EducatAR: Supplementing the STEM Classroom Experience

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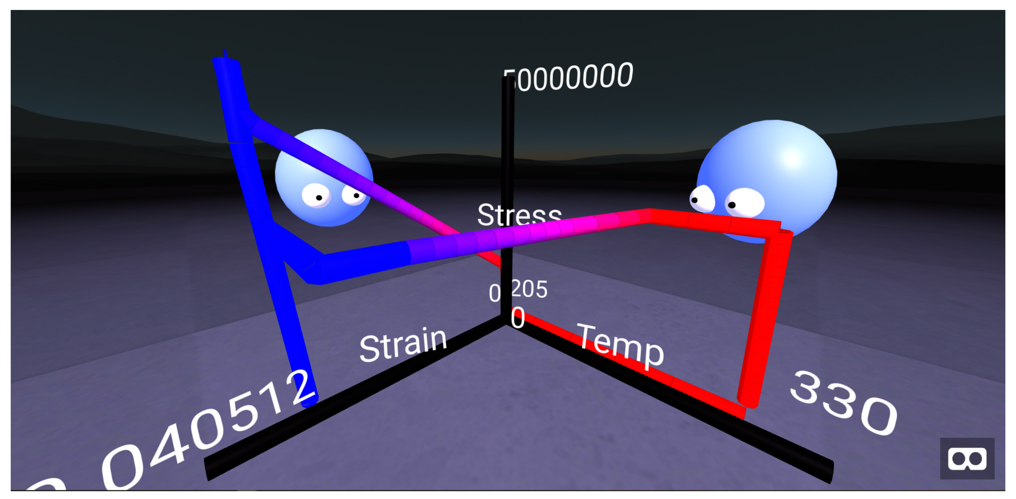
Aerospace Engineering[1], Atmospheric Sciences[2], Materials Science & Engineering[3]

Motivation:

For too long, STEM academics at all levels have attempted to teach 3-dimensional concepts using 2-dimensional educational tools (e.g. whiteboards). This method causes significant problems for students, as the required dimensional reduction is often not intuitive and relies on the student's own ability to visualize higher dimensional concepts. To address this issue, we proposed utilizing emerging Virtual Reality (VR) technologies and applications to make education accessible to a wider variety of learning styles. The system will empower lecturers to take advantage of the 3-dimensional properties of STEM applied concepts and allow for these lessons to be streamed to the low-cost Google Cardboards in real-time. The primary goal of this project is to develop a workflow and the ability to present and interact with results generated by existing STEM software tools within virtual classrooms enabled by VR technology.

Objectives:

1. ***Create***: Applications will be created to facilitate communication with students more directly by developing a robust workflow for viewing aerospace engineering/ material science/ atmospheric science topics in WebVR environments.
2. ***Interact:*** The proposed experience revolves around educators communicating and interacting with students in the classroom using VR technology that will be live-streamed for student viewing using the developed applications, students' own smartphones, and a low-cost VR headset. Educators would develop VR simulations regarding the topics in their course, elucidating their inherent 3-D aspects, and students could view these interactive lessons in real time.
3. ***Share:*** Streams would be made accessible over the cloud for distance-education use. The classroom would no longer be restricted to a physical space, as students could view and collaborate over these streams from virtually anywhere. The experience could also be networked so that they could see the avatars of their classmates in the real-time virtual classroom.

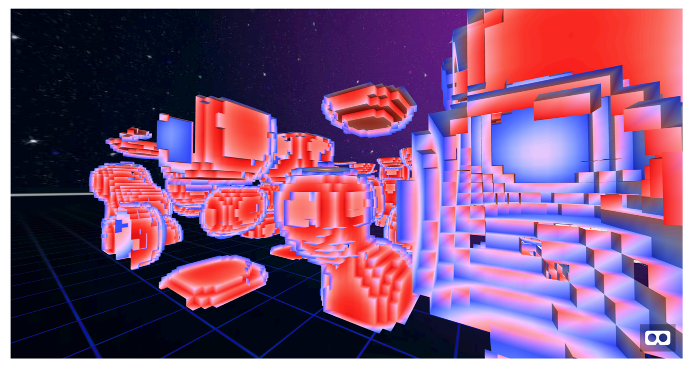


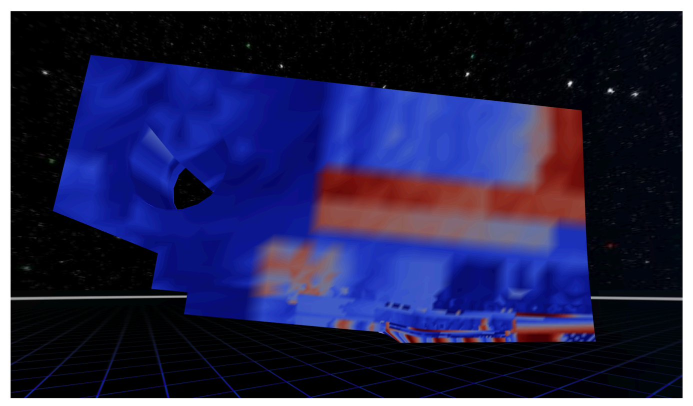
Methodology:

