3D visualization of GIS data in coconut plantation management: challenges and opportunities

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Gonesh Chandra Saha[*1] and Ruzinoor Che Mat[2]

[1]School of Multimedia Technology and Communication, Universiti Utara Malaysia and Computer Science & Information Technology, BSMRAU, Bangladesh.
[2]School of Creative Industry Management and Performing Arts, Universiti Utara Malaysia

gcsaha@bsmrau.edu.bd

Abstract. The coconut (Cocos nucifera) is an essential agricultural crop which delivers oil, food, beverage, fiber, medicine with range of raw materials and widely identified as "tree of life". The coconut grows all over the tropics but is fronting major challenges to its survival. It obviously demonstrates that coconut plantation has declined due to poor agricultural practices and farm management. The aim of this paper is to reveal the existing challenges and find opportunities of online 3D visualization of GIS data in coconut plantation management. In this study, the data collected from a field observation will be used as the source of primary data where coconut plantation took place. The results discovered from the coconut field observation about the techniques for coconut based farming that are traditional challenging manual cultivation practices and there is also lack of proper monitoring activities is the main challenges could be highlight for introducing new technologies. The findings from this study possibly will helps in identifying the suitable challenges and opportunities that could be highlight in implementing online 3D visualization of GIS data for coconut plantation management. It will also be adapted for advancing visualization technologies.

1. Introduction

The coconut (Cocos nucifera) universally planted in around 93 countries [1]. Coconut farming and related activities deliver living safety to millions of people. Hence, sustaining and achieving greater profitability and productivity from coconut farming is a principal goal in helping this farming community. The perennial tropical crop coconut is the fourth essential industrialized crop after rice, rubber and oil palm in Malaysia [2]. There are about 88,093 hectares of coconut cultivation area in Malaysia with a yield of 595,097 tonnes per metric in 2014 [3].

Regarding planting and management of coconut cultivations, [4] pointed out that current day management of coconut cultivation is gone for supporting the individuals who work with little scale farmers and group of farmers through the unpredictable zone of coconut management. On the other hand, the productivity of coconut farming may depend on various diverse factors, for example, yearly rainfall, age of the farm estate, varieties, agro ecological area, soil verity, and management systems (e.g. moisture, manure application, and soil preservation, pests & disease control and weed control [5]. [6] Explored production and global trade scenario of coconut. The worldwide exports of several coconut products throughout the last 5 years exposed a growing trend, mostly for desiccated coconut, coco powder, coco chemicals, shell charcoal and coir products and coir as well [7] measured the

production of coconuts and influences affecting the production of coconut and to warn suitable research and development areas in coconut sub-sector in Tanzania.

Nowadays, many practices for coconut based farming have been presented but all these techniques are considered as manual representations of plantation and poor farming. This is due to the point that the obligation for particular manual skills is making challenges in the coconut business. This issue may be a straight result of the diverse livelihoods of coconut and the different farming technique where it is planted. Henceforth, the motivation behindhand this research is to display the computer dependent system and to build up a solution that would support decrease it. Ensure that coconut farming won't finish in Malaysia since it's recognized that it is appropriately productive to us [8].

In a web based farm management system that permits the farmers to processes and access the information that is accessible on the Internet and utilized to manage different phases of a farm. The study inspects the basic visualization of farm in 3D system for Jigawa state farming environment. This means that, in what way plant of the area will be showed virtually. It looks at the implementation of the model and the design of 3D farmer's visualization technology [9].

Especially in precision agriculture, [10] described the novel 3D sensing methods associate a significant potential to expand crop monitoring. Consequently, in numerous studies it is proofed that corresponding biomass and crop growth can be reliable monitored with 3D data gathering methods.

Also [11] discussed GIS based agricultural system, which can help agriculturalists during various stages of farming. It uses information base to offer support for better reasoning. Work by [12] analyzed the application of GIS & Remote Sensing (RS) for climate change and farming in the Philippines to use the information collected by the GIS and RS to empower the farmers by having a full observation of the farms health which is very helpful the farmers.

