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Research paper



A New Model on Mixed Reality for 3 Dimensional (3D) Geospatial Terrain in Enhancing the Situational Awareness amongst Military Decision Makers'

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Abstract

Decision making process in military require military who are capable and highly skilled of having a complete set of skills in making decision as well as situational awareness (SA). However, the ability and skills the decision maker have are not sufficient without an efficient and effective interaction and control between the equipment and decision maker in conducting an operation. In this day and age, people are exposed to mixed reality concept in line with the growth of software application technology where people started to demand on their needs for applications used. In fact, software application have shown a rapid development in computing technology world regarding processing power, memory capacity and battery life simultaneously with the new technology supplied such as improvement of the connectivity, external peripherals, GPS and location-based services. This paper proposes the implementation of mixed reality technology specifically in design on 3 Dimensional (3D) geospatial terrain to conduct the military decision making in an operation. The research was carried out to determine the appropriate elements and features of mixed reality for this application consists of anything containing pure or virtual elements, mixed reality space and interaction, reaction, and interaction within 3D mixed reality object. This mixed reality application is considered to provide an effective and efficient 3D map that can interact and control for military operation. Usability testing is selected to conduct the experiment in an open area, assigning the test participants as clients and the evaluator to observe and collect data from the participants. In summary, the research proposes a mixed reality for 3 Dimensional (3D) geospatial terrain in enhancing the situational awareness amongst military decision makers'.

Keywords: *Mixed Reality, 3 Dimensional (3D), Situational Awareness, Military Decision Making.*

1. Introduction

Military operation usually takes place in the coordinate on the map. Military staff need a map in the operation because map is important as a survival tool in a terrain. As Mark Monmonier state in his research paper, map is as important as other weapon in an operation as a tactical weapon for the military to counterintelligence and political propaganda1. Army needs to record everything when they discover new thing in a terrain into a map. Accuracy and details is important in sketching map. Map is also used as a strategist planning for military to locate the position of opponent forces, planning operations, accuracy of two distance, places, heights and selecting the best route.

Information such as locations and distances about a places is great for travelling and communication in a battlefield2. Direction selected must vary with time and location when an operation is planned. To make sure that the operation is precise in term of time and place, all soldiers must have the ability in map reading. By giving some significance on the infrastructure during military operation, it can minimizes the loses3. It is important that every cadets need to have the knowledge to understand and use map since it can help in knowing the route and their current position.

In military, it is important for cadets to know how to plan a tactical movement and making decision. Global Combat Support System (GCSS) – Army improves commander's' situational awareness, facilitating decisions using the latest information 4. Terrain map especially in 3 Dimensional (3D) object will enhance the visibility of decision makers' specifically on the physical features of an area which highlight the locations or geospatial topography; shape of mountains, valleys, network streams, river banks and the locations of man- made features such as trails, roads, towns, boundaries and physical buildings.

The primary goal is to describe the state-of-the-art for a typical digital terrain modelling workflow that starts with data capture, continues with data pre-processing and DEM generation, and concludes with the calculation of one or more primary and secondary land surface parameters5. The 3 Dimensional map should be same as the physical environment to make it easy to use and understand. Also, soldiers manage to understand the instruction given by the map and aware of the surrounding scenario. The 3 Dimensional object should follow the physical rule which mean the object should have weight, effect and depth like the physical object.

This such information will enhance the situational awareness amongst military decision makers' in order for them to move or locate any decided strategies such as the scenario of army and

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supplies along a paved road than across a series of brush-covered hills and valleys. To be able to make decisions, the operator must be able to project how the situation is going to evolve into the future6. By using 3 Dimensional, all data recorded from the real world experience will helps military to decide which path do they preferred. In one embodiment, part of the registration process may be to provide details regarding each faction to the new user to facilitate their decision7.

The decision made will be precise and have strong argument and data support. Furthermore, there are difficulties on describing the map terrain using the piece of paper with the limitation of image visualization. Also, paper based map will need some storage space to keep it. Taking these points, the development of 3D Geospatial Terrain will be helpful in terms of situational awareness (SA) and interaction amongst military decision makers' besides eliciting the limitation of visualization. Freezing the camera image (mobile AR view) when desired, while keeping the overlaid graphics live, support manipulating the interface and visualization without having to keep the device pointed at the scene.

