**CHAPTER**

**8**

# AMBIENT COMPUTING ADOPTION APPROACH FOR MILITARY EDUCATION TRAINING COMMAND SYSTEM

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* 1. **INTRODUCTION**

Learning management system is a method or system that base on teaching with help of electronic devices or electronic resources, the use of computers and internet become a major component in learning management system. Military also has its own learning management system named as Military Education Training Command System. This platform is used to train officers and non-officers in all fields or tread that related to military. Most of the courses are conducted in class and on the field. Currently learning management system is a secondary and alternative method of learning compare to face-to-face classes.

Military Education Training Command System has proved to be the best training method during COVID-19 pandemic and military field take a step ahead by developing a complete learning management system to fill the gap due to pandemic.

Basically, Military Education Training Command System can be divided into three type of learning which are Text Driven, Interactive and lastly Simulation [2]. Now era of computing with the development in information technology, information system, software and computer engineering, military generally need a new innovative concept of learning. This future system training is known as Game-based learning. This learning concept is referring to the certain gaming principle with applying a real-life setting to engage users. The material of game-based training is comprehendible when placed into an enjoyable atmosphere. It also encourages productive discussions among members of groups, this meaning the trainees. Games-based training provides an opportunity to be creative and innovative and this will lead to be more fantastic and fresh ideas, plus it is more fun and adaptable to the younger generation.



**Figure 8.1** Example of Extended Reality (ER), Virtual Reality (VR) training

The implement of extended reality (XR) technologies such as Virtual Reality (VR), Augmented Reality (AR) and mixed reality (MR) have a massive potential in the military readiness, safety preparedness, training and education. This method as complement to existing learning management system that enables self-paced and individualized training. This can be referred to Figure 8.1. Currently, materials mostly are digital notes, videos, quizzes and contents are upload in the learning management system. It is a quick and easy process but it lacks an interactive element with students.

Game-based training utilizes and stimulates their senses by including haptic gloves that impart resistance to portray the sensation of forms, textures, stiffness, impact, and resistance in virtual reality (VR) instruction. This system also capable for instructor to structure XR curriculum as game to be more alike conventional technique, the scenario creation will be real time working environment on board ship environment. Example student run a scenario that the objective is to conduct engine oil change for Ship’s Diesel Engine where he must follow the right procedure to complete the process. He will learn trough repetition and error until he is correct and feeling confident. In reality, changing diesel engine oil is costly and expensive because it is consumed lots of engine oil and component parts. The implement XR in training will close this gap and student can keep continue hone their skills and knowledge. Besides that, this system only can be access using close network based on cloud technology because of confidential data inside military ship.

5G is another exciting technology that can be combined with XR. XR requires the high speeds and low latency that are defining characteristics of 5G networks. Edge and cloud computing designs provide for more efficient and cost-effective implementation, but the process requires large amounts of data closer to end users. This is handled by XR applications by dividing processing effort across devices and the cloud.

The objective of this paper is to discuss how computing sub-discipline would help in development of future system as mention above. There are few sub-disciplines can be discussing further such as cyber security, data science cognitive technologies and few others, but we only focus on ambient computing. The details are discussion in section Computing Sub-Discipline.

**8.2 RELATED WORKS**

XR provides an effective way for training and experience especially in education nowadays, and the term AR and VR is not a new technology. The first VR headset was created in 1970s by Daniel Vickers at University of Utah, with two screen and headset he setup the first VR concept [3]. In 1982 the new device known as DataGlove was developed that able to measure the hand and finger movement and connected with computer.

The term Virtual Reality (VR) was proposed by Jaron Lanier in the 1980s in the United States [4] while augmented reality (AR) was invented by researchers Thomas Caudell and David Mizell in 1990.

Over the years VR technologies have evolved. In 2014 Google proposed a model VR helmet in Google Cardboard that can be used with a smartphone. Subsequently, Samsung introduced its Gear VR a mobile version that connects headphones to a computer or game console, and made it available in the market in 2016. This technology is expected to expand further with the accessibility and power of computers, smartphones, internet speed, programming language, and improvement of picture or video quality. A few years ago, what VR provides now was nearly technically impossible. Thus, the capability of head tracking has been significantly enhanced, and the usage of virtual reality helmets is now feasible. According to the American business journal Forbes, the XR industry is projected to reach $209 billion by 2022, which is eight times more than it is currently. Thus, it indicates that the future reality will be beyond the expected. Recent research conducted by Forbes revealed that more than sixty percent of respondents anticipate XR to become mainstream within the next five years.