In farming, routine monitoring of crop yield health is regularly required at high determination for exact site-particular management too [13]. With this, designing of 3D visualization technologies will make significant farming view for decision-making in agriculture, which results in developing a model of online 3D visualization of GIS data for coconut plantation management.

Besides that, GIS is the sharing and gathering of information to provide visual of the agricultural conditions, and monitoring and measuring the effects of management practices for the farm land [14]. Joined with farm managers utilize GIS to visualize their products, farm land and management practices. GIS and RS technology open a wide application of utilization that can be utilize these days [15].

Researchers likewise believe that GIS shows a vital part in farming strategy for monitoring crop yield. In agriculture, GIS plays part in decision making applications, soil disintegration applications, prediction applications, cropping pattern investigation, pest and nitrogen management, weed management, utilizing verifiable management to decrease soil sampling mistakes, yield information and its monitoring, soil salinity mapping and fertility management so on [16]. GIS and RS is the only tool, which allow farmers to visualize information that might be hard to interpret otherwise.

Different 3D visualization systems for geographic data have been developed in the past. They diverge in several aspects such as their used datasets, application, and visualization techniques. But, "Web-based 3D visualization of rapidly changing data is challenging" [17].

Nowadays, the trend is moving visualization, which more often can be seen as photorealistic more effectively [18]. In this way, [19] developed the online 3D terrain visualization system aimed at visualizing oil palm plantation for effectively. On the other hand, digital farm for oil palm plantation was also discussed by [20], but most of the discussion was related on how to manage the oil palm plantation by utilizing RS, GIS, and DBMS technology based on 2D technology. None of the discussions mentioned about 3D technology to manage coconut plantation.

Hence, this study will investigate the challenges and opportunities of online 3D visualization to beat current obstacles in coconut estate plantation to uncover the real issues confronting coconut farmers. At last, it will ensure that coconut plantation will keep on achieving sustained area of coconut palm plantation. An online 3D visualization of GIS data for coconut plantation management may help coconut palm managers to manage their plantation more effectively. The aim of this paper is to reveal

the challenges with potential opportunities of online 3D visualization of GIS data in coconut plantation management. The results from this study possibly will helps in identifying the existing challenges that could be highlighted in implementing online 3D visualization of GIS data for coconut plantation management.

2. Methods and Materials

To investigate the existing challenges and potential opportunities of online 3D visualization, information from the real coconut field is required. This paper focus on the current plantation views from coconut plantation management. This study employed qualitative approach. For the purpose of this study, first the research carried out an observational study at north part of Malaysia referring at Figure 1. From the study site pictures, it perceived the subject as researchers were at a plantation site by personally going there to obtain pictures of the subject, coconut breed, consisting of site of plantation and plantation method, the disease, weeds affecting coconut trees and growth based on their breed. From these pictures, it was recognized the subject as if researchers were at a coconut plantation site. These pictures will be adhered in the research to assist in providing a clear picture of the subject.

