Indoor building evacuation application for emergency response using HoloLens

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INTRODUCTION

Early hands-on experiences with the Microsoft Hololens augmented/mixed reality device have given promising results for building evacuation applications. A range of use cases are tested, including data visualization and immersive data spaces, in-situ visualization of 3D models and full scale architectural form visualization. Our Hololens application gives a visual representation of a building on campus in 3D space, allowing people to see where exits are in the building. It also gives path to the various exits; shortest path to the exist as well as directions to a safe zone. Our proposed AR application was developed in Unity 3D for Microsoft HoloLens. It is a fast and robust marker detection technique inspired by the use of Vuforia AR library. The application offers users an enhanced evacuation experience by offering enthralling visuals, helping them learn the evacuation path they could use during an emergency situation where evacuation is necessary. The goal of this project is to enhance the evacuation process by ensuring that all building patrons know all of the building exits and how to get to them, which would improve evacuation time and eradicate the injuries and fatalities occurring during indoor crises such as building fires and active shooter events. We believe that AR technologies like HoloLens could be adopted by people for building evacuating during emergencies as it offers enriched experience in navigating large-scale environments.

APPROACH

We have incorporated existing features in the building as markers for the HoloLens application to trigger the floor plan and subsequent location of the person in the building. This work also describes the system architecture as well as the design and implementation of this AR application to leverage the Microsoft HoloLens for building evacuation purposes. Pilot studies were conducted with the system showing its partial success and demonstrated the effectiveness of the application in an emergency evacuation. Our results also indicate that majority of participants felt that HoloLens application can be used as a substitute for evacuation plans (2D plan) in a building. The use of AR application gives the user the flexibility and ability to visualize the building and exits in a 3D space.
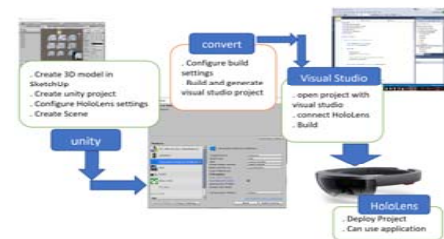
IMPLEMENTATION

Fig. 1: Build lifecycle of the project.

SOFTWARE AND HARDWARE REQUIREMENTS

Software / Programming Language	Usage
Unity 3D Software	Platform to develop the application
Vuforia Plugin	Script added on Unity 3D to detect the markers and project the data
Android Device	Android-based device to install and run the application

PHASE I: MARA AND INTELLIGENT SIGNS

A mobile AR application (MARA) was built to assist users to evacuate the Computer Science Building located at Bowie State University. The uniqueness of this research effort is the inclusion of visual cues, known as intelligent signs, to further assist the user in evacuating the building. The app features four intelligent signs to help users locate the exits in the building and determine how to get to them. All signs are visible by default but users can toggle the signs on and off as they wish using the toggle buttons at the bottom of the display. They are as follows: Blinking Exit Signs, Blue Arrows, Moving Green Doors, and Photo Hints:
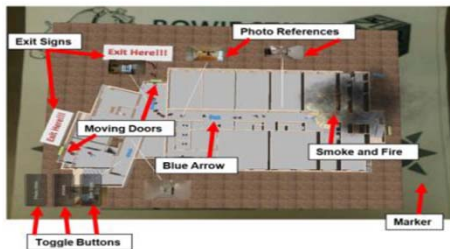

Fig. 2: All the components that appear when the camera detects a marker

Fig.3: The second floor with all intelligent signs visible

PHASE II: HOLOLENS WITH MARKERS

The existing features (such as room numbers and name plates) in the building were used as markers for the MARA and HoloLens application during phase II..

Fig 4: Marker for the Ground Floor of the Computer Science Bldg.

RESULTS / CONCLUSION

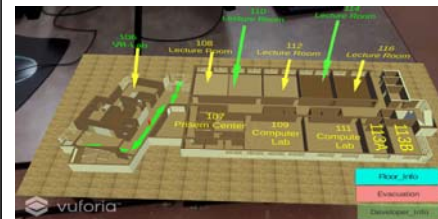Fig.5: Augmented Reality with Hololens: Building Evacuation

Fig.6: Augmented Reality with MARA: Building Evacuation

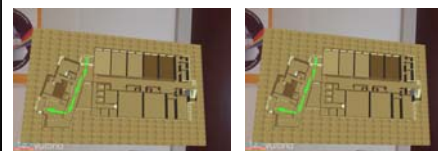Fig. 7. Projecting floor plan on targeted image for the floors.

Fig. 8. CS building floor plan with smoke, fire, and arrows to show the exit.

RESULTS

A very limited user study was conducted to evaluate the effectiveness of our HoloLens AR application. Pilot studies were conducted for the system showing its partial success and demonstrating the effectiveness of the application in an emergency evacuation. We were able to collect 10 responses from participant's. 80% were male participants and 20% were female participants. Post-test part of the questionnaire measured participant's perceptions of motivation, usability, educational and training effectiveness, and AR applications (HoloLens, Mobile phone, and Tablet) appropriateness.
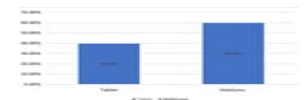

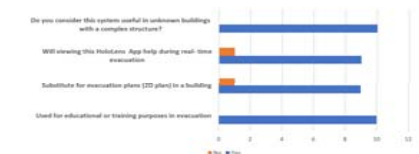Fig. 9. Device suitability for the study.

Fig. 10. Evaluation of usability of HoloLens application.

CONCLUSIONS

As our proposed AR application was developed for Microsoft HoloLens, the application offers users an enhanced evacuation experience by offering enthralling visuals, helping them learn the evacuation path they could use during a situation where evacuation is necessary. We have presented a novel HoloLens AR application that will help people to safely evacuate a building in case of an emergency situation. It is a fast and robust marker detection technique inspired by the use of Vuforia AR library. Conclusively, it can be recommended that AR technologies like HoloLens should be adopted by people for evacuating others from buildings during emergencies.

PUBLICATIONS

1) Stigall, J., Bodempudi, S.T., Sharma, S, Scribner, D., Grynovicki, J., Grazaitis, P., "Building Evacuation using Microsoft HoloLens", Proceedings of 27th International Conference on Software Engineering and Data Engineering (SEDE 2018), New Orleans, Louisiana, pp. 20-25, USA, October 8-10, 2018.[Best paper award finalist]

2) J. Stigall, S. Sharma, "Mobile Augmented Reality Application for Building Evacuation Using Intelligent Signs" in Proceedings of the ISCA 26th International Conference on Software Engineering and Data Engineering (SEDE 2017), San Diego, CA, USA, pp. 19-24, 2017.

3) S. Sharma, S. Jerripothula, "An indoor augmented reality mobile application for simulation of building evacuation" in Proceedings of SPIE Conference on the Engineering Reality of Virtual Reality 2015, © SPIE. doi: 10.1117/12.2086390, 2015.