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VisionARi: An online community-based augmented reality platform for immersive learning

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Abstract
This paper outlines the development of VisionARi, an online community-based augmented reality (AR) platform for immersive learning. At the core of the platform is a public digital library where creators can upload educational AR content, which is then viewable by users on a dedicated mobile application. VisionARi enables educators with little to no experience in immersive technology to begin creating educational AR content in a matter of minutes through short video tutorials and template files, achieved by leveraging popular free-to-use or open-source software such as Unity and Blender. The ubiquity of smartphones enables VisionARi to overcome barriers and issues related to technical competencies and hardware accessibility currently hampering immersive learning, while the community-based ecosystem facilitates online collaboration across multiple disciplines, potentially leading to improved student learning outcomes.

Keywords: *Augmented reality; immersive learning; community-based; online platform; digital library.*

1. Introduction

1.1. Penetration of digital technology in education

Technological development in the digital age has been transforming the pedagogical landscape since the late 1990s, when the growth of the internet enabled educators to realise the use of the computer as a tool for communication and collaboration, rather than as just a means of information dissemination (Zawacki-Ritcher and Latchem, 2018). Zawacki-Ritcher and Latchem (2018) also attribute the launch of the iPhone in 2007 as the beginning of a period of *online learning in a digital age*, in which emphasis is placed on digital media interactivity. It is important to note just how fast the adoption of smartphones in our daily lives has been throughout the 2010s, reaching an estimated 78% global penetration rate by 2020 as a share of the world population (Statista, 2021). The COVID-19 pandemic further accelerated the adoption of digital tools in education, so sudden and dramatic in fact, that the transformation has put a strain on many teachers and students who struggled to equip themselves with the tools and competencies of a digital distant-learning environment (Iivari et al., 2020).

1.2. Emergence of virtual learning environments

In recent years, virtual reality (VR) technologies have been gaining attention owing to their unprecedented level of user immersion. VR relies on computer technology to create a simulated world around the viewer with digital media, creating a highly immersive experience. Whereas VR creates an entirely digital world, augmented reality (AR) and mixed/merged reality (MR) technologies overlay virtual content in the viewers' real-world by incorporating live camera data. Figure 1 illustrates the differences between VR, AR, and MR from a user-immersion perspective. The umbrella term *extended reality* (XR) is often used to refer to the whole spectrum of the reality-virtuality continuum.

The XR industry is poised for rapid growth, with a market size estimated to triple by 2023 (Wolfstein, 2021). This is reminiscent of the early years of the smartphone industry, further evident from the recent public interest in the metaverse. Furthermore, a survey of industry experts has revealed that the education sector is expected to experience the second most disruption by immersive technologies, only after the healthcare and medical devices industry (Perkins, 2020).

However, despite the ostensible potential of immersive technologies in education, a systematic review of immersive VR applications for higher education conducted by Radianti et al. (2020) has shown that while there has been widespread interest, applications of immersive technologies in education has mostly been experimental and confined to a small set of usability tests, rather than being deployed regularly in actual teaching. This raises questions concerning the maturity of the technology.

