Using Augmented Panoramic Views as an Online Course Delivery Mechanism in MOOCs

Masoud Gheisari, Ph.D. and
Nafiseh Sehat
Mississippi State University
Starkville, Mississippi

Graceline Williams, MSC
Autodesk, Inc.
Boston, Massachusetts

While Massive Open Online Courses (MOOCs) seem well suited for lecture-based courses, hands-on learning objectives (labs, studios) might be more difficult to achieve with current MOOCs practices. Labs and studios usually require interaction with tangible objects and are location-specific so their hands-on learning objectives might not be easily achieved through traditional video-audio-text format of the MOOCs. New technologies and ubiquitous computing offer the possibility of providing new means of communication that can let online users have a very similar experience to traditional college students while bringing physical locations closer to online users in a natural, intuitive way. Panoramas provide a natural/intuitive experience that simulates the real environment for users where locations and location-specific information are of the interest of the users. Augmented Panorama will be introduced in this paper and a workflow for creating an augmented panoramic environment will be discussed. Future research should be conducted to investigate the technological and user (students/instructors) requirements of this method while considering students' learning objectives and their feedbacks.

Keywords: Panorama, MOOCs, augmentation, delivery mechanism, location-specific data

Introduction

MOOC (Massive Open Online Courses) is a terminology used for courses that make curriculum freely available online via communication technologies for users around the world who have access to the Internet. MOOCs are not solely considered as a substitution but also as a facilitator to the traditional classroom educational setting. MOOCs are projected to have a significant influence on the traditional education system by allowing students to personalize their learning process based on their needs and time limits. The online courses can be restricted to specific time periods or they can have no time frame at all. MOOCs also have a cost benefit for universities, as they are not bounded by other limitations such as being limited in number of students enrolled or lack of facilities and space for setting up a traditional class environment.

MOOCs usually include online videos created by instructors in which they had recorded their regular teaching in the regular classrooms and supplement them by documents (e.g. PDFs of the assignments and projects, access to other educational websites, or online discussion forums). Within such an online educational environment users can utilize their own personal devices such as smartphones, tablet computers, or laptops to access their required information. They can have access to class information anywhere if they are connected the Internet. This online environment would allow participants to have interaction with each other, with the contents and with the course instructors (Shafaat & Marbouti 2014).

There are problems and limitations associated with MOOCs education systems that make MOOCs very hard to implement. Limited leaner-instructor interaction, numerous registered students, lack of fundamental class structure, communication barriers, and required technological infrastructures are some examples of such barriers (Table 1).

Table 1: A Few Problems and Limitations for implementing MOOCs (Cabiria 2012, Shafaat & Marbouti 2014)

Problem/Limitation	**Description**
Limited leaner-instructor interaction	• Lack of interaction due to the high number of enrolled students. • Instructors are not usually able to follow up with all the students in order to confirm their progress during the course.
Numerous registered students	• More quizzes taken as multiple-choice question. • Assessments are limited to close-ended questions that can be graded by a computer.
Lack of fundamental class structure	• Students may be less motivated or more tempted to cheat • Limited in subjects offered by universities
Communication barriers	• Language barriers • Cultural issue • Time zone
Required technological infrastructure	• Limited internet access for all the students around the world • Limited access to devices such as handheld mobile devices (e.g. iPad), notebooks

New educational tools, pedagogies and technologies have affected construction education more than any other similar fields (Knight et al. 2003, Fong 2005, Shafaat & Marbouti 2014). The goal of these approaches and technologies is to satisfy construction education requirements of creating a problem-based, project-based, and team-based learning environment (Monson 2012). These technologies and approaches are well suited for lecture-based courses and usually require video/audio files or text documents in a MOOCs learning environment. Hands-on learning objectives of construction courses (e.g. labs, studios) might be more difficult to achieve with such MOOCs practices because they require interaction with tangible objects and/or are location-specific. A ubiquitous technological approach (Augmented Panoramic View) has been proposed in this research project. Through Augmented Panoramic View method online users can have a very similar experience to traditional college students. This method brings physical locations closer to online users in a natural, intuitive way. Panoramas provide a natural and intuitive experience that simulates the real environment for construction educators where locations and location-specific information are of the interest of the users. Augmented Panorama is relatively novel to MOOCs and easy to implement. A case study will be used in this paper to illustrate the development phases as well as the implementation process of using augmented panoramas to facilitate student learning in a building structure course.

