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Aurora Simulator: A Software Application for Exploring the Aurora in Upper Elementary Science Classrooms

Anisa Bora

Teachers College, Columbia University, NY, USA
ayb2119@tc.columbia.edu

Abstract. The Aurora Simulator is a web-based software application prototype designed to support exploration of the natural phenomenon of the aurora. The application is intended for use in a classroom setting with upper elementary school-aged learners and focuses on exploring the interactions of electrons entering the earth's atmosphere with gas particles at a range of altitudes above the earth. The application features dynamic visual representations of gas particle-electron interactions that learners can initiate as they explore the simulation. Additionally, learners can create physical representations of electrons and interact with the application through a video sensing feature that detects physical objects based on color in the learner's webcam view. During the session, participants will have the opportunity to engage with the Aurora Simulator application prototype. Participants can use built-in digital representations of electrons as well as physical representations of electrons of their own design to engage in the application.

Keywords: Nature, STEM, Augmented Reality, Elementary, Aurora.

1 Purpose of Application Prototype

Recommendations for improving science education in the context of the United States within the past decade have included designing learning experiences that engage learners in authentic science and engineering practices [2]. Simulation tools developed for use in science education can support learners in engaging in such practices [4], [5], [6]. While a simulation tool with affordances for exploring atmospheric gas particles has been developed [8], the author was not able to identify an existing tool with both features tailored specifically to the exploration of the aurora phenomenon as well as with the range of desired features for exploration within the simulation (such as engagement with both digital and physical representations of electrons). The Aurora Simulator software prototype was developed to address this gap. The Aurora Simulator is a tool designed for use in upper elementary science classroom settings that aims to provide an environment where learners can engage in authentic science and engineering practices in the context of exploring the

aurora. Rather than focusing on the transmission of facts, the application provides an environment that facilitates learners engaging in practices such as using a model and analyzing data. Additionally, the application prototype extends a screen-based experience into the physical world by allowing for engagement with physical representations of electrons.

1.1 Application Prototype Description

Please see the following short video for a demo of the application prototype: https://youtu.be/LYkI94pIxtk.

The Aurora Simulator software application aims for learners to develop an understanding of the nature of gas particle-electron interactions in the context of the aurora. The application seeks to provide a constructionist environment [3] where learners may construct an understanding of the aurora through their own personal exploration of the simulation. The application features a menu bar that allows for multiple menu items to be turned on or off at a given time, providing learners with a degree of agency to create different views and representations of the phenomenon. The affordance to explore the simulation in multiple ways aligns with the idea of epistemological pluralism [7] that acknowledges multiple ways of knowing and relating to the world.

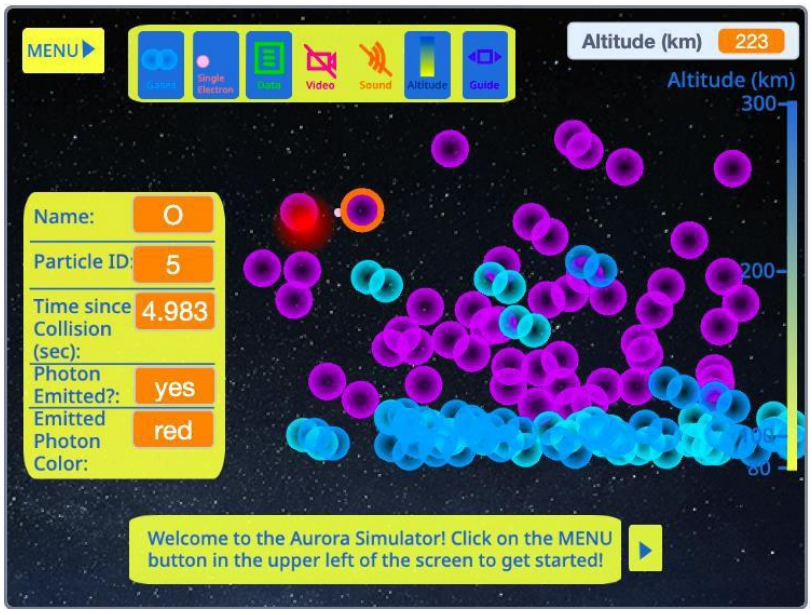

Fig. 1. Screenshot of application user interface with multiple menu bar items turned on.

