

Picture this: Augmented Reality in the Ag Construction Classroom

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Introduction

Agriculture is one of the most dangerous occupations globally, with high fatalities, especially for children (CDC, 2014; Tingle et al., 2018; Mardis & Pratt, 2003). The Cost-Effective Rollover Protection Structures (CROPS) project began eight years ago with the intent of saving the lives of and changing the behavioral safety intentions of farm youth through agriculture education. CROPS is an alternative provided by the National Institute for Occupational Safety and Health (NIOSH) for purchasing and the installation of commercially available Rollover Protection Structures (ROPS) on seasoned tractors (NIOSH, 2019). The CROPS project has undergone several revisions and improvements to further the project's mission and stay engaging with high school students. One of those additions was creating and implementing an Augmented Reality (AR) app, known as the UKYcrops-ar application in the Apple App Store, to assist teachers and students in the project's construction phase.

AR technology is currently used in occupational safety (Le et al., 2015; Li et al., 2018) and safety education for children (Bakar et al., 2011) and shows their effectiveness in improving safety and health. Despite its proven effectiveness, it has seldom been used for children's agricultural safety education. A variety of educational settings are also incorporating AR technology. Liarokapis et al. (2004) utilize AR technology to help students understand the complicated mechanisms in engineering courses by using an AR, 3D views a camshaft arrangement in conjunction with a set of fundamental engine components. The technology is restricted to mechanics and is also being used in chemistry to examine atoms and molecules (Fjeld & Voegtli, 2002; Shelton, 2002).

How it Works

Due to its high levels of system-user interactivity, AR technology has a great potential to enhance the effectiveness of safety education. 3D virtual objects are integrated into a natural environment in real-time by allowing real-world sounds and images to be integrated into a 3D (Azuma, 1997; Lee, 2012). In other words, AR allows the user to see the real world, with virtual objects superimposed upon real-world images. The AR supplements reality rather than replacing it entirely, and the information conveyed in AR helps a user perform real-world tasks (Azuma, 1997).

The CROPS research team saw the need for a tool that teachers participating in the project could use to aid them and their students in constructing the CROPS. One of the goals of the AR app is to minimize the number of materials being used for mistakes. The CROPS AR app has become an essential feature for teachers and students. AR allows one to visualize the parts superimposed on the ground, on a tractor, or next to a constructed part. AR is bringing a new level of technology to the learning process. The app allows participants to see the intricacies of a piece and help minimize mistakes and save time and supplies. Users can select the tractor model and part number and examine the part, its angles, and decide how best to manipulate the metal to fit the plans.

Results to Date

The CROPS The CROPS team launched the AR App before the 2020 school year. At the end of the 2021 school year, student and teacher interviews were conducted by the CROPS team to evaluate in qualitative form the success and impact of the project. During those interviews, both teachers and students repeatedly spoke on the AR app during the construction process. One student said, "Oh yeah, that app! That thing is really cool. The app saved us a few times when we were unsure if we were headed on the right track putting those angle pieces together." Another student from TN said, "The blueprints are nice but being able to see what the finished parts look like makes reading the blueprints easier for me." The popularity and novelty of the app have not been contained to just the classroom. Teachers and students alike repeatedly discussed how they have been showing their parents, friends, and administration the AR technology features.

One teacher discussed during the teacher interviews how the app allowed all of his students to contribute to the project:

I had a few students who weren't as confident about the actual construction, which took hold of the app in the shop. They would pull [the AR app] up and study it, then talk through what they saw with the rest of their shop group to get the job done right.

Many teachers in the 2020-2021 cohort echoed similar comments about the app serving as a great tool and way to double-check before making a cut or laying a weld to conserve resources and time to complete the project.

Future Plans

The future for the CROPS AR App needs to be supported by NIOSH and other safety organizations. The NIOSH website currently has the CROPS blueprints for farmers, teachers, and others to use. The application can assist any tractor owner wanting to equip their tractor(s) with a CROPS. The app will continue to be available to teachers and students of the CROPS project and at their disposal should they continue to build CROPS in their communities.

Costs/Resources Needed

Creating the CROPS AR app took many resources. One of the tools used is Blender, a 3D modeling tool used to make each of the 3D model pieces used in the CROPS. All the CROPS pieces were created from scratch using the blueprints. After completing the models, they are exported as a GLTF file format and converted to DAE, compatible with AR Composer. AR Composer is an AR app creation tool from Apple. With this tool, 3D models are exported into the software and create events, animations, and scenes; this makes all the senses with animation and buttons users of the app can see. Once AR composer creates scenes, Xcode compiles code into the iOS (iPhone and iPad) app. Xcode takes charge of publishing the app to the Apple App Store. The app is free in the Apple app store and runs on iPhone or iPad.

References

- Azuma, R. T. (1997). A survey of augmented reality. *Presence: Teleoperators & Virtual Environments*, 6(4), 355–385. <https://doi.org/10.1162/pres.1997.6.4.355>
- Bakar, N. A. A., Zulkifli, A. N., & Mohamed, N. F. F. (2011, September). The use of multimedia, Augmented Reality (AR) and Virtual Environment (VE) in enhancing children's understanding of road safety. In 2011 IEEE conference on open systems (pp. 149–154). ICOS.2011.6079288/10.1109/<https://doi.org/>
- Centers for Disease Control and Prevention, National Institute for Occupational Health and Safety. (2014). Agricultural Safety. <http://www.cdc.gov/niosh/topics/aginjury/>
- Fjeld, M., & Voegtli, B.M. (2002). Augmented chemistry: An interactive educational workbench. *ISMAR*.
- Le, Q. L., Pedro, A., Lim, C.R., Park, H.T., Park C.S. & Kim, H.K. (2015). A framework for using mobil based virtual reality and augmented reality for experiential construction safety education. *International Journal of Engineering Education*, 31(3), 713-725.
- Lee, K. (2012). Augmented reality in education and training. *TechTrends*, 56(2), 13–21. <https://doi.org/10.1007/s11528-012-0559-3>
- Liarokapis, F., Mourkoussis, N., White, M., Darcy, J., Sifniotis, M., Petridis., Basu, A., Lister, & P.F. (2004). Web3D and augmented reality to support engineering education. *World Transactions on Engineering and Technology Education*, 3(1), 11-14.
- Li, X., Yi, W., Chi. H., Chan, A., Wang, X., & Chan A.P. (2018). A critical review of virtual and augmented reality (VR/AR) applications in construction safety. *Automation in construction*, 86, 150-160.
- Mardis, A. L. & Pratt, S. G. (2003). NIOSH Alert: Preventing deaths, injuries and illnesses of young workers. <http://www.cdc.gov/niosh/docs/2003-128/pdfs/2003128.pdf>
- Shelton, B.E. (2002). Augmented reality and education: Current projects and the potential for classroom learning. *New Horizons for Learning*, 9(1).
- Tingle, A. K., Vincent, S. K., Mazur, J., Dietrich, M. S., Watson, J., & Namkoong, K. (2018). Observing Change in Behavioral Intent among Secondary Youth Regarding Tractor RollOver through an Educational Intervention Curriculum. *Career and Technical Education Research*, 43(3), 243–258. <https://doi.org/10.5328/cter43.3.243>
- Zhou, F., Duh, H. B. L., & Billingham, M. (2008, September). Trends in augmented reality tracking, interaction and display: A review of ten years of ISMAR. In 2008 7th IEEE/ACM International Symposium on Mixed and Augmented Reality (pp. 193–202). 10.1109/ISMAR.2008.4637362<https://doi.org/>