Augmented Panoramas and MOOCs

There is a wide range of new technologies that can have the potential of transforming MOOCs education beyond traditional video and audio formats. Utilizing these technologies will not only enhance learning, but increase student satisfaction making learning online easier and more intuitive. But these various technologies need to be tested and their feasibility, reliability, and sustainability in a MOOCs setting should be examined. There are many research projects investigating the whole spectrum of mixed reality and mobile technology platforms. As illustrated in Figure 1, prototypes and working systems should be developed for each condition on the spectrum to get a better understanding of their weaknesses and strengths as it pertains to a MOOCs learning environment. Further exploration is also required to see how MOOCs students can utilize these technologies through different mobile technology platforms (e.g. handheld devices, tangibles, and wearables).

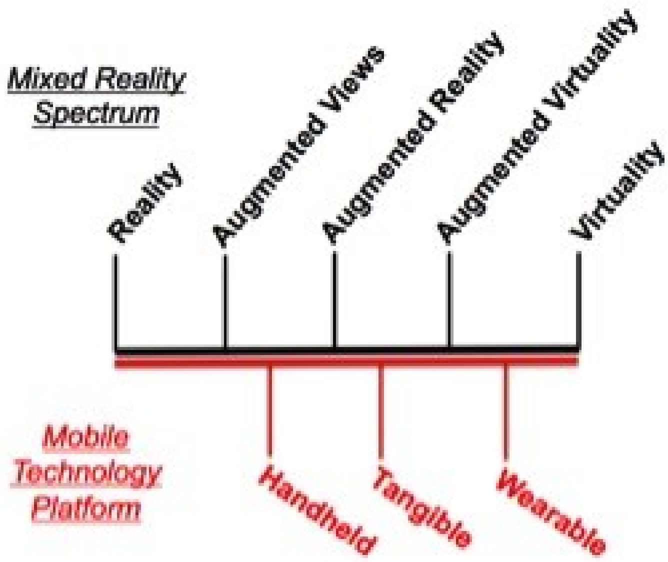

Figure 1: Mixed reality spectrum & mobile technology platform

There have been many research projects on the use of augmented reality in different phases of design (Olsson et al. 2012; Dunston et al. 2003) or construction (Dong et al. 2013; Wang and Dunston 2006) and facility management (Williams et al. 2014; Irizarry et al. 2014; Irizarry et al. 2013). The focus of this research is on the augmented panoramic views (integrating augmented reality and panoramic views) for educational purposes using handheld mobile devices that are accessible off-the-shelf. The target populations are students who engage in hands-on activities or require location-specific data in a traditional classroom setting. In this research, augmented views have been defined as a panoramic video or image capture of real-world environment augmented with specific information related to the capture. Series of relevant images or videos that stitch together is know as a panorama (Brown & Lowe 2007). The augmented information can be in the form of text, audio, image, video or any other format compatible with web technologies.

Pilot Study, A Structural Reading Course

The case study was conducted in a "Structural Reading" course in the College of Architecture at Georgia Tech. As a project within this class, student had to observe and understand structural behavior of a specific building on Georgia Tech Campus (Figure 2-a). Through that project, students ultimately would learn how every structural element of that building would work in a "global" sense while being able to draw free body diagrams (Figure 2-b) for that structural element. An augmented panorama would be a viable and location-independent solution to not only show the whole structure on a specific location but also illustrate free body diagrams of the structural elements of the building. This way the students can have a natural experience of being in front of the building, interacting with structural elements, and viewing associated free body diagrams.