Once the display is frozen, direct manipulation (e.g., touching the screen to show information) is useful8. This research will study the nature of military decision making and the capabilities of mixed technology in virtual reality and hologram in order to enhance the effectiveness of situational awareness (SA) amongst decision makers' and the human-system interaction during the brainstorming of Course of Actions(COAs) parameters. The crux of this research is to provide an effective ways of comprehending the 3S Geospatial Map Terrain to provide an effective and efficient ways of comprehending the 3D Geospatial Map Terrain while applying the technology of mixed reality in the process of military decision making.

2. Problem Statements

The current method of comprehending maps consume a lot of time and works to be done. This is due to the time constraints to make the appropriate decision at the right time. The maps vary greatly in degree of detail reflecting the amount of time spent during the original mapping, and the availability of helicopter support in the different areas9. The development of mixed reality will provide advantages to the military decision makers'. The entry in the legend is placed under the time of formation and not under the time of reworking, as on the original paper map sheets10.

The necessity of sketching the topography with the limitation of visualization images will be the drawback of the whole process in military decision making. The technology of mixed reality will boost up the visibility of important details in terrain geospatial, precise location based ratio in timely manner. The data or important details need to be communicate effectively amongst decision makers'. Interestingly, such devices will promote the design of interactive maps, without the need to superimpose raised-line paper maps. Thus, the future of maps may forego paper11.

The limitation of medium in current scenario will give disadvantages to the military decision makers' in terms of emphasizing the major factors in COAs and visualizing the scenarios. Moreover, VRM enables demonstrating features, functionality and other product attributes, creating a more immersive dimension of storytelling, increasing trust for the brand and therefore, enabling faster decision making for consumers – to mention a few of the characteristics12. The beauty of mixed reality which comprises of virtual reality and hologram technologies create virtual and immersive surrounding in military decision making process. Therefore, audio was added with the use of a separate sound system in order to create a more immersive experience13.

The current method of making decision can affect the situational awareness when cadets in a terrain. Cadets cannot see what is ahead of the because of the limited vision and this may lead to time consuming to make a decision. They have to consider every details to prevent them from facing any problem during operation.

3. Research Questions

This research has been conducted based on the following research questions which are how these elements or features in mixed reality can help in decision making process for military in a terrain? What are the appropriate elements or features in mixed reality in developing the new model of 3D geospatial terrain? How does military decision making are effected when using a new model of 3D geospatial terrain with the elements situational awareness (SA) are applied and interaction of mixed reality? How effective is the new model on mixed reality for 3 Dimensional (3D) geospatial terrain in enhancing the situational awareness amongst military decision makers'?.

4. Research Objectives

This research will embarks four objectives which are to analyses the appropriate elements or features in mixed reality which comprises of virtual reality technology and holograms technology for 3D geospatial terrain.

To propose the appropriate elements or features in mixed reality that will enhance the visibility of decision makers. This elements are taken from an article call Mixed Reality for Robotics written by Wolfgang Honig and his friends in 2015. The elements that appropriate for mixed reality 3D geospatial terrain are anything containing pure or virtual elements. Mixed reality creates a space in which both physical and virtual elements co-exist, allowing for easy interaction between the two. This enables elements in one world to react directly to what is happening in another via direct data communication as opposed to a reconfiguration or modification of existing components. Since users can select which elements are physical and which are virtual, a number of different experiments can be performed based on various constraints and environments. Those object are able to interact with each other and with elements from the virtual environment. The environments themselves can be protected, closed environments to accommodate physical elements that pose a safety hazard, or allow for the installation of special equipment (such as a motion capture system) necessary to complete the physical-to-virtual communication link. Because MR makes direct interaction between the virtual and physical worlds possible, there is much flexibility on which elements exist in the physical world and which can exist in the virtual world.

To develop a new model with the key elements are the situational awareness (SA) and interaction applying the mixed reality for 3D geospatial terrain in military decision making. Develop the model by using selected elements needed for it. Test the usability of the model on cadets. Analyses data collected and respond from the cadets.

To design and develop the prototype version based on the verification of the proposed model. Develop a new model based on the data collected and respond from the cadets to make a solid model.

The Table 1 below has outlined the relationship between problem statement, research question and objectives.