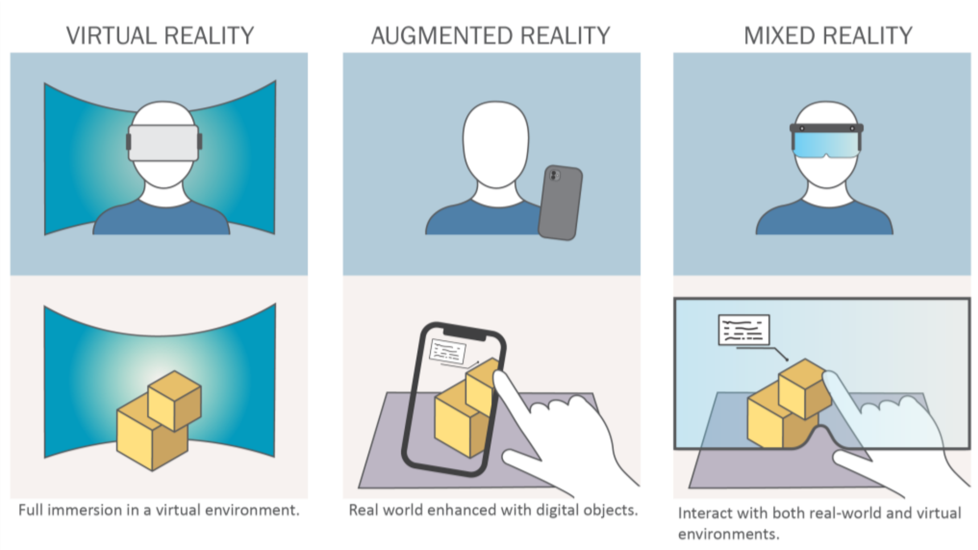

Figure 1. Comparison of VR, AR, and MR

1.3. Barriers of using immersive technologies in education

There are two major requirements for immersive technologies such as VR, AR, and MR to be effectively used by educators and students. First, the hardware must be readily accessible. Immersive technologies traditionally require the use of specialised hardware, such as headsets fitted with screens, and may additionally require gloves or hand-held devices fitted with sensors, such as the Oculus VR kit. MR headsets such as Microsoft's HoloLens 2 can cost upward of US$3,500 per set. The high costs of dedicated hardware limit their accessibility.

Smartphones, on the other hand, have already reached mass adoption, and the onboard computing power has advanced to the point where it can reliably support AR technology. ARtillery Intelligence (2021) estimates that among the 1.35 billion active users running AR applications on their smartphones, 374 million users (28%) are running them on ARKit or ARCore, which are opensource AR software development platforms provided by Apple and Google, respectively. These numbers show that AR technology is easily accessible to the wider public with an active base of application developers. Thus, while it may take another few years for dedicated immersive technology hardware to mature and be easily accessible to the education sector, smartphones make a compelling bridge towards such a future, while achieving high outreach immediately.

Another major requirement for immersive technologies to be effectively deployed in education is the technical competency of both educators and students. As of now, immersive technologies require special training to use, and most of the time require lengthy and costly application development by third-party developers. Indeed, through a semi-structured interview with school teachers who use VR/AR technology regularly, Alalwan et al. (2020) found that a lack of competency, a lack of environmental resources, and limited instructional design are some of the key challenges preventing the effective use of VR/AR in classroom settings.

2. Development of the VisionARi platform

2.1. The need for a common platform

A major hurdle for educators in incorporating immersive content in their teaching is that they need to design, develop, and test their application from scratch. As mentioned earlier, this requires educators to gain strong technical competency in immersive technology first. A common platform with simplified and semi-automated processes for creating immersive content can alleviate much of this burden, enabling educators to focus more on content quality for their learning outcome goals.

To overcome these technical barriers and limits with hardware accessibility, we propose a new framework that leverages free-to-use or open-source software to create a community-based educational AR platform for mobile devices. The platform is being developed by our team at the Hong Kong University of Science and Technology in collaboration with VisionARi Limited, with the aim of empowering educators, students, and professionals to create, share, and use high-quality educational AR content more effectively and more collaboratively.

2.2. Our proposed framework: VisionARi

Our proposed framework is called VisionARi and its outline is illustrated in Figure 2. At its core is an online digital library that hosts “modules” for users to download and run. Each module contains a compressed package of files such as 3D models, animations and toggles, which collectively make up the central AR content. Modules are uploaded by content creators directly to an online library, analogous to how a video creator would share their content on an online streaming platform. Users can access the modules through our dedicated mobile application, enabling them to view the AR content. The library is also accessible through the community website, where users can also manage their account and content, leave comments on specific modules, and share tips and experiences.

The VisionARi viewer is built on the Unity engine, a free-to-use game development engine with AR plug-in capabilities. Content creators would use Unity to create their AR content through the provided templates, with support from short tutorial videos. Unity has a large online community owing to its relatively simple and modular workflow, making it ideal for novices to get started on creating AR content, in just a few minutes, without any expert coding skills.

Our framework enables all levels of creators, from teachers and educators with no experience to professional 3D modelers and animators, to create and share AR content in a collaborative and interactive manner. Beyond this, students themselves can become content creators, for instance, using AR content to present their science/engineering project.

Compared with other AR platforms, the VisionARi ecosystem has the distinct advantage that it can enable any given module to be accessed by educators all around the world to incorporate into their teaching. Furthermore, as the modules are deployed onto smartphone devices instead of dedicated hardware, the technical barrier is significantly reduced while hardware accessibility is drastically improved.