Virtual reality applications have been developed at NASA/Marshall Space Flight Center (MSFC) since 1989 with the goals to create, evaluate, validate, and utilize VR in hardware, operation development, and to support mission, operation, and training. Example application is Virtual Tunnel that developed by NASA at NASA Ames Research Centre, the scientists have opportunity to used data glove as input and manipulate the streams of virtual smoke with a digital airplane model or space-shuttle. The designing and building space-shuttle model are complicated and expensive process, applying VR in system and development help scientists to visualize in three-dimension spaces about their new space-shuttle model shape affected to air stream flow without need to build exact model. This indirectly can improve their experience and save a lot of resources in term of money and time.

Virtual GloveboX is another existing system that relates to the training (VGX). VGX was created to aid astronaut training and sophisticated experimentation in the Space Station Glovebox [5]. VGX is proposed to integrate ultra-high-resolution imaging, force feedback devices, and real-time computer simulation to provide a realistic environment. This technology simulates real-time and delivers a 3-D virtual environment that mimics the actual Life Sciences Glovebox (LSG) environment for astronauts, with the option to toggle gravity while they are still on Earth. Besides that, VGX also combines all modules to fully prepare the astronauts, these modules such as aerospace flight simulator and medical simulation system.

Base on existing system that have been developed by NASA are related to the propose system for military, this new system have a massive potential to be include in military training with extended and mixed reality for user experience.

**8.3 COMPUTING SUB-DISCIPLINE**

In this section we will discuss Ambient Computing helping in the development of Game-based learning for military. Before we go deep further about ambient, what is ambient computing? Ambient computing is the setting of sensors, device intelligence and agent that can put the Internet of Things (IoT) to work [7]. The concept ambient already introduced by Mark Weiser in vision of ubiquitous computing, this term refers enhancement computer by making many computers available in physical environment and invisible to user [8]. The ambient computing is required capability to integration information flow between varying types of devices from wide range of data and technologies [7]. There are few factors must take into consideration when discuss with ambient computing and the propose system.

**8.3.1 Connectivity Technology**

The first factor is about connectivity and network technologies. As we know XR and ambient computing requires high speeds connectivity, low latency and greater bandwidth with real-time data. Ambient computing is relying on connection that enables all devices to communicate effective and efficiently. The evolution in network technology from previous generation to 5G, we can see the advance in data transfer up to 100 times faster than 4G, added with network development in control and routing, information processing and security make this thing possible to be implemented.

Communication history started with cave paintings, pictograms, handwriting printing, and recently telecommunication and the internet. Communication also evolved according to time, before the invention of the internet and mobile phones. People communicate using telegraph and telephone. Telecommunication involves microelectronics and computer technology to send, receive, and switch speech data and visual communication via many transmission media [16]. In 1844 Alfred Lewis Vail and Samuel Morse have develop a system for sending and receiving coded electric signals over a wire, this device known as telegraphy. The internet started in the 1960s for information sharing between computers as solution internet was invented, with introduction of internet has revolutionized in computer and communication technology until today. Now the tern Internet of Things is use when relate to extension of internet and web and this has result in the growth of Ambient Computing [17].

In order to implement the propose system in military with ambient computing concept, first it should upgrade current network facilities and ensure this network coverage cover the whole naval bases. It also can optimize the use of X-Band to connect with their ships or others mobile platform. The combination of ambient computing with intelligent and propose system will help education and training centre by assist in customized learning path and specific coaching or training for each students, it is because the system understand the need and user requirement.

**8.3.2 Security and Privacy**

The second factor is security and privacy risk issue, these are keys to be taken as consideration when the system is connected to Wide Area Network (WAN) or Local Area Network (LAN). National Cyber Security Agency (NASCA) as Malaysia Cyber Security Strategy also state that anything connected to the internet is exposed to cyber risks. The objective is to ensure the propose system is secure from intrusion whether inside or outside network. While privacy is deals on how we properly handle and manage confidential or sensitive data. The intrusion is unauthorized activities which involve stealing network resources or data information.

