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Research Article

ENHANCING GEOMATICS ENGINEERING EDUCATION THROUGH VIRTUAL REALITY

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ABSTRACT

This paper investigates the application of the virtual reality (VR) technology in geomatics engineering education and its possibilities of changing the learning landscape in this discipline. Several challenges can be attributed to fields like Surveying, Geographic Information System and Remote Sensing which inclusive comes under Geomatics Engineering. This technology programming provides students with rich experiences through immersive and interactive features which allow learner to practice technical competencies and solve problems through field exposure. Today, it is entirely possible to develop new forms of courses by using the VR technology: adapting the course modules, organizing group learning, providing access to industry instruments and applications. In addition, the introduction of VR works well in improving delivery more specifically on accessibility constraint in the areas of geographic location, cost as well as disability. This paper explores the possibility of VR integration for geomatics engineering education, analyses trend and discusses direction for added improvement and research within the field.

1. Introduction

Geomatics engineering is the discipline derived from a combination of geography, surveying, and technology occupies a central position in the study and management of the surface and sub-surface of the Earth. Given the fact that technology continues to develop at a very fast pace especially in the development of Virtual Reality (VR), geomatics education is therefore in the process of a rather innovative revolution. A learning strength of VR is the ability to foster students' learning in ways that are interactive, realistic and practical, giving the students full physical training, which lies between a paradigm and a model in the educational process (Coban et al., 2022).

This paper aims to establish how Geomatics engineering students can benefit from the application of VR technology in their learning process. It outlines the importance of Geomatics today to society and the numerous ways it can be used in for instance, land use planning, environmental management, the development of infrastructure among others. Further, it opens the possibility of bringing about the implementation of VR into traditional pedagogy or teaching methods with real enhancements that will surely benefit educators and students alike in enhancing the understanding of the course and particularly the geospatial connections.

The advantages and limitations for the integration of VR in the geomatics curriculum, and their consequences are also presented in this paper. As such, based on the analysis of the current state, trends, and possible development of VR technology, it is possible to present real information on how to develop the learning process in the GE field to prepare the students for the further profession in accordance with the modern tendencies.

2. Literature Review

This section discusses transformative potential of VR to embrace geomatics engineering education offering chances to enrich scholars' pedagogy, advance laboratory proficiency, enforce intercession, and support diversity. When problems arise and when innovations emerge, educationists can enable students to succeed in their careers in geomatics through the use of VR technology in contributing to the development of the field.

It is, therefore, viable to incorporate virtual reality (VR) technology in geomatics engineering learning to boost the learning achievement and in a view of shaping, the students for careers in the growing and innovation-based field of geomatics engineering (Chen et al., 2019). In this literature review, we review possibly accessible and relevant literature on the use of VR in geomatics education regarding applications, advantages, constraints and important considerations for practice (Singla, 2021). The use of VR for delivering learning contents has been demonstrated in prior research as a mean of creating meaningful and engaging experiences à la Geomatics students (Duarte et al., 2020). For instance, studies showed that introducing VR-based simulation resulted in enhanced students' performance on surveying and spatial reasoning more than conventional approaches indicated by Ding and Li, 2022. Therefore, research conducted by The VR developed students' spatial visualization and critical thinking skills in GIS & remote sensing (Rong et al., 2022). Applying VR system provides the students with practical experiences of practicing within a setting that simulates real life geomatics environment as specified by Liu et al., (2022). Students were able to practice surveying methods, process geospatial data and etc., in a virtual environment provided by the VR devices and software The study showed that conducting VR simulations enhanced students' practical skills and their confidence while using geomatics tools and technologies (Putra et al., 2023)

Virtual learning environment allows for joint work and effective interaction incorporating applicable technology with geomatics projects, data sharing, and real-time communication (Abd-Elrahman et. al., 2023). Some research focused the VR-based collaborative environments as facilitating views regarding interaction, teamwork, and group cohesion among the geomatics students (Spadavecchia et al., 2024).