The augmented reality component of the application is accessed through the "Video" menu item on the menu bar. When turned on, the "Video" menu item changes the background of the user interface to the user's webcam view, with a faint overlay of the space background that appears when the "Video" menu item is turned off also remaining visible. When "Video" is turned on, the application has been programmed to trigger gas particle-electron interactions when the gas particles are touching anything that is detected as the color black in the webcam view. The video sensing feature provides an alternative to mouse-based interaction. The flexibility to choose a physical representation of an electron rather than being restricted to the digital representations of electrons built into the software allows for some level of personalization and agency in the exploration of the simulation, potentially appealing to learners who prefer tangible objects over digital objects [1]. Additionally, through video sensing, multiple learners can potentially engage with the application simultaneously, facilitating a social learning experience.

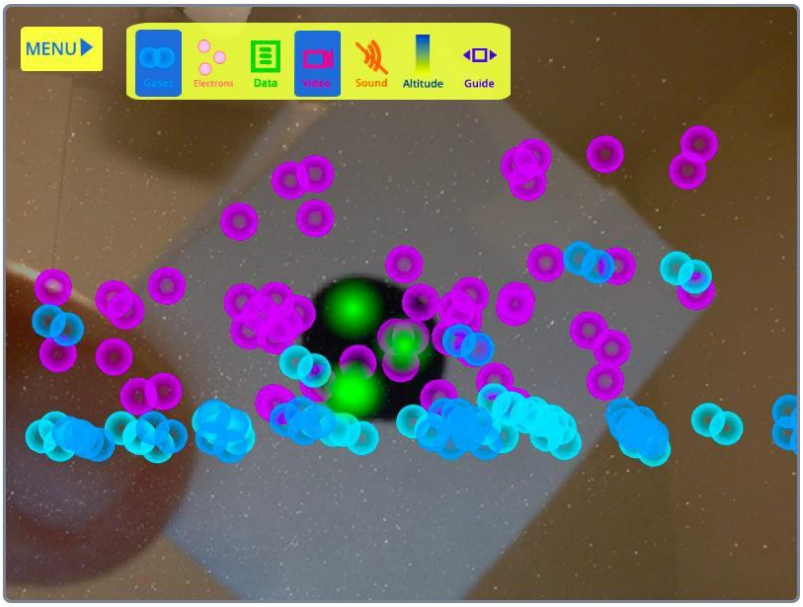

Fig. 2. Screenshot of application user interface with "Video" and "Gases" menu bar items turned on.

Ideas for further developing the prototype include incorporating features that allow for a more in-depth exploration of processes related to light emission, as well as features that support exploration of other aspects of the aurora such as the shapes of auroral structures. Ideas for improvement to the video sensing feature include incorporating motion detection technology as a possible avenue for providing learners with opportunities for embodied learning experiences (such as tying learner motion to a variable quantity relevant to the

simulation) or if using color detection allowing for learners to select the color of the object to be detected. Future iterations of the application might also provide additional support for engaging in science and engineering practices, such as improving features for data analysis. Feedback from implementations in a classroom setting would also be beneficial in informing future prototype development.

1.2 Recommendations for Implementation

Based on the current prototype, recommendations for classroom-based implementation include introducing the simulation within an activity where learners are positioned as investigators of a natural phenomenon and are given agency to explore the simulation, make observations, and generate questions and analyses. The instructor might model basic navigation and use of the simulation as well as provide guidance to learners around the process of documenting their observations and questions. Following a period of learner exploration with the simulation, the instructor might facilitate a group discussion of observations, analyses, and questions to inform future explorations.

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