(a) Stamps Health Center building on XXXXXX campus (b) A Free body diagram

Figure 2: Structural Analysis Exercise

The very fist step for generating an augmented panorama is to identify the location that simulates where the user would stand since digital augmentations and panoramas are generated based on this position (augmented panorama spot). Next, a sequence of photos of the environment is taken from the panoramic camera. After stitching individual images to an equirectangular projection, the panorama image needs to be converted into six square textures for rendering. Figure 3 illustrates the system architecture for developing the augmented panoramic view, which has four phases of data, computing, tangible and presentation (Chi et al. 2013). In data phase, any kind of data (e.g. video, audio, and text) can be augmented in a panoramic environment. In this phase, panorama of the structure and PDFs that are illustrating the free body diagram of each structural element are generated as inputs to for the next phase. Panorama of the environment is captured as six square images, which forms a skybox around augmented panorama spot. In the computing phase, GPS, accelerometers, and gyroscopes sense the environment and capture data related to a mobile device's position, orientation, location, and context. The mobile device acts as the user's tangible tool aiding them in controlling the visual feedback they receive through the mobile device's screen. In the final presentation phase, handheld devices such as iPad or iPhone loaded with Argon 2, an open-standards augmented reality browser, enable users to see and interact with digital augmentations on panorama.

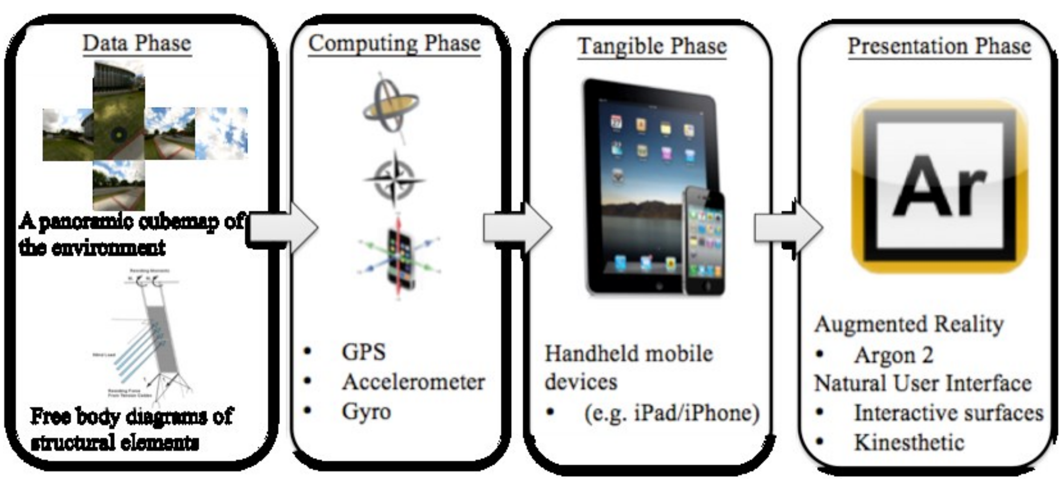

Figure 3: The system architecture of the augmented panoramic view

Figure 4 illustrates the process of bringing augmented panorama into mobile augmented reality. The developed method involves hardware and several software programs. Gigapan EPIC Pro was used to take photos due to ease of generating panorama and shooting automation. Gigapan Stitch was used due to multiple format supports and built-in vignette correction. The process begins with converting panorama photos from the stitched image to six square images (equirectangular to cubic). The transformation is done via Panorama Converter for Argon, a web-based tool for generating skybox images. Finally, Argon 2, an iOS based AR web browser was used to access the panorama and associated information. The panoramic images are in PNG format and will be used as textures in Argon 2. The code is written in JavaScript, HTML5, and CSS3 so all the files can be accessed via a HTTP request exactly similar to requesting a web page. After loading the main page in Argon 2, the virtual camera will update immediately according to physical orientation, which creates an augmented panorama experience.

