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Poster: Use of Augmented Reality (AR) and Virtual Reality(VR) to tackle 4 amongst the ”14 Grand Challenges for Engineering in the 21st Century” identified by National Academy of Engineering

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Edward W. Davis received his PhD from the University of Akron in 1996. He worked in the commercial plastics industry for 11 years, including positions with Shell Chemicals in Louvain-la-Nueve Belgium and EVALCA in Houston TX. He joined the faculty at Auburn University in the fall of 2007. In 2014 he was promoted to Senior Lecturer. He has regularly taught courses in three different engineering departments. In 2015 he began his current position as an Assistant Professor in the Materials Engineering Program.

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Joni M. Lakin, Ph.D. The University of Iowa, is Associate Professor of Educational Research at the University of Alabama. Her research interests include educational assessment, educational evaluation methods, and increasing diversity in STEM fields.

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Dr.Virginia A. Davis' research is primarily focused on using fluid phase processing to assemble cylindrical nanomaterials into larger functional materials. Targeted applications include optical coatings, 3D printed structures, light-weight composites, and antimicrobial surfaces. Her national awards include selection for the Fulbright Specialist Roster (2015), the American Institute of Chemical Engineers Nanoscale Science and Engineering Forum's Young Investigator Award (2012), the Presidential Early Career Award for Scientists and Engineers (2010), and a National Science Foundation CAREER Award (2009). Her Auburn University awards include the Excellence in Faculty Outreach (2015), an Auburn University Alumni Professorship (2014), the Auburn Engineering Alumni Council Awards for Senior (2013) and Junior (2009) Faculty Research, the Faculty Women of Distinction Award (2012), and the Mark A. Spencer Creative Mentorship Award (2011). Dr. Davis is the past chair of Auburn's Women in Science and Engineering Steering Committee (WISE) and the faculty liaison to the College of Engineering's 100 Women Strong Alumnae organization which is focused on recruiting, retaining and rewarding women in engineering. She was also the founding advisor for Auburn's SHPE chapter. Dr. Davis earned her Ph.D. from Rice University in 2006 under the guidance of Professor Matteo Pasquali and the late Nobel Laureate Richard E. Smalley. Prior to attending Rice, Dr. Davis worked for eleven years in Shell Chemicals' polymer businesses in the US and Europe. Her industrial assignments included manufacturing, technical service, research, and global marketing management; all of these assignments were focused on enabling new polymer formulations to become useful consumer products.

Dr. Daniela Marghitu, Auburn University

Dr. Daniela Marghitu is a faculty member in the Computer Science and Software Engineering Department at Auburn University, where she has worked since 1996. She has published seven Information Technology textbooks, over 100 peer reviewed journal articles and conference papers, and she gave numerous presentations at national and international professional events in USA, Canada, England, France, Italy, Portugal, Spain, Germany and Romania. She is the founder director of the Auburn University Educational and Assistive Technology Laboratory (LEAT), Co-PI of NSF EEC ”RFE Design and Development: Framing Engineering as Community Activism for Values-Driven Engineeringan”, Co-PI of NSF CISE ”EAGER: An Accessible Coding Curriculum for Engaging Underserved Students with Special Needs in Afterschool Programs”, institutional partner of AccessComputing (http://www.washington.edu/accesscomputing/), AccessCS10k and AccessEngineering NSF funded Alliances, CO-PI of NSF INCLUDES: South East Alliance for Persons with Disabilities in STEM (https://cws.auburn.edu/apspi/pm/includes), CO-PI and

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the PI of NSF Computer Science for All (http://cs4all.eng.auburn.edu),. She is the recipient of the 2011 AccessComputing Capacity Building Award, the 2012 Auburn University Access award, the 2012 SDPS Outstanding Achievement Award, the 2013 Microsoft Fuse Research award, the 2015 DO-IT Trailblazer award, the 2017 IARIA Fellowship, the 2017 SDPS Fellowship, and the 2019 Samuel Ginn College of Engineering 100+ Women Strong Leadership in Diversity Faculty Award.