This virtual classroom experience was accomplished by leveraging JavaScript, HTML and the A-Frame environment. A-Frame is a web framework that enables virtual reality experiences to be hosted on the cloud. Any user with a web-enabled device (e.g. phone, desktop, VR headset) can visit the hosted site and be immersed in a virtual reality experience. This allows for VR technology to be easily deployed to classrooms and makes the educational experience more accessible. Simulations were developed to help students understand difficult concepts in the realm of Atmospheric Science, Materials Science and Aerospace Engineering by visualizing them as animated 3D models within a WebVR environment. Users can increase the immersion of the experience by putting on a VR headset or sliding their phones into a Google Cardboard VR device.

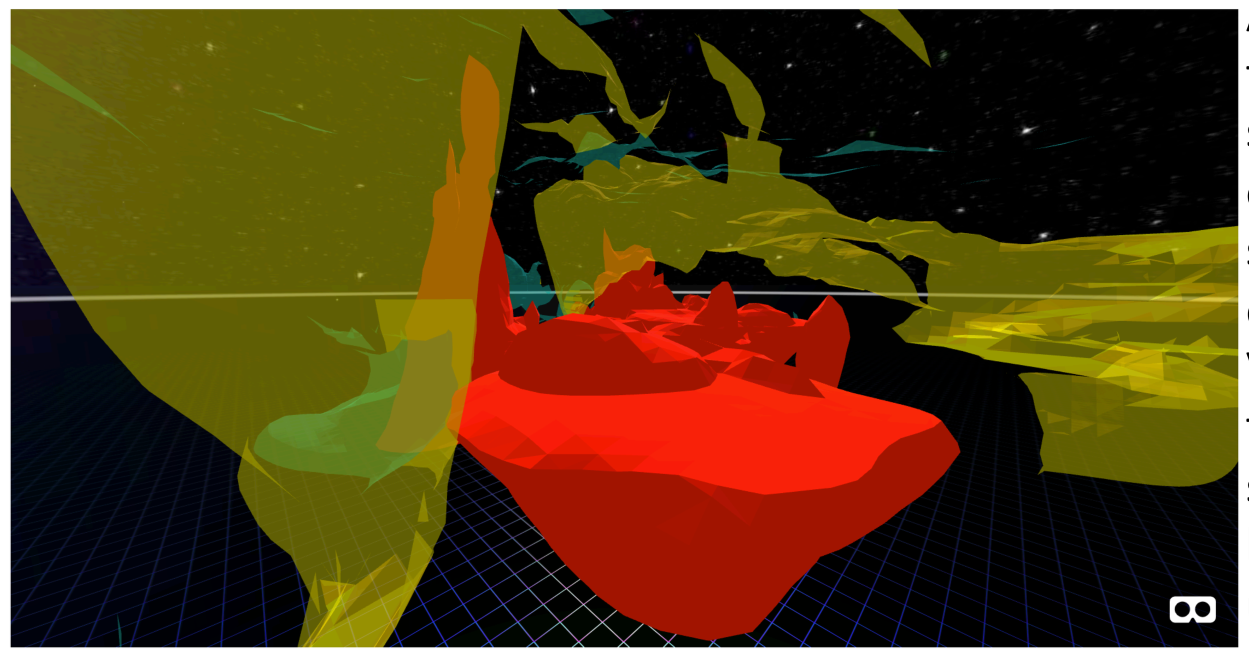
Materials Science

A simulation was developed whereby students could see animations of the internal particles of a materials specimen at different stages of growth. This same workflow was later utilized by the A&M Computational Materials Science Summer School (CMS³) program to investigate materials phenomena across various scales. This allowed distance education students to virtually participate in lectures by interacting with the models and asking pertinent questions.





