Toward Smart and Immersive Classroom based on AI, VR, and 6G

https://doi.org/10.3991/ijet.v18i02.35997

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Abstract—The technological revolutions greatly impact current and future Classrooms. These advances in technology include the revolution of artificial intelligence, virtual reality, and super highspeed internet. In the coming next generation (6G), the data rate will be very sufficient for live scenes in virtual reality applications such as telepresence and teleoperation. This paper review and discuss next-generation technologies in AI, VR, and communication. Moreover, we examine the motivation for establishing an Advanced Technology based Smart and Immersive Classroom (SIC) and the advantages of its availability to the virtual society. Recent advances in computer and communications technology have delivered capabilities to tomorrow's SIC. Advances in virtual reality and real-time streaming on the internet have created a revolution in curricula and classrooms. Index Terms—Virtual Reality in education; 6G for education, Artificial Intelligence in education, Immersive Classroom.

Keywords—virtual reality, virtual classroom, AI, virtual teaching, 6G in education, 6G for VR

1 Introduction

Today's education system is a rapidly changing environment due to successive developments in computation and communication systems [1]. The emergence of new technologies and innovations in virtual reality, artificial intelligence, and high-speed internet has advanced the classroom's interaction with the world [2], [3]. Therefore, the use of VR and AI in education has moved the traditional classroom to a classroom based on smart technology [4], [5]. Furthermore, the global job competition has dictated the progress in educational systems [6].

A reliable data connection is essential for a virtual classroom. Optical fibers and mobile networks are the highways for data, and in a fully connected, intelligent digital world, we need to connect everything, including students, to the world they are learning from. Sixth-generation (6G) wireless networks, which are currently in the advanced research phase, offer important developments that may be able to meet the full connectivity requirements of immersive classrooms in the future [7], [8]. The sixth generation (6G) is essential for virtual reality (VR) and the Internet of Things (IoT); Connecting several intelligent devices to the Internet. The authors of [9] study discuss 6G applications in virtual education and discuss common advantages in current and future technologies and applications.

Recently, virtual reality (VR) has become popular through head-mounted displays (HMDs) of both computer-powered and smartphone-powered headsets [10], [11]. Virtual reality (VR) has become a major player in education. This technology takes students to the next level of immersion in education. the paper demonstrates how virtual reality technology maximizes student benefits from using virtual reality [12].

The authors of [13], presents their research in the field of virtual reality in education and they develop a collaborative education system with virtual reality. The system uses virtual reality, multimedia, and communication tools to support collaboration between students. In [14], the authors aim to examine how virtual reality can be used with telepresence robots to create inclusive classrooms that provide better learning opportunities for homeschooled students with special needs. In study [15], the authors present a telepresence system for distance education. The system follows an Augmented Distributed Reality (ADR) approach, in which students at home, wearing a VR head-mounted monitor, are immersed in a mixed reality scene consisting of a 360-degree realtime video stream of the classroom, a scrolling view of the hands, and additional information obtained through artificial intelligence. The system can assist students who have to attend class remotely.

Analytical research on the advantages of applying virtual learning is presented in the study [16].

This paper presents a review of Artificial Intelligence (AI), Virtual Reality (VR), and High-speed communication of the sixth generation (6G). We review these technologies of the past and provide supported imaginations of how they will be in the near future. Furthermore, we review and discuss next-generation technologies in AI, VR, and communication. Moreover, we examine the motivation for establishing an Advanced Technology-based Smart and Immersive Classroom (SIC) and the advantages of its availability to the virtual society. Recent advances in computer and communications technology have delivered capabilities to tomorrow's SIC. Advances in virtual reality and real-time streaming on the internet have created a revolution in curricula and classrooms. We explain how to integrate Virtual Reality, teleoperation, telepresence, Artificial Intelligence, and Internet-based learning technologies into a common framework for the (SIC).

The remaining sections of this paper are as follows. Section II covers some basics background information and some related work. Section III discuss virtual reality in classroom. Subsequently, section IV discusses artificial intelligence in classroom. Section V presents telecommunication for advanced technology in classroom. Section VI is discussion and suggestion. Finally, section VII present the conclusion.