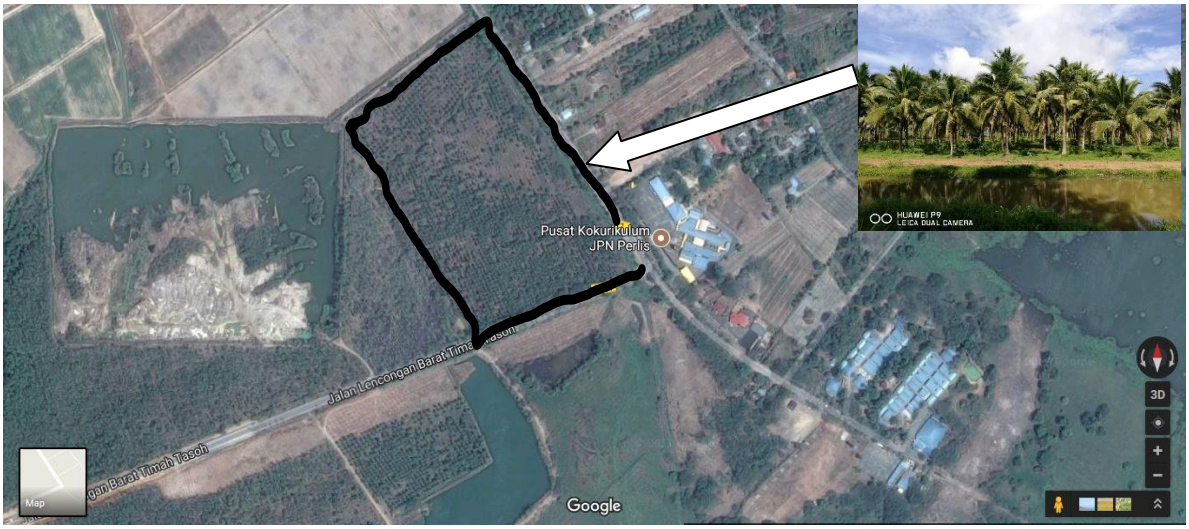

Figure 1. The study area (Source: Google maps)

3. Results and Findings

From the field observation, it's showing that the traditional cultivation practices are the main challenges for the deterioration in productivity. The area of plantation is neither planned nor organised wisely that wastages area and harming of soil here. The cultivation site pictures showing presence of pests and weeds that is necessary to identify earlier for ensuring normal growing and selection of quality seedlings for better yield to sustainable growth in productivity. Theoretically, the best utilization of water, light, nutrients and space by individual plants in a crop stand occurs when plants are equal distance from each other in all directions. This distance, known as the equidistant plant spacing but it's discovered from the picture that is not equal. This is another investigation issue in cultivation site in north part of Malaysia.

At the same time, Agricultural department is using GIS based analysis for Jackfruit management. When the coconut plantation owner was asked about the usage of online 3D visualization of GIS data for coconut plantation management, the respondent agreed with the concept and gave a positive respond.

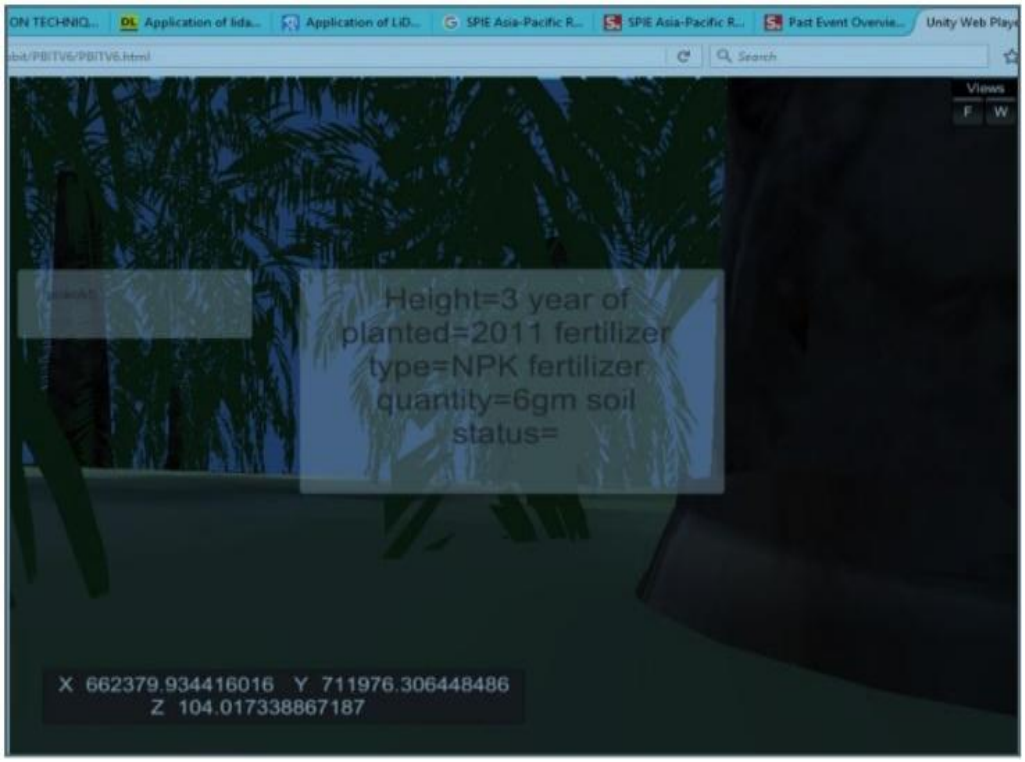

Figure 2. Sample of data view in online 3D visualization for oil palm plantation management (adopted from [21])