Cyberattacks are becoming increasingly complex and difficult to detect. Therefore, slow and ineffective prevention of an intrusion could diminish the security's trust in terms of data confidentiality, availability, and integrity [18]. According to the Symantec Internet Security Threat Report, higher than three billion attacks were recorded in 2016 compared to the previous year, and hackers have stolen nearly nine billion data records since 2013. In 2019, during a meeting of the e-Sovereignty Committee, the Malaysian Ministry of Communication and Multimedia resolved to introduce a cyber security act in order to limit intrusion activities.

The NETC as training centre is responsible in managing military education system and part of Armed Forces (AF), all information and data are confidential because it involves with national security and defense policy. It is a requirement for NETC to ensure this data are handles and manage properly. System admin also must take necessary precaution by always keep software up to date and ensure there is no week points occur. Opportunities in the use of ambient computing are exciting. But we need to ensure security and privacy are carefully considered in propose system design, so we can confidently employ these impactful technologies in future.

**8.3.3 Artificial Intelligence**

As a competitive requirement, new products frequently incorporate intelligence, and the revolution is already well under way. People can access all electronic devices anywhere and anytime with embedded electro-domestic appliances and users do not to be computer expert or specialist to operate or use these devices [9]. Now most of sensors and computing devices are better performance and become smaller and lower cost, all these devices are embedded with intelligence capability to collect information, detect patterns and predict behaviors. According to Deloitte Insights website estimate about 11 billion sensors are currently deployed on production include vehicles, containers, offices, and homes equipment’s. The exposure of Ambient Intelligent (AmI) enables the system to make decision according to situation and base on real time information [9]. Implement of propose system can refer Smart Home as model, for example Smart Home contains with sensor and AI to control light, temperature, door and others equipment base on occupant in the room, besides that this sensor also can give notification or reminder to alert user.

The AI technology believes has begun early 1950s, it started with well known Turing Test by Alan Mathison Turing an English mathematician, computer scientist and theoretical biologist [19]. Alan Turing known as father of modern computing, he use universal calculator known as Turing machine to proved machine is capable to solve any problem as long as it can be represented by an algorithm. The Turing Test is a simple method to determine the intelligence of machine whether the machine capable of thinking. In 1996 Deep Blue build IBM supercomputer is first chess computer that able to beat chess world champion Garry Kasparov in a match and AI start to get attention of world public.

**8.4 RESULT AND DISCUSSION**

In this section we will discuss disruptive technology and how these technology help in the development of propose system. First, we must understand what disruptive technology is about, historically this term was developed in 1990s by business professor Clayton M. Christensen, it is based on case studies to explore why successful firms failed when confronted with technological change [10]. Finding of this case study conclude that good firms are supposed to listen to customers need and improve their existing products to meet customer demand and also take into consideration to include others non-consumer need.

**8.4.1 Cloud Computing**

Cloud Computing is a subclass of IT service that is dynamically scalable, elastic, and based on virtualized resources [11]. There are numerous cloud computing service providers on the market today such as Amazon Web Service (AWS), Microsoft Azure, Google Cloud, IBM Cloud, and Oracle. All services are demand-based and pay-as-you-go. There are three types of service model examples in AWS. The user can choose between Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS), and each model has its own benefits.

 The Cloud Computing, the word “Cloud” is referring to carrier or provider that provides the services over the internet and “Computing” mean the processing or computations or calculation that are provided by computer [20]. The concept of cloud computing was introduced by John McCarthy in 1961. The first company start with concept of cloud computing is Salesforce in 1990, this company start with providing SaaS which provides customer relationship management for its users. Salesforce is an American cloud base software company that founded in 1999 at California.

Suggestion NETC can apply AWS services by selecting PaaS service. This allows organization to focus on the deployment and management of application. Other than that, resource procurement, capacity planning and software maintenance are also not to be concerned. In PaaS, AWS is responsible on platform to manage and handle all related hardware and operating system. This gives advantages to organization by stop spending money on running and maintenance data centers and avoid guessing infrastructure capacity.

