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THE SYNERGY OF MIXED REALITY (MR) IN REVOLUTIONIZING THE FUTURE COMBAT VISUALIZATION WITH GEOVISIONARY (GEO-VIS)

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ABSTRACT

Military or combat scenario require an efficient and effective interaction and communication in order for decision makers' to actively participate in conducting an operation or Course of Actions (COAs). Based on this fact, the leveraging of a powerful data engine with a virtual geological will enables decision makers to visualize, analyse and interact with large of geoscientific datasets. This research proposed the implementation of Mixed Reality Technology (MR) which include the technology of Holograms and Virtual Reality specifically on 3 Dimensional (3D) geospatial terrain as the tool and platform to conduct the strategies of military decision making in an operation. Symbiosis of military decision making nature with immersive 3D, real time environment may reduce the risk of death and serious injury during military operations. Hereby, this research will integrate the appropriate elements and features of combat visualization which consists of virtual elements; mixed reality space and interaction; reaction and interaction within 3D mixed reality object. At the end of this research there will be a porotype and verified framework to support the military decision making. The elements of combat visualization will be exploring to give positive impact on highlighting the important details during Course of Actions (COAs). The prototype (GEO-VIS) will give impactful to military community in order for them to make the most appropriate solution. GEO-VIS visually integrates terabytes of elevation and photography data covering a huge geographical area in real-time. It allows geospatial data such as geological models, environmental and GIS data to be visualized and interpreted creating an intuitive communication in virtual a reality.

Introduction

In military decision making environment, the comprehending of map is crucial whereby a map may provide all the geological information on the existence of the location; the distance between ground features as such populated areas; routes of travel and communication besides the variations in terrain. In map terrain, the parameters of natural features such as height and breadth will be stated. The military forces are heavily relying on maps to provide information and communication to combat elements and to resolve logistical operations.

Soldiers and materials need to be transported, stored and placed into operation or Course of Actions (COAs) at timely and proper place [1]. Much of these activities must be referred to maps. Adding to this point, the storage of maps also need to consider since the data privacy of location of COAs and details on tactical and strategies must be secured and protected from the other opponents of enemy. So based on this facts, the approach that will be counted in this research are as follows: i. Enhancement in comprehending and understanding the map in order to boost up the communication elements between Commander and sub-ordinate. ii. The features on the map that will be helpful in visualization of decision makers'. iii. The storage, data privacy and protection are needed in map terrain. iv. The accuracy of locations and features in map.

Besides that, the purpose of a map is to permit one to visualize an area of the earth's surface with pertinent features properly positioned. The map's legend contains the symbols most commonly used in a particular series or on that specific topographic map sheet by refer to Fig. 1. Therefore, the legend should be referred to each time a new map is used. Every effort is made to design standard symbols that resemble the features they represent will be a hard time for map makers [2]. Due to this, the military decision makers' need to have a powerful tool to assist them in map terrain so that process of making the map and comprehending the map will be less time consuming as in Fig. 2 [3-4].

The implementation of Mixed Reality Technology (MR) is a huge leap in geoscience visualization technology whereby this technology may have advanced data that can be visualized in seconds specifically in map terrain. The full richness of geospatial and geoscience visualization data can be presented in real-time and supported practically with Head Mounted Display (HMD) in visualizing all the elements in map such as topological areas; colours; geographic coordinates; grids include latitude and longitude; coordinates scales; directions and base line are all the elements in map that need to consider during the making and comprehending the map [5-8]. The ability of MR which included the Holograms for presentation purposes and Virtual Reality for visualization and virtually simulated environment are the crux elements in this research.