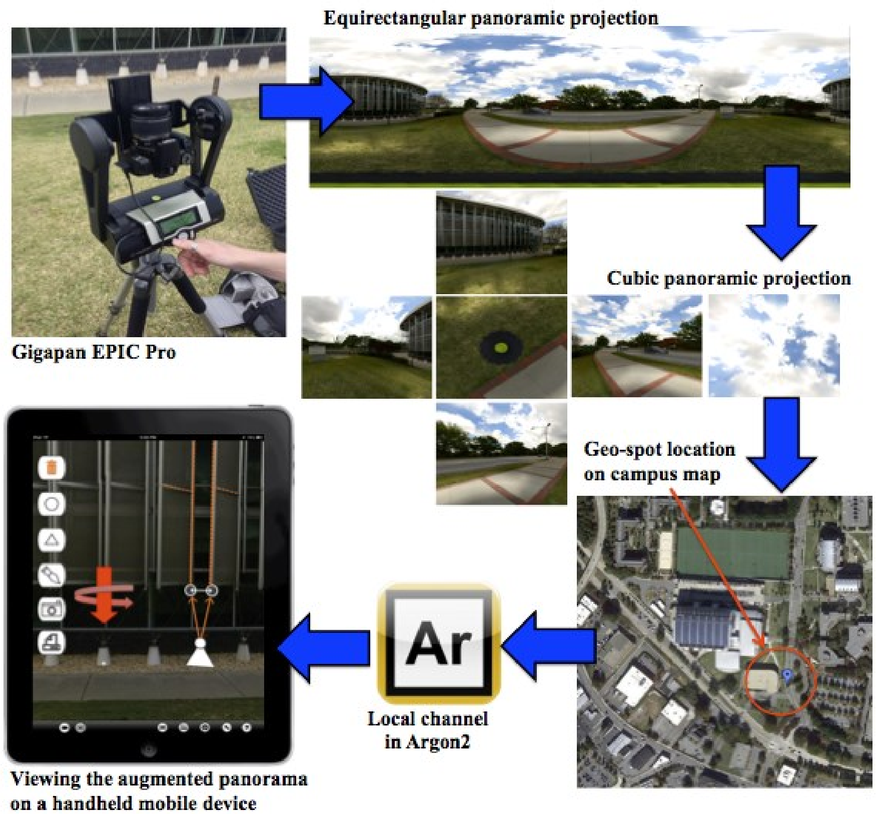

Figure 4: The workflow for developing the augmented panoramic view

For using this system, users should download and install Argon app on their mobile devices. When they log in to the app, on the map they should choose the location of the augmented panorama (Figure 5-a). This way the augmented panorama channel loads and user would experience the augmented panoramic environment (Figure 5-b). Highlighted structural elements in the building are clickable (Figure 5-b) and if users touch those structural elements, the details of the associated free body diagram would open up through a PDF file (Figure 5-C). This app can be used on/off the location providing a natural intitule experience for users to interact with structural elements of the building and see different types of information tagged to them.

(a) Location of the augmented panorama on the map

(b) Augmented load diagrams on the panoramic view of the structure

(c) Associated PDF of the free body diagram

Figure 5: System User Interface (UI)

Conclusion & Future Work

There is a mindset especially between construction-related educators and students that MOOCs and online education might not provide an appropriate learning environment for construction related education. The justification is mostly ties with the nature of construction education and its requirement of having hands-on or location specific learning experiences. But there is a wide range of new technologies and ubiquitous computing that can have the potential of transforming MOOCs education beyond traditional video and audio formats to satisfy the requirements of the construction education by providing new means of accessing information for online users. Augmented panoramic environment brings physical locations closer to online users in a natural, intuitive way and is an example of how ubiquitous computing can help to overcome the obstacles of implementing MOOCs type of education in construction domain through online methods. Augmented panoramic view, as a new medium and method of teaching students in an online environment, showed that MOOCs and online education has the potential to provide an appropriate learning environment for construction related education. One of the main challenges in this research was getting the system to work in the Argon 2 environment. To ensure stable results, we often communicated with the developers of the Argon 2 to help them debug issues with the incremental releases.