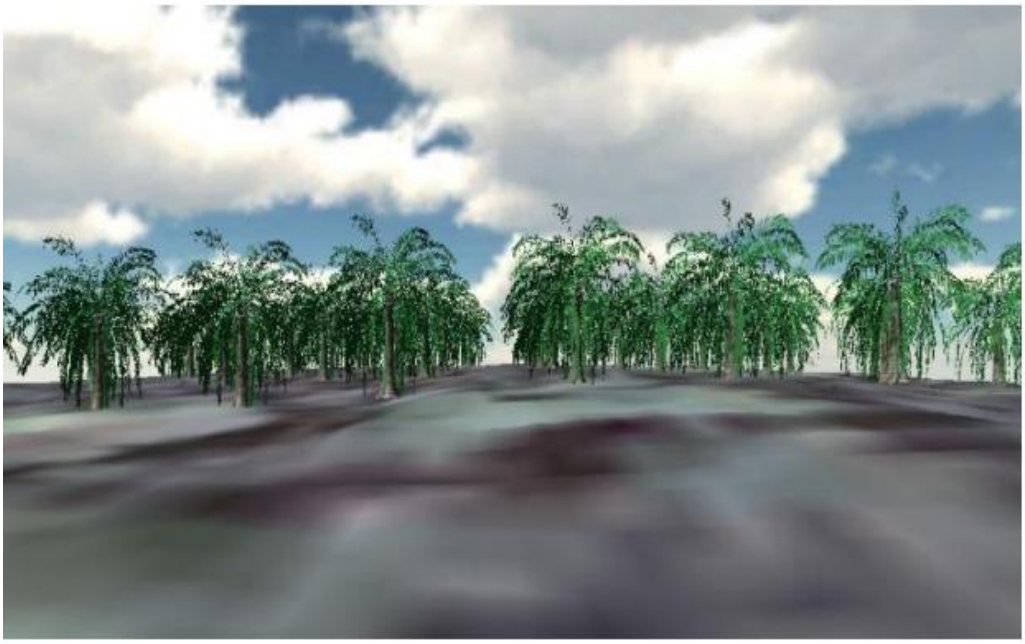

Figure 3. Sample of scenery view from west in online 3D visualization for oil palm plantation management (adopted from [21])

The sample of the system for oil palm plantation management can be refer at Figure 2 which showing the representation of data of oil palm. While Figure 3 shows the scenery view from west

inside oil palm plantation where the user can have experience virtually inside the environment. This system have potential to be apply for coconut plantation management [21]. For example, by introducing this new system, it's potential to disseminate information from actual coconut palm plantation data such as area of the plantation, will be view virtually and accessible on the internet, the information of plants in 3D form to farmers (like the air pressure, name, distribution of water, solar radiation and soil type or soil pH of the area or soil materials on the field). The information gathers from actual coconut plantation data such as number of trees, tree location, dried or dead leaves. Besides ripe fruits status, weed and pests control and satellite images and selection of unproductive and old coconut palm with area of plantation, and management practice data could be used. As the real field data could be used for real world simulation in the future system, it is vital for decision makers to understand what information that they can gather for decision making process.

4. Conclusion

Based on the findings that have been discussed earlier, it can be concluded that in order to plant coconut, it can't be denied that the farmers might face many challenges. In conclusion, from the observation, there are many challenges need to be consider in ensuring the sustainable coconut plantation. When the coconut trees are in good condition, more yield can be reap from the plantation. The result from this study helps in identifying the suitable issues need to be focus in implementing online 3D visualization of GIS data for coconut plantation management which are currently manage by manual cultivation practices. By implementing this new system, most of the issues could be solved successfully.

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