**8.4.2 Machine Learning**

Other disruptive technology that can be considered is Machine Learning (ML). ML is a subclass of artificial intelligence (AI) that enables computers or teaching machines to make intelligent judgments based on all past data [12]. Teaching and training have traditionally been based on measurement and outcome, but current educational practices have become dynamic components of the learning process.

The ML is referring to idea of Frank Rosenblatt an American psychologist base on idea about the work of human nervous system. He et al. builds a machine known as “perceptron” which to recognize the letter of the alphabet Rosenblatt, thus this machine becomes a prototype for modern Artificial Neural Network (ANN) [22]. This modern ANN was close to animal and human learning development in psychology. ML is often referring as AI but in reality, it is a part of AI evolution.

 ML becomes new technique in education and it is a main role in AI and human interaction. Example ML able to track student’s progress and also adjust the courses respond to student’s capabilities then give feedback to instructor or provide suggestion for improvement for high-quality training in future. Feedback from ML, instructors can understand further about student potential, interest and weakness, thus instructors can customize and personalize their teaching technique accordingly.

Lastly ML algorithm combines with others computing technology such as ambient computing can improve scalability and efficiency, and this can be summaries that the disruptive technology as innovation that can change how consumer, industries, business and education operate. A disruptive technology sweeps away the old system and habits and replace with new concept.

**8.4.3 Automation and Robotic**

Automation and robotic technology also part of disruptive technology and this technology seem to evolve rapidly. It is believed in future robotic will become vital components in a number of application and robot will comprise with AI and able to perform complex action and capable to learning from human and driving intelligent automation [13]. As technology progresses, in 2005 about 90% of robot can be found in assemble and automotive factories and most of these robots consist of mechanical arm. Robotic can be refer as programmable machine that is build to assist human or mimic human actions.

The term of “robot” is believing origin from Czech word “robota” which mean “heavy work” or “forced labour”, this is base on Czech writer Karel Capek in his novel “Rossum’s Universal Robots” [21] in 1920. Meanwhile word “Robotic” was first introduce by Isaac Asimov a writer and professor of biochemistry in his novel “Runaround” in 1942. In his novel he had defined three rules concerning the robot behavior and interaction between human. The first robot is known as “Unimate” originally invented by George Devol in 1950, in 1961 he and Joseph Engleberger successfully produce and market the robot. The Unimate is industrial robot base on hydraulic system which is a single task.

Today all sector starts to apply robotic to almost all of possible field with conception that the emerging technologies that could deal with any task, example of robotic field are healthcare, medical and surgery, military, entertainment, environmental, art, industrial and others [13]. The successful of this technology in our living environment will be determined by the successful of integration process such as distributed network architectures, human-robot cooperative systems and other assistive technologies like ambient assist [14].

As suggestion robotic technology can be applied into education system by automate in installation, maintenance, construction, operation and others and other process that are critical and unsuitable for human. This technology can be concluding as a complement to current or future system development.

**8.4.4 Big Data**

Discussion about disruptive technology not complete if we not include big data, we have seen how technology evolves since creation of mechanical computer until IoT. A decade ago, online activity cause data from IoT and mobile device create a massive pool of data in network. Most companies are using big data to analysis market trends, with this finding they can determine customers need and risk pattern in order to maximize their profit.

The term of “Big Data” refer to the mass of digital data which characteristic are large volume, difference form and speed of processing and required specific and sophisticated computer storage and analysis tools [23]. Big Data Analytics is the act of collecting, organizing, and analyzing massive amounts of data to identify patterns and other useful information. All this term is introduced by Roger Mougalas director of market research O’Reilly Media in 2005.

These days most of web Service Company such as Facebook, Twitter, eBay and Amazon already optimize technology big data and most of these company use open-source software utilities which is known as Apache Hadoop. As suggestion for NETC as nonprofit organization can make use of this technology in design and develop game base training system.

**8.5 CONCLUSION**

In this chapter, we have review and describe the future VR system that base on gaming training to stimulate sense by adding element feeling of impact, shapes, textures and stiffness using haptic glove. We also highlight an essential component of ambient computing that give impact to new propose system, besides that this paper also discuss on previous related work that related with VR, AR and XR technology especially in education. Lastly, we also discuss briefly the disruptive technology that allows or enable the development of new VR future system.

