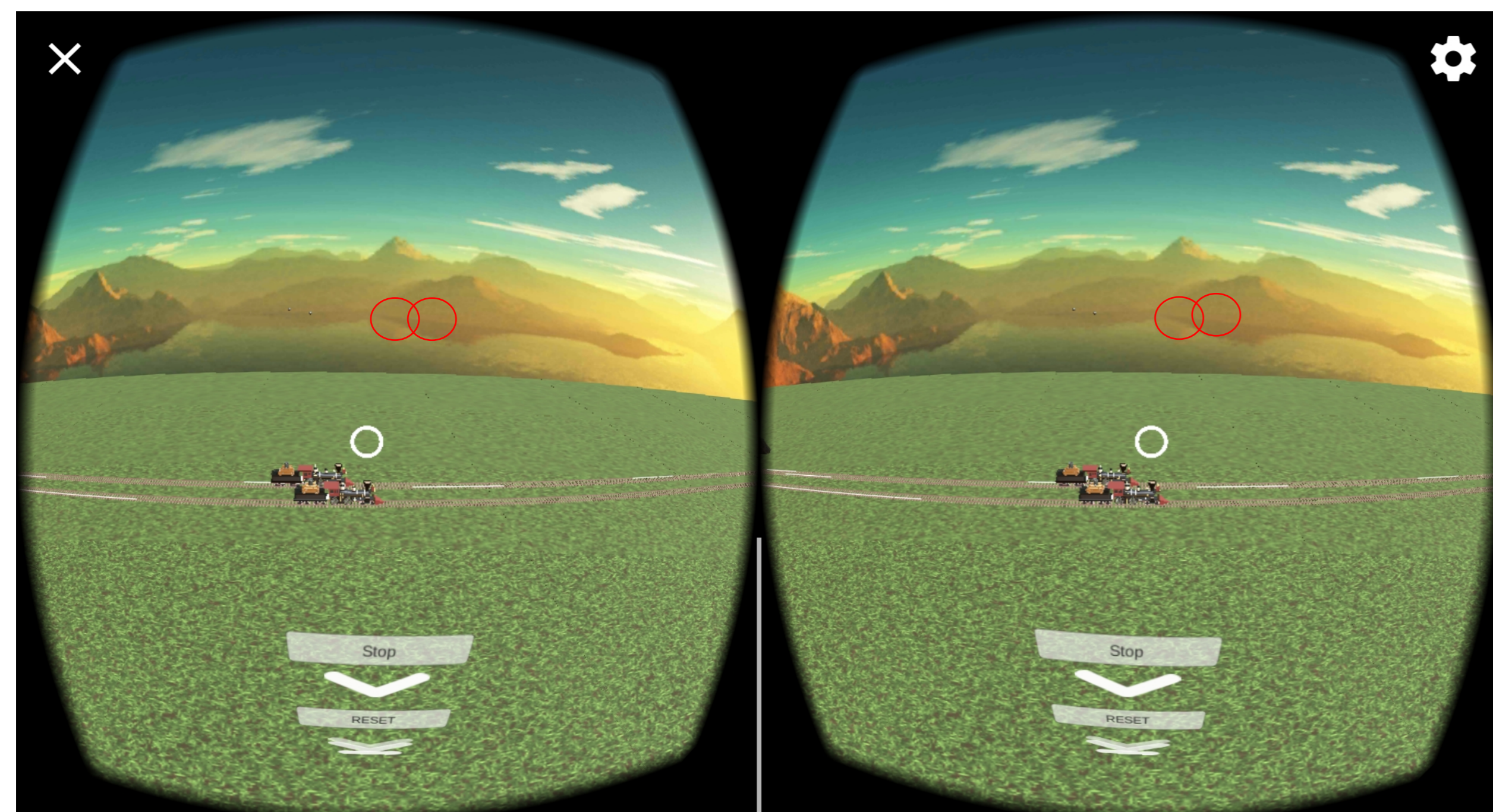


Newtonian Mechanics

Without grasping the idea of separating motion into independent horizontal and vertical components, it is difficult for students to understand the explanation of projectile motion by Newton's Laws of Motion. These modules provide **an illustration of the separation of component motions**. Besides, this enables them to **appreciate the conceptual change from Aristotle's explanation of projectile motion to Newton's explanation**.

Module 3 & 4: Cannon balls shot upward from stationary train and moving train

The modules show a **3D animation of a stationary train and a moving train shooting cannon balls vertically upward simultaneously**.



Moving Train

The cannon ball contains both horizontal and vertical motions, showing trajectory of a projectile.

Stationary Train

The cannon ball moves vertically upward and downward.

As the vertical and horizontal components of motion are independent, **the vertical positions of both cannon balls at various time should be the same**, and remain unaffected by the horizontal motion. User can pause at any time to examine and compare the positions of both cannon balls. User can also move freely in the VR environment to observe at different positions.

Implementation

The app was implemented in UGFN1000 course during 2018-19 T1. Two of the modules have been used in the tutorial session on The Beginnings of Western Sciences by David C Lindberg. The other two of the modules have been used in the tutorial session on Principia by Newton & The Birth of a New Physics by I Bernard Cohen. **Each micro-module was used in tutorial classes for around 10-15 mins**, during which students were provided with VR headset and used the app together to learn the concerned concept together under the guidance of the teacher. **Approximately 500 students have already engaged the app.**