USE OF AUGMENTED REALITY (AR) & VIRTUAL REALITY (VR) TO ADDRESS FOUR OF THE "NATIONAL ACADEMY OF ENGINEERING GRAND CHALLENGES FOR ENGINEERING IN THE TWENTY-FIRST CENTURY"

AUBURN UNIVERSITY

ABSTRACT

The National Academy of Engineering's "Fourteen Grand Challenges for Engineering in the Twenty-First Century" identifies challenges in science and technology that are both feasible and sustainable in order to help people and the planet prosper. Four of these challenges are: enhance virtual reality, advance personalized learning, provide access to clean water, and make solar energy affordable. In this poster, the authors discuss developing of applications using immersive technologies such as Virtual Reality (VR) and Augmented Reality (AR) and their significance in addressing four of the challenges.
Drinking Water AR mobile application helps user easily locate drinking water sources in Auburn University campus, thus providing easy access to clean water. Sun Path mobile application helps user visualize Sun's path at any given time and location. Students studying the Sun Path in various fields often have difficulty visualizing and conceptualizing it, so the application can help. Similarly, the application could possibly assist the users in efficient solar panel placement. Architects often study Sun path to evaluate solar panel placement at a particular location. An effective solar panel placement helps optimize solar energy cost. Solar System Oculus Quest VR application enables users in viewing the solar system. Planets are simulated to mimic their position, scale and rotation relative to the Sun. Using the Oculus Quest controllers, users can teleport within the world view, and can get closer to each planet and the Sun in order to have a better view of the objects and the text associated with the objects. In a camp held virtually, due to Covid-19, K12 students were introduced to the concept and usability of the applications. Likert scales metric was used to assess the efficacy of application usage. The data shows that participants of this camp benefited from an immersive learning experience that allowed for simulation with inclusion of VR and AR.

MOTIVATION

This research discusses ideas on creating AR and VR applications and also examines the efficacy of such application usage amongst K12 students. The goal is to develop immersive applications and use them to address four of the fourteen engineering challenges.
A literature by Pombo, L. and M. M. Marques [1] presents a survey study regarding use of augmented reality enabled mobile devices for learning and the associated pros and cons of the device usage. The authors of the paper weigh in on students' perspective with the application usage. The findings of the paper suggest that the overall perspective remained positive with application usage amongst the students. Similarly, a literature by Lehman, S., et al. (2018). [2] proposes an AR app that helps cognitively impaired elderly people with hydration. The paper claims that the AR app proposed has advantages over existing water drinking reminder apps when it comes to helping cognitively impaired old adults to stay hydrated.
The work in this poster demonstrates development of AR/VR applications and examines their efficacy of use amongst K12 students. The results align and corroborate the claims made by authors of above mentioned articles.