2 Background information

2.1 Evolution of the use of artificial intelligence

The time periods for the development of artificial intelligence can be divided into four stages.

The First Stage: AI Birth, Concept, and Definition Which was established immediately after the end of the Second World War. It was started in 1950 by Claude Shannon, who founded the information theory with his search for the game of chess. The word Artificial Intelligence was officially used in 1956 when Marvin Minsky and John McCarthy hosted the Summer Research Project on Artificial Intelligence (DSRPAI) at Dartmouth College in New Hampshire. The workshop is the start of the AI Spring. The goal of DSRPAI was to bring together researchers from a variety of fields for the purpose of creating a new research area called Artificial Intelligence in order to simulate human intelligence [17], [18].

The Second Stage: Expert Systems. It is called the ROMANTIC stage, which extended from the mid-sixties to the mid-seventies when the scientist Minsky made frames to represent information and a system for understanding English sentences such as stories and conversations. The famous computer program ELIZA was created between 1964 and 1966 by Joseph Weizenbaum at the Massachusetts Institute of Technology. This program was an NLP tool capable of simulating a conversation with a human. In addition, Herbert Simon, a Nobel Prize winner, and the scientists' Cliff Shaw and Allen Newell of the RAND Corporation created the General Problem Solver program, which had the ability to automatically resolve a particular class of straightforward issues. In an interview with Life Magazine in 1970, Marvin Minsky predicted that it would take three to eight years to create a machine with the general intellect of the ordinary person. The developed system described above was made up of several "if-then" statements, or Expert Systems. Expert Systems struggle in fields that don't lend themselves to such formalization, though. For instance, it is difficult to train an expert system to recognize faces [19]. The above system is an expert system that performs poorly in training such as face recognition

The Third Stage: Machine Learning which is called the modern stage, which began in the midseventies and was characterized by the emergence of various technologies that dealt with many applications that actually led to the modeling of human intelligence. This period is considered the golden age of the prosperity of this science, which led to the emergence of many modern artificial intelligence systems, and the nucleus of technologies has crystallized Artificial intelligence which interacted with many branches of science [20], [21].

The Fourth Stage: Deep Learning. Artificial neural networks revolutionized in the form of Deep Learning in 2015. Deep learning discovers patterns in large data sets by using the back-propagation algorithm to indicate how the algorithm tunes its hyper parameters for optimal models. Deep convolutional Networks are the best for computer vision, speech recognition, natural language processing, engineering applications, and robotics [22], [23].

2.2 Evolution of the use of virtual reality

In the far past, people used to look at a painting on walls and imagine a three-dimensional world as a part of a story. The next step was to put the painting into motion. The action of stroboscopic apparent motion is the basis for today's motion pictures. Flipping fast through a sequence of images gives the illusion of motion, even at a low rate such as two or ten images per second. At higher than ten images per second, the motion actually appears to our eyes as if it is continuous.

The next era to staring at a rectangle painting is presenting a separate picture to each eye in order to induce a "3D" effect and increase the field of view so that the user is not distracted by the stimulus boundary. Human brains infer the distance of objects from the eyes by stereopsis; the perception of depth produced by the reception in the brain of visual stimuli from both eyes in combination; with binocular vision. In 1968, Ivan Sutherland constructed the first VR headset. As the user turns his head, the images presented on the screen are manipulated so that the virtual objects appear to be fixed in space [24].

In [25], To organize and direct eXtended Reality (XR) research in human perception, the authors suggest the founding principles of a new discipline called perception engineering. In order to comprehend how the perceptual experience itself may be built, perception engineering makes use of approaches from mathematical modeling, neuroscience, robotics, and perceptual psychology.