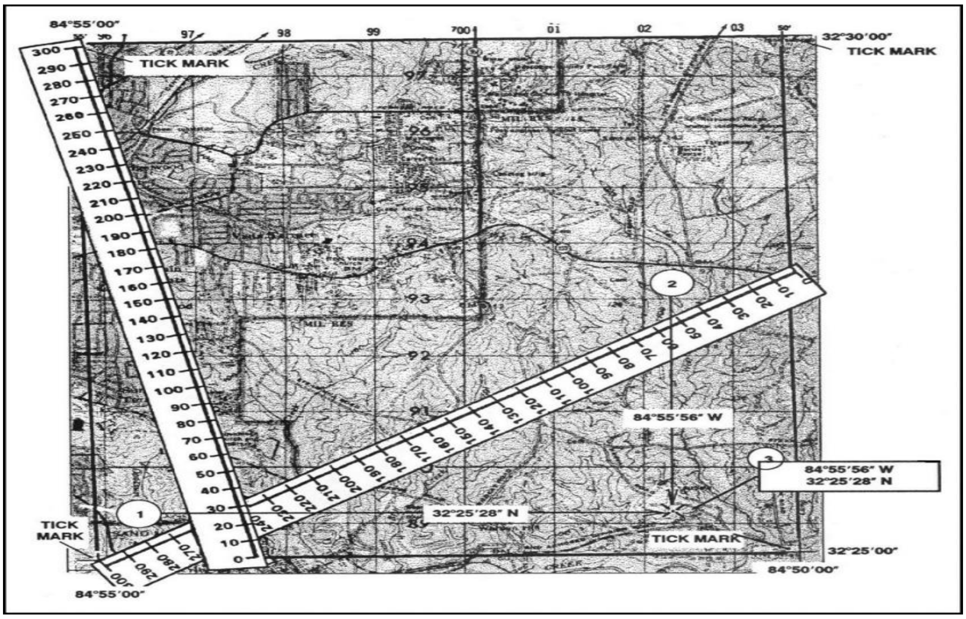


Fig. 1: Topological Map Sheet

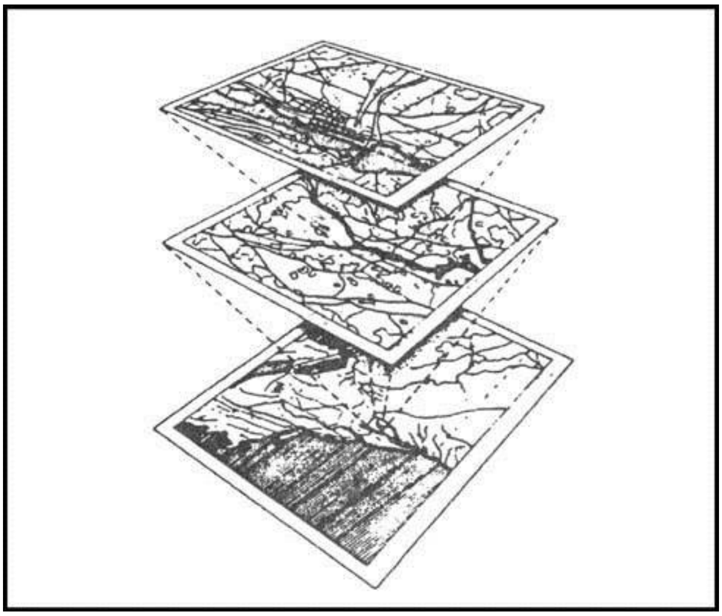


Fig. 2: Overlay of Making the Map

Methodology of GEO-VIS

This research integrates the advancement of MR technology with powerful engine management to create the most similar simulated environment in 3D visualization. This spatial data management is an important tool in providing a new paradigm in planning, design and training combat scenarios activities. At the moment in Malaysia Military environment, the technology of MR is limited in practical due to many factors. The synergy of MR is proven to be a best practice in military decision making specifically in geographical of Malaysia [9]. The topologies in Malaysia is unique with jungle and forest besides the weather is humidity and hot over the year.