Table 1: Description of problem statements, research questions and objectives

Problem statements	Research questions	Objectives
The current method of comprehending maps consume a lot of time	How can these elements or features in mixed reality can help	To analyses the appropriate elements or features in mixed

and works to be done.	in decision making process for military in a terrain?	reality which comprises of virtual reality technology and holograms technology for 3D geospatial terrain.
The necessity of sketching the topography with the limitation of visualization images will be the drawback of the whole process in military decision making.	What are the appropriate elements or features in mixed reality in developing the new model of 3D geospatial terrain?	To propose the appropriate elements or features in mixed reality that will enhance the visibility of decision makers.
The limitations of medium in current scenario will give disadvantages to the military decision makers' in terms of emphasizing the majors in COAs and visualizing the scenarios.	How does military decision making are effected when using a new model of 3D geospatial terrain with the elements situational awareness (SA) are applied and interaction of mixed reality?	To develop a new model with the key elements are the situational awareness (SA) and interaction applying the mixed reality for 3D geospatial terrain in military decision making.
		level-1 heading, left-justified reference heading acknowledgement heading
The current method of making decision can affect the situational awareness when the cadets in a terrain.	How effective is the new model on mixed reality for 3 Dimensional (3D) geospatial terrain in enhancing the situational awareness amongst military decision makers'?	To design and develop the prototype version based on the verification of the proposed model.

5. Research Scope & Limitation

The research for the new model on mixed reality for 3 Dimensional (3D) geospatial terrain in enhancing the situational awareness amongst military decision makers' will be focused on the interaction and effectiveness of the program design to help in decision making during operation. The scope of this research can be divided into user, hardware, software, and interface.

The users are selected amongst 50 undergraduate students majoring in computer science from Universiti Pertahanan Nasional Malaysia (UPNM), acting as clients. The evaluator give the clients use the program to see if it help them in decision making while does not neglect the situational awareness.

The users operate mixed reality headset to see the virtual reality and hologram in real time and real life. The HMD headset is operated by using Windows 10 Active User. Also, a specific laptop is used to develop this program which is VR ready. The laptop is OMEN by HP Laptop 17-an023TX.

The program is develop by using Unity Software and 3D Blender. Unity is used to make the interface for this mixed reality 3d geospatial terrain application. While 3D Blender is used to develop the 3D objects such as hills, stream network and town.

The mixed reality 3D geospatial terrain application is all based on Windows 10 Active User because this application is run on the HMD. The program is interactive. User can interact with it by using button and hand gestures. It consists of different font type (i.e. monospace, 12 sans-serif, and serif), font style (i.e. normal, bold, italic, bold italic), font size (i.e. 14pt), font color (i.e. red, green, blue, black and white), 3D objects (i.e. river and trails), and input gestures (button and motion gestures).

There are also several limitations obtained in this research which are respondents, power management, and mobile application brightness level.

The user is selected amongst the cadets to be the test participants to test the system. Since UPNM cadets were undergoing military training, they somehow have the experience and knowledge to implement in a situation that requires a process of decision making and reading map skills.

The motion controller is power on by using 4 AA batteries. Which means, it only last for a couple of hours. The evaluator need to change the battery to keep it turn on to give to the user to test it.

This research only focused on the brightness level of 50% for the application which providing a proper legibility as well as to minimize the use of battery power.

6. Research Significance

The development of mixed reality 3D geospatial terrain application will be a huge help for military in making a decision without neglecting the situational awareness (SA).

The significance of this research are the application may help in a better time management because it does not need to comprehend map during military operation, by using the appropriate element in this mixed reality 3D geospatial terrain application, military will make the decision faster.

The mixed reality 3D geospatial terrain will help military visualizing what is ahead of them. This is because the application provide 3D objects in the map and the appropriate elements and features that can enhance the visibility of the decision makers'.

The appropriate medium and technology is adapted in the application may give advantage to the military decision makers' with the key elements are situational awareness (SA) and interaction with the mixed reality.

The effectiveness of the mixed reality 3D geospatial terrain application can enhanced the SA in military decision makers' with the appropriate elements, features and time consuming.

7. Summary

The research that has been conducted mainly the analysis of Situational Awareness (SA) in military. The concept of mixed reality has also been imposed in this research. The effectiveness of elements and features in mixed reality are analyzed based on geospatial terrain. Moreover, the research objectives such as analysis of the appropriate elements or features in mixed reality, the validation of elements or features, the development of the new model based on SA and military decision making, and lastly designing a prototype based on the proposed model.

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