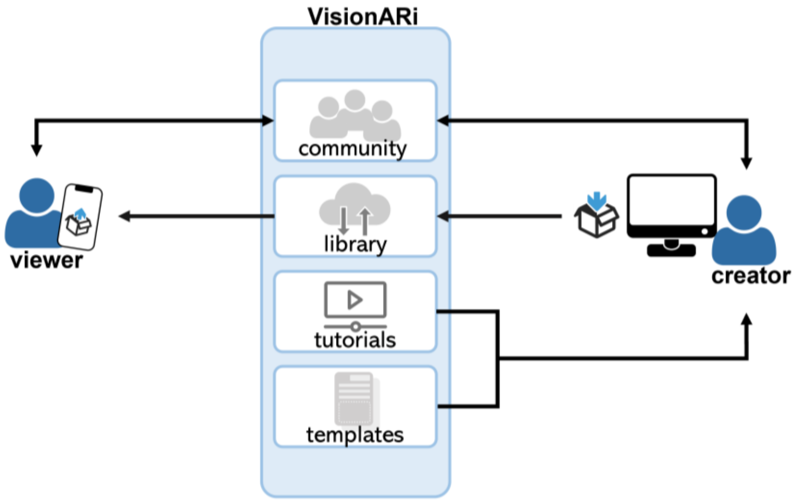

Figure 2. Framework of the VisionARi platform

A short video demonstration of the mobile application running different example cases can be found here: https://youtu.be/S0KtApSDa1U (VisionARi, 2022).

2.3. Case study A: CAD model of a DC motor

A simple example module was created using a generic CAD model of a DC motor downloaded from an external online library (Suchet, 2021). The CAD model contains all the internal components of a DC motor, such as permanent magnets, rotor, and copper coil. The CAD model can demonstrate the inner workings of a DC motor effectively.

The CAD model was imported into Blender, a popular open-source 3D modeling software, where realistic materials and textures were added to the various motor components. Once prepared, the CAD model was imported into Unity, where two toggles were defined that can show/hide the outer casing and cover of the DC motor in the mobile application. Once the module was prepared, it was packaged as an asset bundle and uploaded to the VisionARi library.

Figure 3 shows the example case being viewed on the VisionARi mobile application, with the outer casing and cover of the motor shown (top) and hidden (bottom). The steps to creating this module – including the use of Blender – have been documented as a 5-minute tutorial video. Tutorials of example modules will equip novice creators with the skills and knowhow to create their own modules via Unity, Blender, and other open-source software.