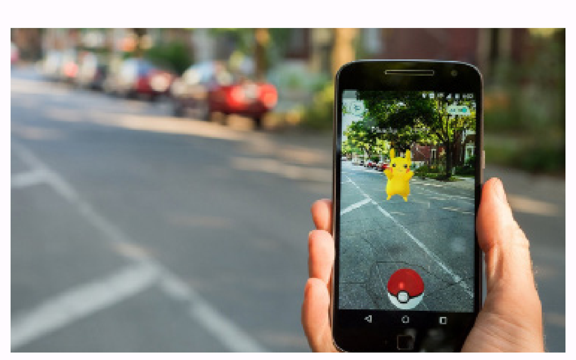


Figure 1: AR game PokeMonGo

Figure 2: Kid with VR Headset

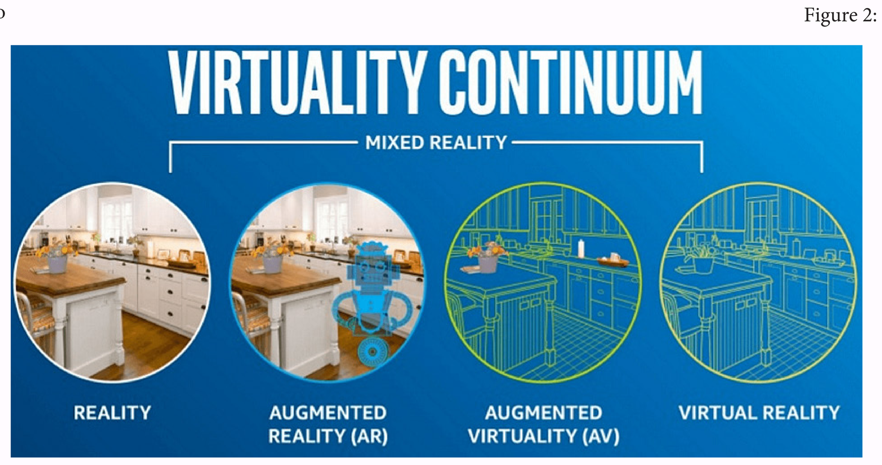


Figure 3: Reality–virtuality continuum

METHODOLOGY

The applications discussed in this poster will serve as a proof of concept for using AR/VR technologies to address four engineering challenges.
The water AR application is developed in android studio using Java programming language, and libraries such as Google's ARCore, Google's FireBase and ARCoreLocation by APPoly.
The Sun path AR application is developed in visual studio using JavaScript programming language and React Native framework.
The Solar System VR application is developed in Unity using C# programming language.
Each of the applications were developed using Waterfall development methodology.