2.3 Evolution of communication networks

Recent years have witnessed unprecedented growth in Telecommunications. The tremendous impact of this sector has recently been studied in many types of research. Today, in parallel with advancements in computer and telecommunication technology, the demand for new methods for education is increasing. The smart classroom which utilizes emerging technology has become much easier and the interaction between students and class materials has become more and more intense [26], [27]. Broadly, telecommunications is categorized into Guided and unguided communications

Guided Communication Networks from dial phones to fiber optics. The telephone had as much of an impact on the twentieth century as the industrial revolution in the nineteenth century, and the industries associated with it have produced some of the most incredible technological advances in humanity. In 2003, phone calls were able to be transmitted through a computer and the Internet. Long-distance callers would use almost free already existing computer networks [28], [29].

Telecommunication advanced rapidly during the last century, and more rapidly during the last two decades. Alexander Graham Bell successfully invented the telephone in March of 1876. He made his first coast-to-coast telephone call in January 1915 with his assistant. It was the first long-distance call in history from a landline. In 1964, Charles Kao and George Hockam published a research paper that demonstrated that optical fiber communication could be possible. In 1983, the Internet was officially created and the Transmission Control Protocol/Internet Protocol (TCP/IP) became a standard [26], [30], [28].

Unguided Communication Networks from 1G to 6G. The mobile networks have a vast amount of development every decade starting in 1990 as shown in Table 1, the first mobile or first generation (1G) was characterized by using mobile phones, then digital cellular systems were developed in the second generation (2G), while the third generations of mobile communication began to use wide bands with higher speed of packet transfer rate to satisfy the transmission of videos. The fourth generation is characterized by using Orthogonal Frequency Division Multiplexing (OFDM) that implements multiple antennas transmission such as Massive Multiple Input Multiple Output (MIMO) technologies to transfer higher data rate applications. The fifth generation (5G) communication standards were completed in 2020 and it was characterized by the spreading of the internet everywhere and at any time with the proliferation of IoT devices and sensors causing the data traffic to reach 82 GB per user per year [31]. The use of Virtual Reality and Augmented Reality (VR/AR), smart self-driving cars, and new intelligent application systems which need higher transmission data rate and low time latency raises the tendency to develop 5G technologies into the sixth generation or 6G which is expected to deploy in 2030 [32]. The table summarizes the mobile network generations milestones which include technologies, Key Performance Indicators (KPIs), and applications. The infrastructure to satisfy these requirements requires fiber optic cable to install the antennas and boost the backbone fibers [33]. It is noted that the data traffic, security, power consumption, spectrum efficiency, and QoS are increased exponentially with the evolution of mobile network generations.

3 Virtual reality-based education

Technology is reshaping the future of education in today's environment of many prospects for innovation by continuously developing new tools and platforms for teaching and learning. Instead of using the virtual world, with virtual reality (VR), students and teachers participate in it [40,50,51].

Education is advancing as fast as the technology that is used to assist teachers and students. With high-speed internet, it is possible for graduate students to learn remotely with few face-to-face classes. Virtual reality, one of the most recent technological advances, offers students an immersive learning environment with interactive telepresence [49].

This study focuses on the "virtual educational experience" that the most recent technology offers, which combines audio and visual content with an immersive movement tracking and haptic feedback experience. Compared to what is currently available with the Classroom Management Software (CMS) programs used by the majority of remote learning institutions, this immersive experience is significantly more immersive. Classroom Management Software (CMS). The Blackboard suite is arguably the most popular CMS solution on the market right now. The most popular content management system (CMS) that enables teachers to upload course content in the form of PowerPoint presentations, videos, and other multimedia kinds is Blackboard. The student would enter into Blackboard and click a link to begin the VR class in order to use VR [40].

4 Artificial intelligence-based education

The AI tool is emerging as a solution for managing large amounts of data, especially for making predictions and providing suggestions based on the data sets. Applied AI such as Deep Learning (DL) is suitable for next-generation communication systems for training and prediction using cloud services such as google Colab, which makes it feasible instead of the need to buy an expensive GPU-based server [41].