The use of virtual reality tools can expand the opportunities to give geomatics education to the students with different backgrounds, pick learning styles and abilities. This helps to implement the principles of equity and diversity and makes education in geomatics accessible for learners of all types with the use of the VR that offers different types of lessons and does not let physical limitations hinder the way of a student. However, cost effectiveness of the VR equipment and software including the technical knowledge for implementation has remained some of the challenges hindering the uptake of VR in learning institutions (Chen et al., 2024).

Thus, it is pertinent to continue research and advance in creating a better package of educational materials and approaches based on the VR strategy in geomatics engineering education and providing adequate measures of assessment for such approaches. Further, multi-disciplinary partnerships follow educators, technologists, and industrialists for better development of more enhanced opportunities offered by VR for geomatics research study, profession and training.

3. Implementation of VR in Geomatics Engineering Education

Teaching and learning strategies for geomatics engineering education using VR require several factors to be put in place to allow for the integration of VR as teaching tool. The approach for implementing VR in geomatics engineering education can be classified as follows:

- **Assessment Phase:** Start with defining concrete educational purposes as well as learning intentions and the areas of the geomatics curriculum which might benefit from VR in learning. Carry out a survey that asks students and educators their needs, and their opinion on learning geomatics or teaching it, and barriers they face while learning or teaching geomatics.

- **Technology Selection Phase:** Choose right VR hardware and software according to the teaching-learning goals, available amount of money and technical specification. Some of the factors that could be taken into consideration include compatibility of the device, convenience, application of the software, and customer service. Typical VR gear may refer to Oculus Rift, HTC Vive, and standalone types such as Oculus Quest. Similarly, the recently developed VR-based Digital Mapping Simulator that has been developed by the SOUTH company is one of the best illustrations of surveying engineering applications.

- **Content Development Phase:** Develop VR content for use in virtual reality materials corresponding to the geomatics curriculum and learning outcomes. This may comprise developing of simulations, exercises, virtual trips, and graphical visualization for surveying, GIS applications, remote sensing, and geospatial analysis.

- **Pedagogical Design Phase:** Design clear practical lessons and learning-teaching experiences incorporating ideas on virtual reality to augment students' activity in learning and mastery of knowledge. Apply the elements of the experiential learning approach, problem-solving, and discovery approaches that foster exploration and problem solving and critical thinking.
- **Training and Support Phase:** Equipping the teachers and learners themselves with adequate skills about the utilization of VR hardware and software. Provide information on general VR-system tools and opportunities for work experience and tutorials that would help users to compose navigation scenarios, avoid common mistakes, and seek for help and consultation from their peers.

- **Integration into Courses Learning Outcome Phase:** Incorporate VR activities and materials to the general lessons in the course or build new lessons that teach the students about the applications of VR in geomatics education. Integrate the VR content with the course learning outcomes, lecture material and assessment criteria to reinforce the learning outcomes, and where possible support the development of skills in geospatial analysis, data interpretation and problem-solving in the context of Virtual Reality experiences designed for learning.

- **Assessment and Evaluation Phase:** Implements techniques to use in the evaluation of learners' outcomes as well as the impact of VR in Geomatics studies. Part formative and summative assessments like quizzes, assignments, project, and performance assessments that put into checks student comprehension, competency, and interactions with VR-infused instructional paradigm.

- **Feedback and Iteration:** Interview students and educators to gather information about their own and VR technologies' application in teaching geomatics. To find out information on usability, contents' relevance, effectiveness of learning, and the areas that need to be changed. Feedback information should be incorporated in enhancing the content of the Virtual Reality application, the design of the instructions and formation of the implementation strategies in successive cycles.

- **Research and Collaboration:** Promote the development and application of research partnership and collaboration between the academia, industry and VR developers with a view of enhancing knowledge and innovations focused on the use of VR in Geomatics education. Investigate fresh of the press technologies, teaching methodologies and the use of resources by undertaking inter-disciplinary research endeavours and activities.

Thus, it is possible to establish the sequences of phase that will allow institutions and educators to introduce VR technology in geomatics engineering education and provide the students with appropriate levels of learning experiences to achieve comprehensive knowledge and worth-learning experiences. The integration of the VR has the benefits in the development of spatial skills, skill practice and success of students in the geomatics.