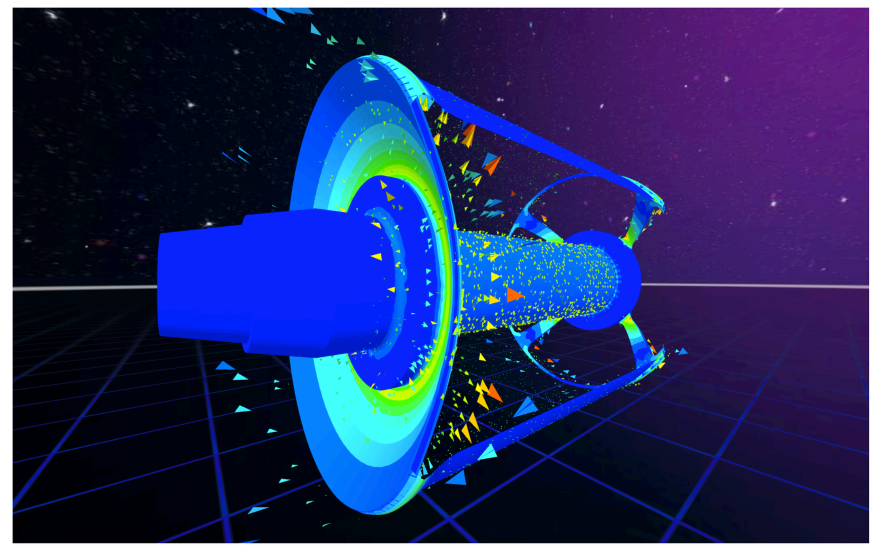
Atmospheric Science

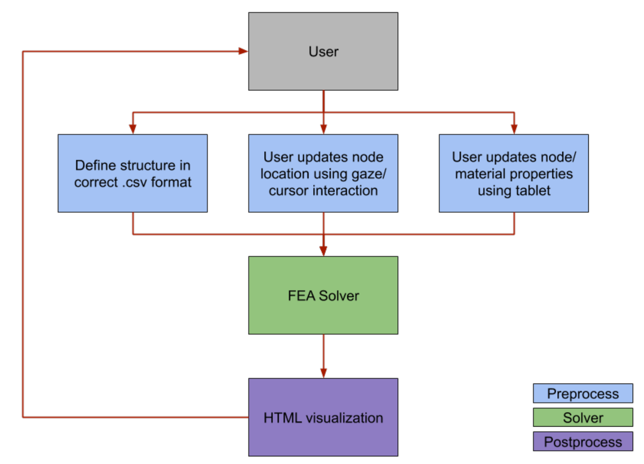


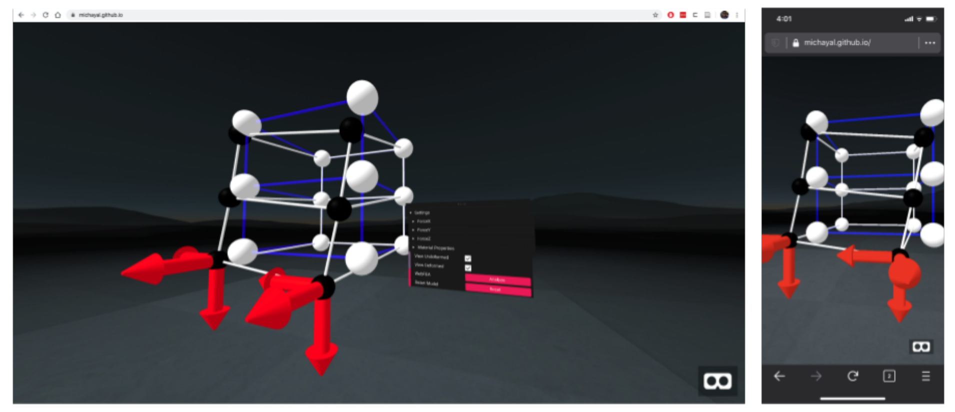
A simulation was developed so that atmospheric science students could view animations of a computationally predicted storm and visualize its evolution through time. Viewing the storm by moving through the animation helped students develop their knowledge and spatial understanding of weather phenomena.

Aerospace Engineering

A simulation was developed for students to visualize and interact with their models after it had been analyzed by a commercial FEA software. This was developed even further by creating a system which implemented the workflow shown on the right. Students could design their own structure, manipulate its nodal locations, forces, and boundary conditions. This new structure could then be analyzed in real-time within the WebVR environment. This enables students to learn structural engineering by doing structural engineering and could be very valuable for STEM outreach and education.







Desktop Browser

Mobile Browser

Conclusions:

- Immersive experience of the kind created lead to positive student feedback (written and verbal), indicating that the learning experience was both valuable and enjoyable.
- Inhabiting the same space as one's design, even virtually, allows accelerated understanding of design features and even critical faults.
- Further capabilities will need to be researched to enable students to more intuitively interact with objects within the virtual environment.

Future Work:

- Research offloading heavy computational processes to a server to limit latency and so that all user interactions are networked.
- Incorporate teacher-recorded lectures with audio inside WebVR.
- Utilize a green screen to add in a mixed reality component and further enhance the educational experience for students.

Potential for Future Support:

- Have been invited to join multi-disciplinary research teams in proposing new immersive visualization tools (e.g. urban air mobility noise visualization)
- Continuing to seek NSF Engineering Education support