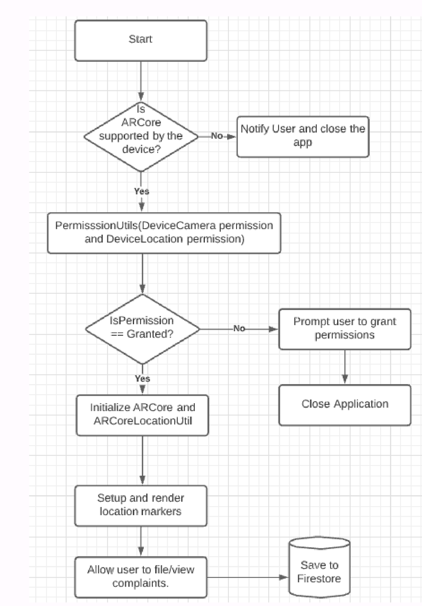


Figure 4: Water AR app flow chart

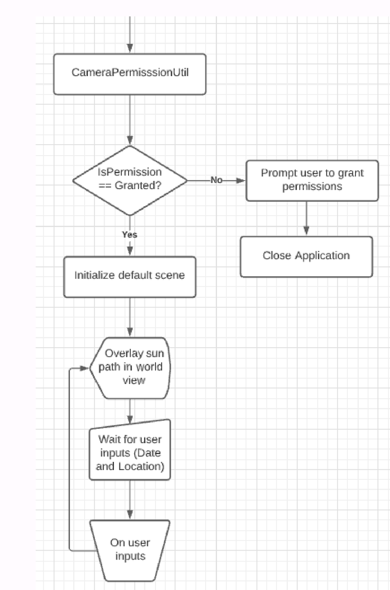


Figure 5 : Water AR app flow chart

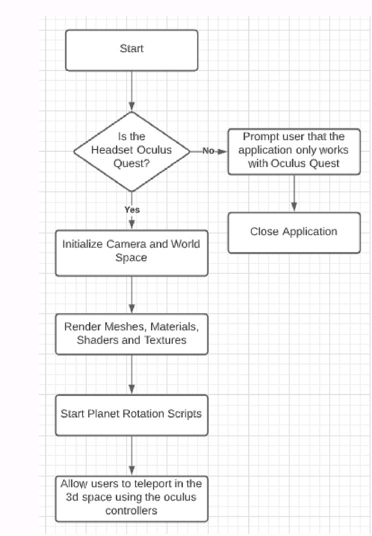


Figure 6: Solar System VR app flow chart

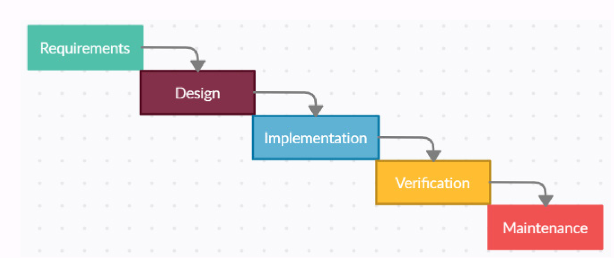


Figure 7: Waterfall Model

RESULTS

Figure 8: Drinking Water AR app Main Screen

This is the main activity of the water app. It shows the information overlay at the water location using real world coordinates. Users/Admins are able to login to view/file complaint.

Figure 9: Sun Path AR app Main Screen

This is the main activity of the sun path app. It shows sun path virtual overlay on real world. Users are able to select date, time and location of the sun-path.