As for conclusion the VR approach has revealed with added value of game-based mechanics able to create a meaningful learning experience. While military takes a step in upgrading infrastructure and education via the game-based VR approach, similar technology has been used and available in other industries too. People do learn faster from games by effective techniques, processes, and procedures that reliably to achieve intended instructional objectives.

**ACKNOWLEDGEMENT**

This work was funded by the Ministry of Higher Education of Malaysia under Fundamental Research Grant (FRGS/1/2021/ICT01/UTM/02/1)**.** We also thank to the Malaysian Armed Forces (MAF) for scholarship funding of this Master's Degree study.

**REFERENCES**

[1] C. Christou, “Virtual reality in education”. Cyprus, February 2015.

[2] A. P. Chitra, and M. A. Raj, “E-learning”. Phoenix Research Publishers India, pp. 11-13, April 2018.

[3] E. Noureddine, “Augmented reality and virtual reality in education. myth or reality?”. Morroco, pp. 234-241, 2019.

[4] P. Fuchs, G. Moreau, and P. Guitton, “Virtual reality: concepts and technologies”. BocaRaton: CRC Press Inc, 2011.

[5] J. P. Hale, “Applied virtual reality research and applications at nasa/marshall space flight centre”.

[6] J. Smith, A. Twombly, C. Bruyns, S. Wildermuth, and R. Boyle, “Nasa virtual glovebox (vgx): advanced astronaut training and simulation system for life science experiments aboard the international space station”. American Institute of Aeronautics and Astronautics USA, pp. 1-8, 2001.

[7] A. Daecher, and T. Galizia, “Ambient computing putting the internet of things to work”. Deloitte University Press, pp.1-11, 2015.

[8] M. F. Khalfi, and S. M. Benslimane, “A framework for ambient computing”. Proceeding of the 4th International Conference on Cloud Computing and Services Science, pp. 170-178, April 2014.

[9] J. C. Augusto, “Ambient intelligence: basic concept and applications”. Conference Paper, September 2006.

[10] D. Cressman, “Disruptive innovation and the idea of technology”. pp. 17-39, June 2019.

[11] M. Carroll, A. V. Merwe, and P. Kotze, “Secure cloud computing benefits, risks and controls”. Information Security for South Africa, 2011.

[12] I. T. Nafea, “Machine learning in education technology”. IntechOpen, pp. 175-183, 2018.

[13] L. Pagliarini, and H. H. Lund, “The future of robotic technology”. Journal of Robotics, Networking and Artificial Life, vol.3, pp. 270-273, March 2017.

[14] T. T. Bock, T. Linner, and S. Y. Lee, “Ambient integrated robotics: new approach for supporting elderly people with integrated technology in living environments”. Robotik, pp. 838-841, 2010.

[15] I. Zakari, “History of computer and its generations”. Nigeria, pp. 1-17, October 2019.

[16] Pearson Higher Education, “Telecommunications evolution and future”,https://www.pearsonhighered.com/assets/samplechapter/0/1/3/0/0130281360.pdf

[17] C. Tsirmpas, A. Anastasiou, P. Bountris, and D. Koutsouris, “A new method for profile generation in an internet of things environment: an application in ambient-assisted living”. IEE Internet of Things Journal, vol.2, pp. 471-478, December 2015.

[18] A. Khraisat, I. Gondal, P. Vamplew, and J. Kamruzzaman, “Survey on intrusion detection systems: techniques, dataset and challenges”. Springer Open Cybersecurity, pp. 1-22, 2019.

[19] M. M. Majwil, “History of artificial intelligence”. Baghdad. pp. 1-5, April 2015.

[20] J. Surbiryala, and C. Rong, “Cloud computing: history and overview”. 2019 IEEE Cloud Summit. pp. 1-7, August 2019.

[21] A. Gasparetto, and L. Scalera, “A brief history of industrial robotics in the 20th century”. Scientific Research Publishing. pp. 24-35, 2019.

[22] A. L. Fradkov, “Early history of machine learning”. IFAC Conference Paper Archive. pp. 1385-1390, 2020.

[23] Y. Riahi, and S. Riahi, “Big data and big data analytics: concept, types and technologies”. International Journal of Research and Engineering, vol .5, pp. 524-528, 2018.