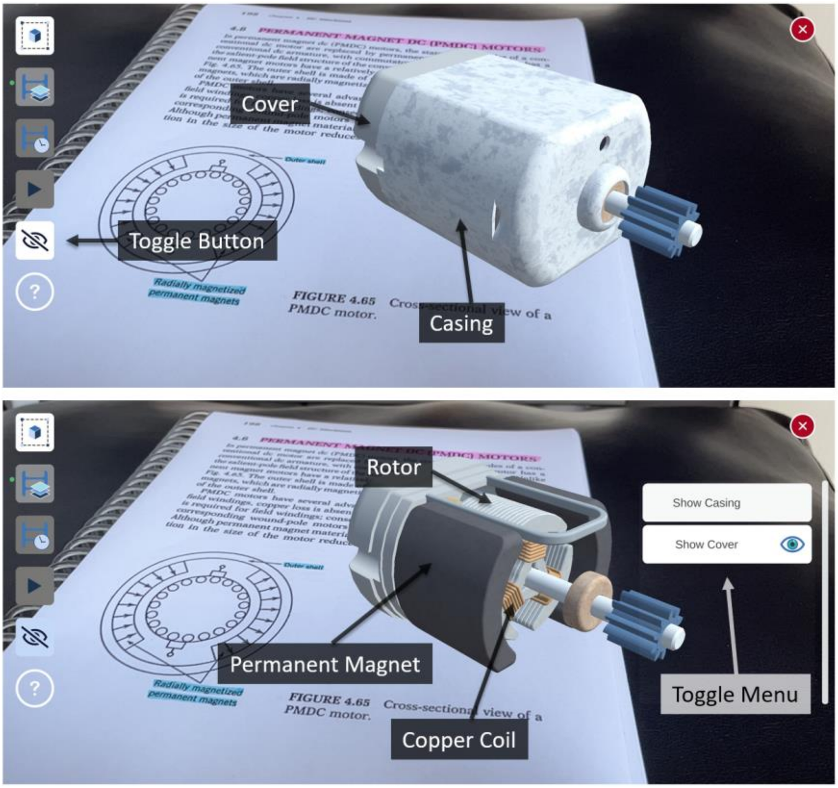

Figure 3. Case study A: DC motor viewed on the VisionARi mobile application

2.4. Case study B: CFD simulation data of a ship propeller

A second example module geared towards professional engineers is discussed next. In this module, computational fluid dynamics (CFD) simulation data of the fluid flow around a rotating ship propeller is considered. As Figure 4 shows, viewers can toggle through various types of datasets on the VisionARi mobile application, such as the Q-criterion and the pressure distribution on the propeller surface (top) and slices of the velocity field (bottom).

Such scientific datasets can easily consume tens of gigabytes and usually require professional software and computing skills to process and interpret. With the VisionARi platform, educators would have the option to incorporate high-level scientific datasets into the classroom, with module files on the order of just a few megabytes.

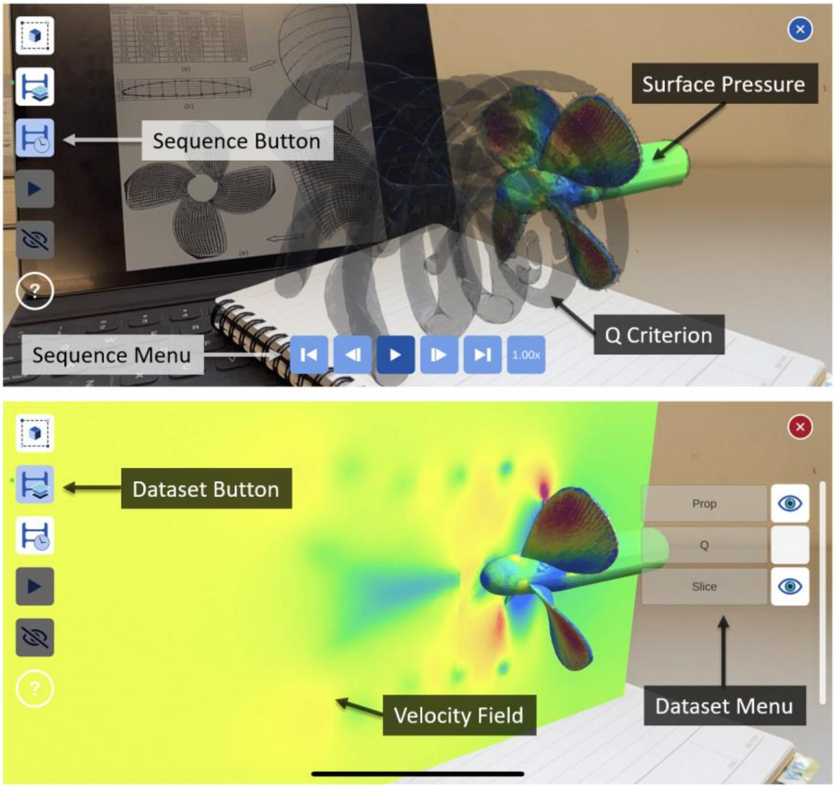

Figure 4. Case study B: Ship propeller CFD data viewed on the VisionARi mobile application.

3. Summary and outlook

In this paper, we have presented a fully integrated online educational platform, VisionARi, that aims to empower students and educators with a more technically accessible and more effective teaching tool based on augmented reality (AR). The VisionARi ecosystem achieves this by creating an active online community and by facilitating the use of various open-source tools to develop immersive content. By providing templates, short tutorial videos, and example modules, all within a unified framework, VisionARi empowers educators and professionals alike to create, share, and use AR content, without the technical and mass-adoption barriers that have traditionally hindered faster and wider adoption of immersive technology for education.

The VisionARi platform is currently being internally tested with various example modules, based on feedback from educators at the secondary and tertiary levels, as well as from professional designers and engineers. Currently, there are 23 individual beta-testers. The platform is planned for official launch in July 2022, beginning with a hands-on augmented reality workshop for highschool students, organised with a local international school.

While the current development of VisionARi focuses on AR content for mobile phones due to the maturity and ubiquity of smartphones, our platform can easily be scaled up to other immersive technology hardware as they mature in the future.

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