4. VR Case Study

The focus of the case study is to use GPS surveying in a real field work area with advanced technology of simulating real condition by software. The main tool to achieve this task is software based on Digital Mapping developed by SOUTH company. Hence, Digital Mapping Simulator is a software program which was developed intentionally for implementation of VR approach. This program grants the user initiation to numerous ways of surveying plus comprehensive surveying equipment exactness. The software is used to familiarize the students with GPS observations through collection using the VR technology.

The students were instructed to conduct the survey through VR using the Digital Mapping software which was introduced by the SOUTH company for the virtual area through the GPS system which comprised of one GPS base receiver and one GPS rover receiver. The following are the tasks conducted in this case study:

- The GPS base station is virtually set up on the known geodetic coordinates on the roadside with instrument height one. 5m as depicted by the following figure 1; Subsequently, the GPS base controller, as illustrated in Figure 2, is employed for defining the base station and logging the GPS observation of such base station.

Figure 1: Virtual GPS base station setup

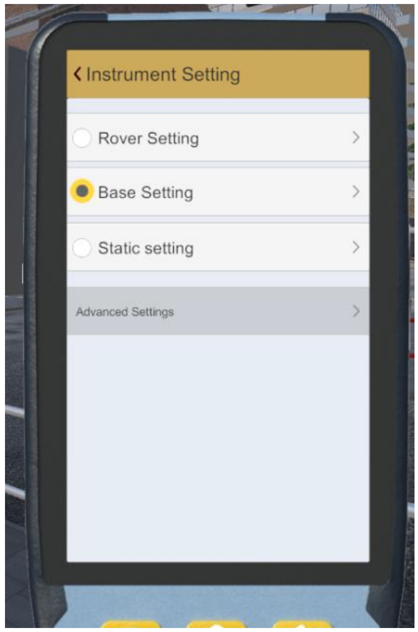

Figure 2: Base station recording using virtual controller.

- The GPS rover is virtually utilized to collect the GPS observations and accurate coordinates of survey points as shown in Figures 3 and 4.

Figure 3: Virtual GPS rover points setup.

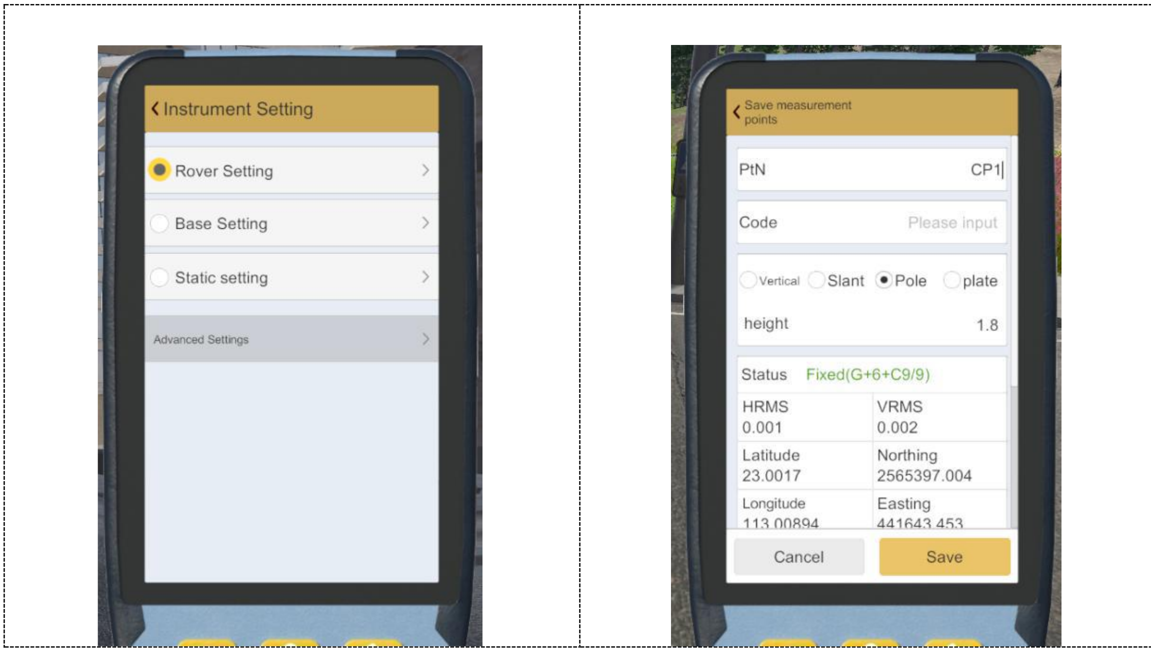

Figure 4: Rover points recording using virtual controller.