So based on this facts, this research will provide the package of high quality of spatial data management in order to create highly detailed models of map terrain and in virtual environment. These elements will enable the military decision makers to visualize, analyse and share large datasets in seamlessly with an immersive and real time environment [10-11]. At the end of this research is the product that have all the elements of future combat visualization packages. Based on Fig. 3, depicted the methodology of this research which included the phases of Specification Needs, Design, Development & Implementation, User Testing and Verification & Evaluation.

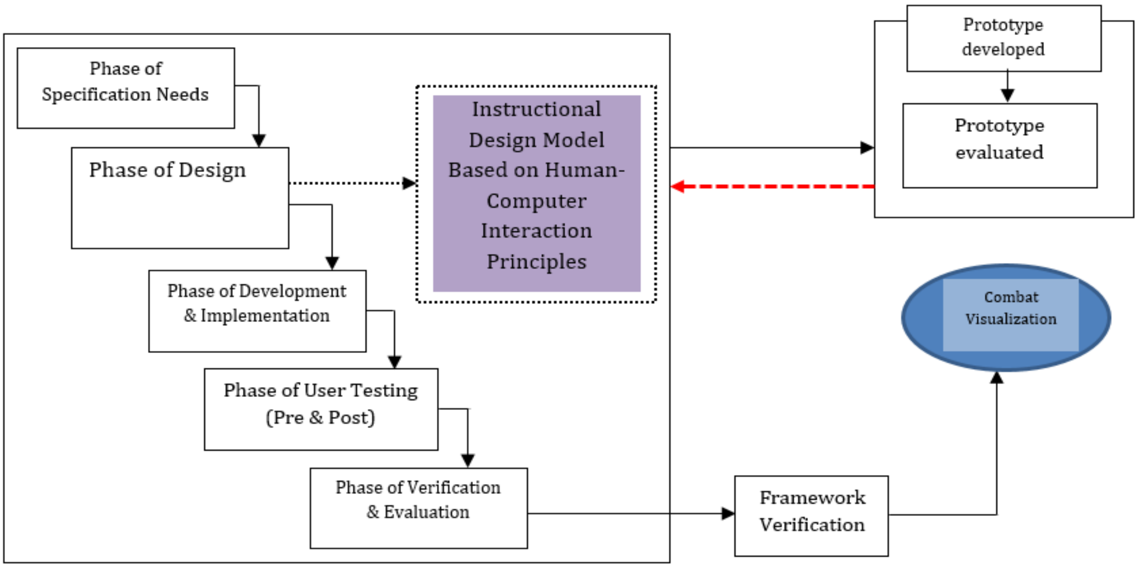


Fig. 3: Methodology of Geo-Visionary (GEO-VIS)

The methodology for this proposed research is the Iterative Model System Development Life Cycle (SDLC), which consists of five (5) phases as follows:

i. Phase of Specification Needs

This phase involved the preliminary analysis and literature review. Some series of interview with Subject-Matter Experts (SMEs) will included in this phase to gather information on research direction and problem statements verification.

ii. Phase of Design

This phase will be conducted based on the Instructional Design (ID) Model based on Human-Computer Interaction Principles. The HCI principles are needed to identify the human factors and ergonomics of users. The flow chart and storyboarding also will be conducted during this phase.

iii. Phase of Development and Implementation

This phase which involved programming and storyboard interpretation. The model of 3D included geospatial data and combat visualization will be imposed during this phase. The map terrain will be captured and modelling will take part in this phase. The advancement of Holograms Technology and Virtual Reality will be crucial integrated during development and implementation of this research.

iv. Phase of User Testing (Pre & Post Test)

This phase will be conducted to test on the identified variables based on the development of GEO-VIS framework. The data collection will be imposed during this phase.

v. Phase of Verification & Evaluation

The prototype of GEO-VIS will be evaluated based on heuristics variables that have been identified through user testing. The verification of framework will include of components and elements in combat visualization, components of communication and interaction amongst decision makers' and features of Mixed Reality Technology. During this phase the verification of framework will be performed to verify the effectiveness and efficiency of GEO-VIS prototype implementation.