A Further research on augmented panoramic environments for MOOCs should be conducted to enhance the current practice and workflow while investigating two elements of (1) technology requirements (hardware/software) and (2) human requirements (students/instructors). New technological approaches should be recruited considering the needs of students and instructors and guidelines should be defined for successful learning evaluation and satisfaction in such an online educational environment. Students' learning objectives and their qualitative and quantitative feedbacks should also be investigated in the future phases of this research projects.

References

Brown, M., & Lowe, D. G. (2007). "Automatic panoramic image stitching using invariant features." International Journal of Computer Vision, 74(1), 59-73.

Cabiria, J. (2012). "Connectivist learning environments: Massive open online courses." In The 2012 World Congress in Computer Science Computer Engineering and Applied Computing (pp. 16-19).

Chi, H. L., Kang, S. C., & Wang, X. (2013). Research trends and opportunities of augmented reality applications in architecture, engineering, and construction. Automation in Construction, 33, 116-122.

Dong, S., Behzadan, A. H., Chen, F., & Kamat, V. R. (2013). Collaborative visualization of engineering processes using tabletop augmented reality. Advances in Engineering Software, 55, 45-55.

Dunston, P., Wang, X., Billinghurst, M., and Hampson, B. (2003). "Mixed Reality benefits for design perception." NIST SPECIAL PUBLICATION SP, 191-196.

Fong, P. S. (2005). "Aspects of learning and knowledge in construction projects." In Construction Research Congress 2005 (pp. 1-10).

Irizarry, J., Gheisari, M., Williams, G., and Roper, K. O. (2014). "Ambient Intelligence Environments for Accessing Building Information: A Healthcare Facility Management Scenario." Emeral Journal of Facilities, 32(3/4).

Irizarry, J., Gheisari, M., Williams, G., and Walker, B. N. (2013). "InfoSPOT: A Mobile Augmented Reality Method for Accessing Building Information through a Situation Awareness Approach." Automation in Construction, 33 (Augmented Reality in Architecture, Engineering, and Construction), 11-23.

Knight, D. W., Carlson, L. E., & Sullivan, J. F. (2003, June). "Staying in engineering: Impact of a hands-on, team-based, first-year projects course on student retention." (In CD) Proceedings of ASEE Conference and Exhibition.

Monson, C. (2011) "Concepts of inquiry, constructivist learning, and the potentials of studio in construction education." 47th ASC Annual International Conference Proceedings

Olsson, T. D., Savisalo, A. T., Hakkarainen, M., & Woodwand, C. (2012). User evaluation of mobile augmented reality in architectural planning. eWork and eBusiness in Archetecture, Engineering and Construction. Gudnason & Scherer (Eds). Taylor & Francis Group, 733-740.

Shafaat, A. and Marbouti, F. (2014) "A New Model for Offering Construction Education on MOOC Platforms. Construction Research Congress 2014: pp. 399-408. doi: 10.1061/9780784413517.041

Wang, X., and Dunston, P. S. (2006). "Compatibility issues in Augmented Reality systems for AEC: An experimental prototype study." Automation in Construction, 15(3), 314-326.

Williams, G., Gheisari, M., Chen, P., and Irizarry, J. (2014). "BIM2MAR: An Efficient BIM Translation to Mobile Augmented Reality Applications." ASCE J. Manage. Eng. , 10.1061/(ASCE)ME.1943-5479.0000315 , A4014009.