- Using GPS rover, all survey points of the roads, buildings or any features required in the survey area are again measured and the coordinates are noted from the VR based GPS rover. As applied, we begin with staking of a point on the road and then the edges of the building and the features. For road R point is shown in Figure 5, the code of road is R while that of the building is B.

Figure 5: Example of rover point on road coding using virtual controller.

- After completing data collection for all survey points, the data is exported to a file data in ***.csv*** format.

- Then, the conversion is made from .csv file to .dxf file using Microsoft Excel in five fields, namely, ***Point No., Northing, Easting, Elevation, and Code***.

Finally, the ***.dxf*** file is used to map out the area of all points using AutoCAD software to provide the digital map for the area as shown in Figure 6 using VR technology.

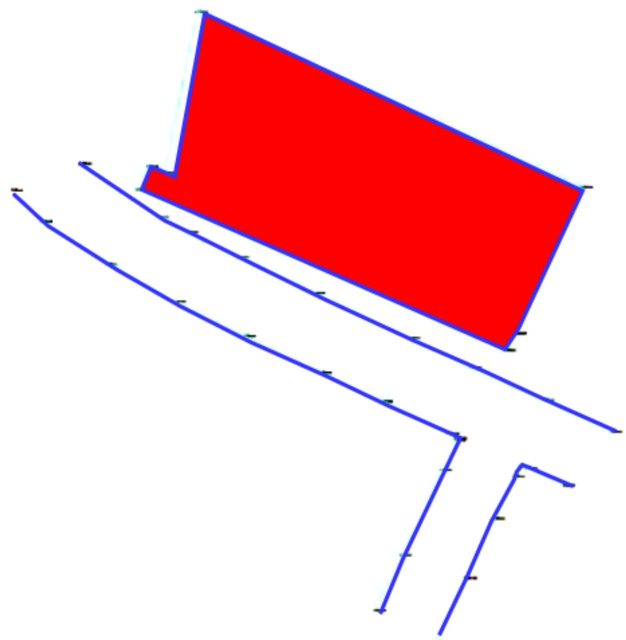

Figure 6: Digital map derivable of the survey area in AutoCAD format using VR technology.

In summary, the use of the VR can be is deemed effective for improving the students' competencies in surveying/ geomatics engineering projects whenever the number of surveying instruments available in the geomatics laboratory is restricted.

5. Conclusion

Incorporation of virtual reality technology in geomatics engineering education therefore promises to be one of the most significant developments that would transform the teaching learning practices with the promise of giving students intellectual and holistic training through virtual exposure. From the cases presented in this paper, it is possible to present examples of how VR can be used to support the teaching of geomatics and related subjects such as surveying methods. Therefore, with saturated technology computational environment involving VR and virtually real geospatial data interfaces can revolutionize geomatics engineering education to enable students to become responsible professionals and innovation agents. In future to unleash the full potential of VR innovation and collaboration among educators and institutions shall be driven and embraced. By adopting and integrating strategic planning, innovative approaches towards teaching and learning as well as interdisciplinary cooperation, VR has the potential to transform the delivery, outcomes, and potential of geomatics engineering education.

6. Recommendations and Shortcoming

Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) technologies are promising technologies that can enhance accessibility to practical education by overcoming barriers related to physical location, cost, and disability. I strongly recommend and encourage the universities to invest more in the implementation of such emerging technologies (VR, AR and Mixed reality) in education.

However, there are some limitations that are still affecting the use of VR in geomatics education; some of these limitations may include Cost, Technical know-how, and content development. Also, the shortcoming of using VR is that the students need extensive taring to use the VR, AR and Mixed reality in education.

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