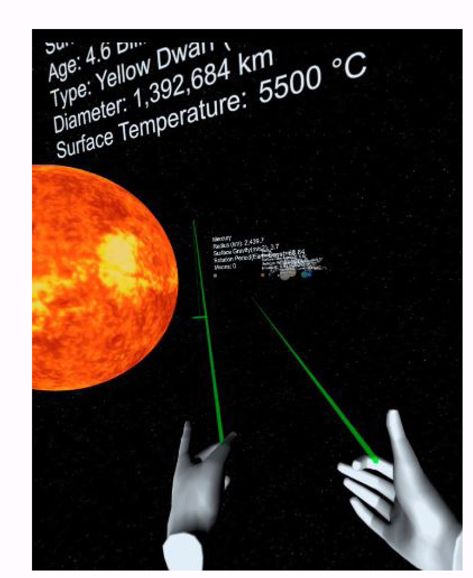


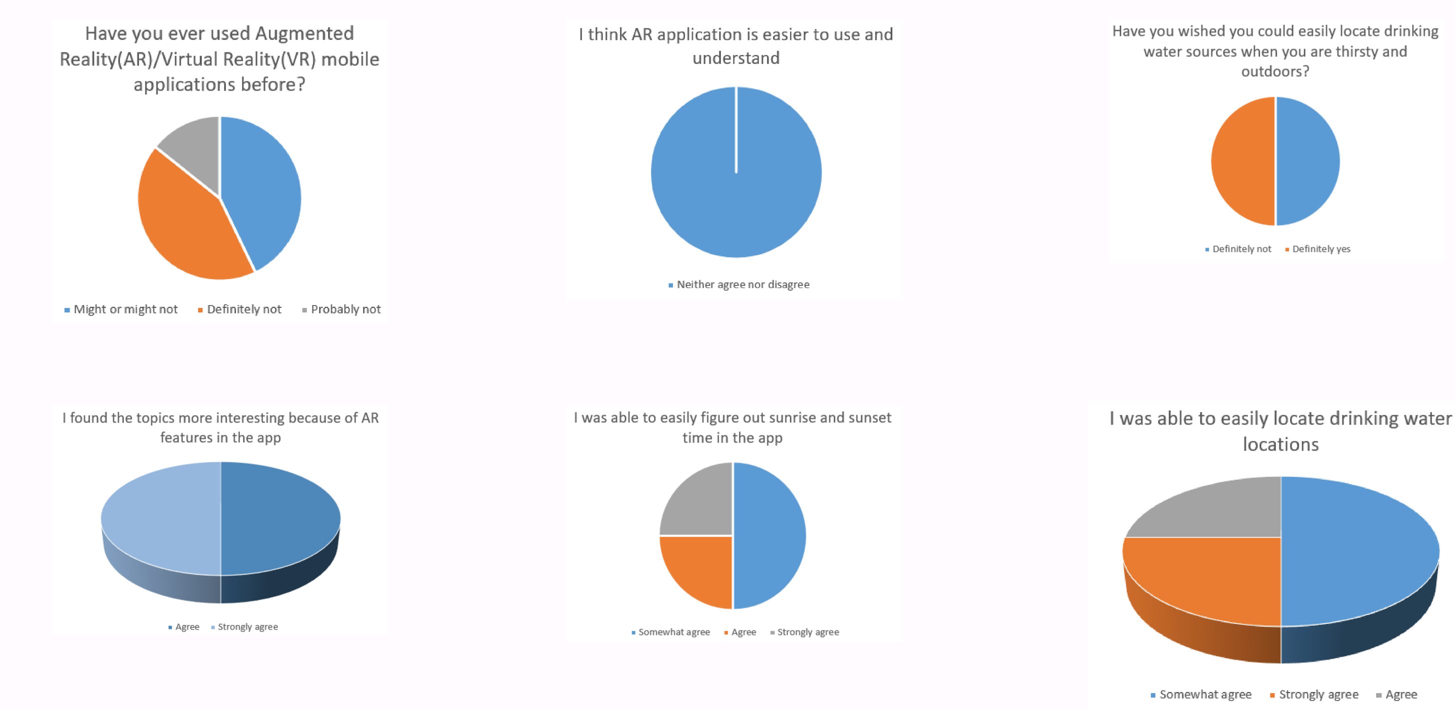
Figure 10: Solar System VR Quest View

This is the main scene that consists of all the GameObjects. Users are able to teleport to different places in the 3D view using the headset controller.

QUANTITATIVE EVALUATION

An RFE computing virtual camp was conducted for K12 students, in which, students from various part of the country participated. These students were instructed on important topics of AR/VR and were also asked to use the applications. The following observations were gathered from students' responses:

- Many students indicated that the use of AR/VR functionalities helped them in better understanding of subject topics.
- Students equivocally agreed that the apps were easier to use and that they were able to effortlessly determine drinking water sources and sun location.



FUTURE WORK

A virtual camp, conducted online due to Covid-19, wasn't quite effective to quantitatively evaluate the effectiveness of the work considering the lower number of student participation. In the future, the authors propose evaluating the application in an in-person camp with greater number of participants. Besides, following changes to the applications is proposed:

- Currently, the water application only supports two of the buildings inside Auburn University, and so scaling it to add more buildings is proposed.
- The mock data used for drinking water application could be replaced with actual data from the university.
- Both the sun path application and the water application are developed for android phones only. So, equivalent versions of the applications compatible to Iphones could be developed.
- Similarly, solar system VR application is only runnable in Oculus Quest Headset, and could be built to support more number of headsets.

REFERENCES

[1] L. Pombo and M. M. Marques, "Improving students' learning with a mobile augmented reality approach – the EduPARK game," ITSE, vol. 16, no. 4, pp. 392–406, Nov. 2019, doi: 10.1108/ITSE-06-2019-0032.
[2] Lehman S., Graves J., Mcaleer C., Giovannetti T., Tan C.C. (2018) A Mobile Augmented Reality Game to Encourage Hydration in the Elderly. In: Yamamoto S., Mori H. (eds) Human Interface and the Management of Information. Information in Applications and Services. HIMI 2018. Lecture Notes in Computer Science, vol 10905. Springer, Cham. https://doi.org/10.1007/978-3-319-92046-7_9
Figure 1. https://phys.org/news/2018-11-augmented-reality.html
Figure 2. https://vrgames.io/best-vr-games-for-kids/
Figure 3. https://medium.com/@Maria_Nova/4rs-or-get-your-head-around-virtuality-continuum-625e256ddd1d