Characteristics of GEO-VIS

This research may provide the following characteristics; analyse the elements and features of combat visualization that give advantages to decision makers' in visualizing, interpreting and managing the information, details and decision making parameters (SALUTE: Size, Activity, Location, Unit, Tactics and Equipment) during military operations. The research also tries to design the prototype (GEO-VIS) that consists of components such as 3D geospatial map terrain; virtual elements; mixed reality space and interaction; reaction and interaction within 3D mixed reality objects in embracing the challenging of combat situation during military decision making. Then, to test the prototype (GEO-VIS) and execute mapping the elements and features with critical successful factors to respondents for pre and post user testing with identified datasets followed by verifying the framework for prototype (GEO-VIS) which includes attributes, independent and dependent variables. Last but not least to evaluate the effectiveness and efficiency of prototype (GEO-VIS) for successful military operations based on advanced technologies of Mixed Reality (MR) and Holograms coupled with features of combat visualization to create an immersive military environment.

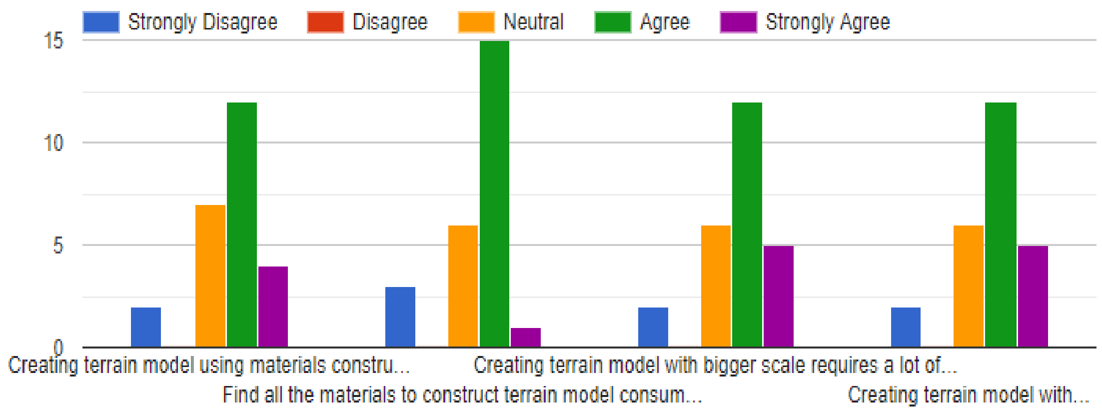
Discussion

An initial analysis was conducted to identify the problems faced by the military during the process of preparing a map terrain model. Analysis through quantitative method has been carried out by distributing a questionnaire to the military student at UPNM as respondents. The respondent comes from a different position in a military operation and the information given is based on their experience and practice in the real field.

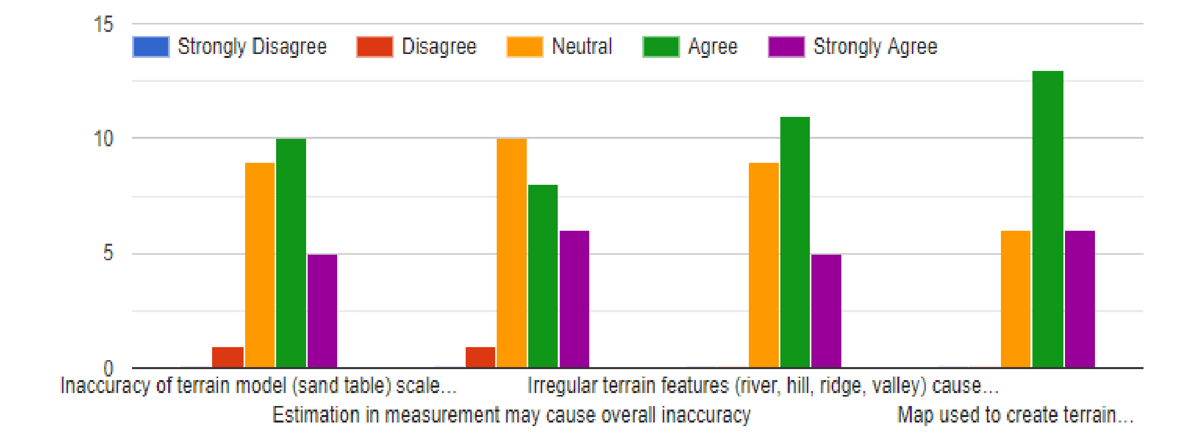
The quantitative method through questionnaire instrument has been used which involving 25 respondents from a military background in this study. Questions raised are relevant to military practice which focus on terrain modelling before executing the real military operation. Table 1 show the results of the questionnaire administered to the respondent from the military.