With the recent fast development of AI, the application of AI-based robotics in teaching has attracted researchers to experiment with AI-based systems in education [52]. Several studies have shown that systems based on artificial intelligence or robotics can provide new opportunities for vocational training or academic purposes. The study analyzed the roles of AI-based robots as assistants to the teacher in the classroom, especially in language classes where most teachers lack the native correct pronunciation and accent. The fields of languages and science have benefited from the most application of AIbased robot research. This article offers various suggestions for educational policymakers and researchers working on AI-based solutions in the field of education [42,43].

5 Next generation communication technology for virtual reality in education

Multi-user VR environments and high-data rate wireless connections should be taken into consideration for the next generation of virtual reality (VR) devices in order to enhance the user experience. In this article, we investigate the viability of high-data-rate wireless VR. Devices for virtual reality (VR) can offer an immersive VR learning experience (SE) [11].

There have been significant efforts to enhance visual and audio quality, interaction delay, connectivity to VR consoles/computers, or remote robots such as telepresence and teleoperations in order to improve the SE of VR educational services. A wireless communication system with low latency should be employed for VR devices in order to create a comfortable VR service environment without the need for wires. The high-resolution features, however, put a strain on wireless bandwidth. Therefore, we need to find the ideal compromise between HD video quality and dependable Wi-Fi connections [44].

Table 1. Mobile network communications generations evolution

Network Generation	Technologies	Performance (KPIs)	Applications
First Generation (1G)	– FM modulation – FDMA access – Circuit switching	– AMPS spectrum – BW 30 KHz – Data rate 2.4 kHz generations\ [34]	– Voice
Second Generation (2G)	– GMSK modulation – TDMA/FDMA access – Circuit switching for voice – Packet switching text	– GMS 900 Spectrum – BW 200 kHz – Data rate 9.6–200 kbps\ [35] – Latency 300 ms	– Voice & Data
Third Generation (3G)	– QPSK modulation – WCDMA access – Packet switching	– UMTS spectrum – BW 5 MHz – Data rate 0.3–30 Mbps\ [36] – Latency 100 ms	– Voice, Data, Video call, and Multimedia
Fourth Generation (4G)	– QPSK, QAM, 64 QAM modulation – OFDMA access – Packet switching	– LTE spectrum – BW 1.25–20 MHz – Data rate 0.07–1 Gbps\ [37] – Latency 10 ms	– Voice, Data, Video call, Digital Video Broadcasting (DVB), and Video chat, High-Definition TV content and Mobile TV
Fifth Generation (5G)	– DWDM multiplexing – Next Generation Passive Optical Networks(NGPON)	– 3–300 GHz spectrum – BW 0.25–1 GHz – Data rate up to 20 Gbps\ [38] – Latency 0.5–10 ms	– Voice, Data, Video call, Digital Video Broadcasting (DVB), Video chat, VAR/AR/366 Videos, UHD Videos, V2X, IoT, Smart cities, and Wearable devices
Sixth Generation (6G)	– Terahertz spectrum band – AI and ML – Blockchain technology – Quantum Communication	– Spectrum efficiency 100 bps/Hz – Mobility 1000 Km/h – Data rate 1 Tbps\ [39] – Latency 10–100 µs	– Haptics communication – Massive URLLC – Unmanned mobility – Nano-IoT, Bio-IoT and Holographiccommunication

6 Discussion and suggestion

By utilizing deep learning, a robot can assist the class teachers in selecting students' personalized additional topics based on his/her level. For example, In English class, at the beginning of the academic year, the class can have a placement test in order for the robot to provide extra practice weekly material for each student to improve language and catch the class easily, or to provide more challenging material for those who have an equal or higher level than the curriculum.

English as Second Language teachers usually lacks the correct pronunciation and native accents, especially in India, China, Egypt, and other non-English native countries. Robots can assist the teacher in reading and conversation. In addition, robots can be an app or a website and can be customized for student level and organize a course series to assist in reaching a specific goal of English level. The robot can use speech recognition, speech synthesis, natural language processing, recommendation system, and reinforcement learning to teach the students the four skills; reading, writing, listening and speaking.