Table 1: Result of Questionnaire Survey

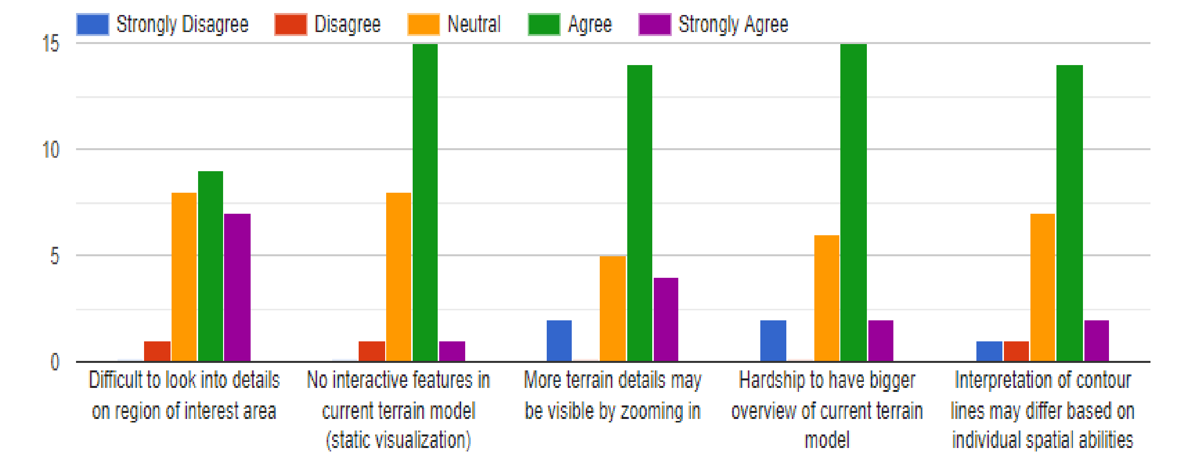
Aspect: Preparing map terrain model	**Strongly Disagree**	Disagree	Neutral	Agree	Strongly Agree
Problem 1: Time					
Creating terrain model using materials construction (sandbags, rock, spray paint) requires a lot of time	8% (2)	0% (0)	28% (7)	48% (12)	16% (4)
Fill all the materials to construct terrain model consumes a lot of time	12% (3)	0% (0)	24% (6)	60% (15)	4% (1)
Creating terrain model with bigger scale requires a lot of time	8% (2)	0% (0)	24% (6)	48% (12)	20% (5)
Creating terrain model with complex geographic surface require a lot of time	8% (2)	0% (0)	24% (6)	48% (12)	20% (5)



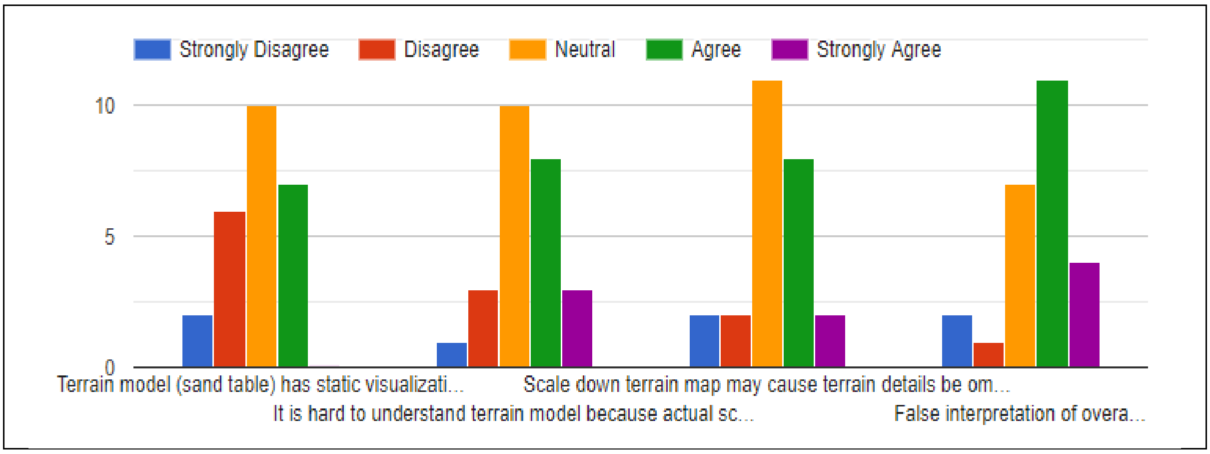
Aspect: Preparing map terrain model	**Strongly Disagree**	Disagree	Neutral	Agree	Strongly Agree
Problem 2: Inaccuracy					
Inaccuracy of terrain model (sand table) scale can contributes to wrong strategy and false analysis	0% (0)	4% (1)	36% (9)	40% (10)	20% (5)
Estimation in measurement may cause overall inaccuracy	0% (0)	4% (1)	40% (10)	32% (8)	24% (6)
Irregular terrain features (river, hill, ridge, valley) cause misjudgement	0% (0)	0% (0)	36% (9)	44% (11)	20% (5)
Map used to create terrain model is not updated	0% (0)	0% (0)	24% (6)	52% (13)	24% (6)



Problem 3: Difficulties in terrain visualization					
Difficult to look into details on region of interest area	0% (0)	4% (1)	32% (8)	36% (9)	28% (7)
No interactive features in current terrain model (static visualization)	0% (0)	4% (1)	32% (8)	60% (15)	4% (1)
More terrain details may be visible by zooming in	8% (2)	0% (0)	20% (5)	56% (14)	4% (1)
Hardship to have bigger overview of current terrain model	8% (2)	0% (0)	24% (6)	60% (15)	8% (2)
Interpretation of contour lines may differ based on individual spatial abilities	4% (1)	4% (1)	28% (7)	56% (14)	8% (2)



Problem 4: Hard to understand terrain model					
Terrain model (sand table) has static visualization which hard to understand	8% (2)	24% (6)	40% (10)	28% (7)	0% (0)
It is hard to understand terrain model because actual scale of terrain features may not be fully expressed	4% (1)	12% (3)	40% (10)	32% (8)	12% (3)
Aspect: Preparing map terrain model	**Strongly Disagree**	Disagree	Neutral	Agree	Strongly Agree
Problem 4: Hard to understand terrain model					
Scale down terrain map may cause terrain details be omitted and lead to difficulties to understand actual environment	8% (2)	8% (2)	44% (11)	32% (8)	8% (2)
False interpretation of overall terrain features which lead to wrong analysis	8% (2)	4% (1)	28% (7)	44% (11)	16% (4)



Based on the initial analysis studies conducted among UPNM student, some conclusion can be obtained as time constraint to prepare the map terrain model. In most of cases, the data are inaccuracy and unreliability to be rely on and difficulties in terrain visualization (eg: zoom in and out, interaction and manipulation). The map terrain using 3D visualization can help to increase better understanding and reduce false interpretation

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