China has incorporated as much of the future technology as possible. One main area seeing an increase in Artificial Intelligence use has been in the Chinese school system. China has introduced concentration measuring headbands into their classrooms. The headbands are fitted with three electrodes, two above the ears and on the forehead. These three electrodes measure the electrical signals of the brain and compare them to patterns established when the child is resting to determine if they are paying attention or not. An LED indicator on the front of the headband alerts teachers to the mental state of students. Red means they are focused, blue means they are distracted, and white means they're offline. The data is refreshed every 10 minutes and sent to the teacher's computer so that they can make sure that the way they are teaching is engaging; more interesting and engaging instruction means students are distracted less easily. A low-class average in concentration suggests that there is something wrong with the teacher, and as a result teachers are motivated to work harder. Along with everything being recorded, teachers and students both were forced to be more productive and focused [45].

Virtual reality can be utilized in education in three scenarios:

- a pure simulation of a synthetic world,
- a recording of the real world, or
- a live connection to another part of the real world.

VR in education has a number of benefits. The main benefit of technology, according to research, is enhanced learning outcomes brought about through immersion [46]. Enhancing immersion, enhancing spatial abilities, promoting empathy, boosting motivation, and maybe improving learning outcomes are some of the advantages of VR in education. The consequence is that virtual reality technologies have been shown to have a huge potential for use in education and will be a crucial part of teaching and learning in the future [47].

VR makes it much easier to teach humanities like history, geography, and languages by visiting cities in different places and at different times. Instead of reading a book on the Pharaonic era in Egypt, you can roam the streets of that as they were area 3000 years B.C, in a simulation that has been constructed by historians. You could even visit an ancient city that has been reconstructed from ruins. In science, students can immerse themselves in anatomy and physiology instead of reading them from a book or even watching them in a video.

In medicine, Doctors can provide guidance through telepresence and use VR technology for training people to perform routine medical procedures in remote communities around the world. Through telepresence, people can try experiences through the eyes of robots. Experiences that are impossible (or perhaps deadly) in the real world.

One of the inspiring Examples of applying virtual reality in the classroom is Virtual Field Trips. Using VR for virtual field trips, students can virtually travel to various continents, countries, cities, historical sites, and cultures, while in the classroom. In addition, virtual field trips are a cost-effective option for schools, as students can fly anywhere in the world instantly. Furthermore, with immersive virtual reality displays such as ClassVR [48], students feel like they are in the place they are. This ensures the virtual trips are unforgettable learning experiences.

7 Conclusion

The study objective is to assist in the employment of artificial intelligence (AI), virtual reality (VR), and high-speed 6G networks in the classroom. The study provides a realistic picture of how artificial intelligence and virtual reality can be applied to enhance the educational process. The paper discussed the utilization of artificial intelligence, virtual reality, and high-speed networks in the classroom. Virtual reality refers to interactive content (photos or videos) that enables the viewer to explore 360 degrees of the entire scene. Virtual reality is becoming part of the classroom as more and more schools are embracing technology.

Virtual reality allows students to experience destinations from all over the world without ever having to leave the classroom. Imagine the students being able to explore the pyramids of Egypt without leaving their classroom. Experience can be live or recorded. Virtual reality can improve classrooms by providing students with unforgettable and immersive experiences that would not otherwise be possible. Moreover, it can all happen inside the classroom.

Using a robot with artificial intelligence to improve the learning experience for English language students and assist teachers in delivering their lessons. AI can be used in the classroom to improve the process of teaching languages. By practicing with students and utilizing voice recognition and speech synthesis skills, the robot may concentrate on teaching pronunciation and boosting fluency. Additionally, it emphasizes the personalized method of language acquisition by employing a Chabot that offers conversions like textto-speech and speech-to-text while utilizing technology to practice communication. Therefore, the article looks at how AI might be used in education, and language acquisition specifically. It also looks into the potential effects of artificial intelligence in learning environments that use novel teaching strategies.

8 References

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Article submitted 2022-10-12. Resubmitted 2022-11-13. Final acceptance 2022-11-15. Final version published as submitted by the authors.