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AN ENHANCED ARCHITECTURE OF ONLINE 3D VISUALIZATION FRAMEWORK FOR MONITORING COCONUT PLANTATION

GONESH CHANDRA SAHA

Universiti Utara Malaysia

DOCTOR OF PHILOSOPHY
UNIVERSITI UTARA MALAYSIA
2020

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Abstrak

Penggambaran ladang pertanian yang sedia ada dan masa depan menjadi lebih penting untuk pemantauan tanaman serta pembuatan keputusan, kerana ia sangat membantu untuk mempengaruhi pengeluaran. Konsep pemantauan kelapa sawit yang terbaik adalah tahap perkembangan teknologi pertanian; contohnya, menggunakan sistem visualisasi 3D dalam talian untuk menyokong proses pemantauan. Matlamat penyelidikan ini adalah untuk membentangkan dan mewajarkan masalah penyelidikan yang dikenal pasti dengan penggunaan rangka kerja visualisasi 3D dalam talian. Masalah penyelidikan yang dikenal pasti disiasat kerana rangka 3-lapisan semasa mempunyai kekurangan, seperti kelemahan dalam saiz visualisasi graf, terutama keupayaan untuk memvisualisasikan graf saiz besar dalam visualisasi 3D dalam talian. Dalam keadaan sedemikian, visualisasi 3D nampaknya mencabar kerana ia menghasilkan sejumlah besar dataset imej dan objek atau graf 3D yang besar untuk setiap pokok kelapa. Oleh itu, dalam pendekatan novel ini, kajian ini memperkenalkan rangka kerja berasaskan struktur pelanggan / pelayan yang membahagikan keseluruhan proses ke dalam konsep lapisan untuk mengatasi masalah yang ada. Satu lagi lapisan akan ditambah kepada rangka kerja tiga lapisan sedia ada untuk diresmikan ke dalam rangka 3-lapisan untuk mengendalikan visualisasi graf saiz besar. Ia terdiri daripada empat lapisan berasingan, iaitu lapisan antara muka, lapisan proses visualisasi, lapisan maklumat paparan, dan lapisan pangkalan data. Setiap lapisan mempunyai fungsi tersendiri dan berbeza dari yang lain. Rangka kerja ini telah dikaji semula, dinilai dan disahkan oleh pengurus ladang kelapa dan pakar visualisasi 3D; ia kemudian digunakan sebagai asas untuk membangunkan prototaip untuk memvisualisasikan kawasan maya kelapa sawit yang besar. Selepas itu, prototaip itu dinilai oleh pengguna dengan pengalaman yang pelbagai. Secara keseluruhannya, hasil dari pengujian kebolehgunaan menunjukkan bahawa ia dapat menyokong atau mengendalikan lebih banyak grafik tanaman perkebunan kelapa, sehingga mencapai kepuasannya melalui perumusan masalah visualisasi graf yang telah dikenalpasti.

Kata Kunci: Dalam talian, visualisasi 3D, Rangka Kerja, Pemantauan, Perladangan Kelapa

Abstract

The visualization of existing and future agricultural plantation is becoming more important for monitoring crops as well as for decision-making, as it considerably helps to influences the production. The concept of best monitoring coconut plantation is an important stage of agricultural technology development; for instance, utilizing online 3D visualization system to support monitoring processes. The goal of this research is to present and justify an identified research problem with the utilization of a proposed enhanced architecture of online 3D visualization framework. The identified research problem was investigated since the current 3-layer framework has shortcomings, such as, weaknesses in the size of graph visualization, especially the ability to visualize large size of graph in online 3D visualization. In such situation, 3D visualization seems challenging as it generates a massive amount of image datasets and large 3D objects or graphs for each of the coconut trees. Therefore, in this novel approach, this study introduced a client/server structure-based framework which subdivides the total process into the concept of layer to overcome the existing issue. One more layer will be added to the existing three-layer framework to formalize into 3-layer framework for handling the large size graph visualization. It consists of four separate layers, namely interface layer, visualization process layer, display information layer, and database layer. Each layer has its own specific function and distinct from others. The framework was reviewed, evaluated and validated by the coconut plantation manager and 3D visualization experts; it was then used as a basis to develop a prototype to visualize the large virtual area of coconut plantation. Subsequently, the prototype was evaluated by users with diverse experience. Overall, results from the usability testing demonstrated that it can comfortably support or handle more graphs of the coconut plantation, thus achieving its satisfaction through formulating identified graph visualization problem.

Keywords: Online, 3D visualization, Framework, Monitoring, Coconut Plantation

Dedication

This thesis is dedicated to the **almighty**, the most merciful for His benevolence and mercies towards me and my family,

And to

My father, Nirmal Kumar Saha

My mother, Kalpana Rani Saha

My wife, Hasi Saha

My son, Oikyo Saha

My brother, sister, and friends, for their sacrifices, love and prayers.

With love,

Gonesh Chandra Saha (2020)

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List of Abbreviation

4S4L:	Four Steps Four Layers
AICT:	ICT in Agriculture
AR:	Augmented Reality
BSMRAU:	Bangabandhu Sheikh Mujibur Rahman Agricultural University
CPU:	Central Processing Unit
CS:	Computer Science
CVIS:	Computerized Visitor Information System
DEM:	Digital Elevation Model
DSRM:	Design Science Research Methodology
DTEM:	Digital Terrain Elevation Model
DTM:	Digital Terrain Model
FFB:	Fresh Fruit Bunches
FTC:	Farmers' Text Center
GE:	Google Earth
GIS:	Geographical Information System
GLSL:	OpenGL Shading Language
GPS:	Geographic Positioning System
GPU:	Graphic Processing Unit
GQM:	Goal Questions Metric
GUI:	Graphical User Interface
HCI:	Human Computer Interaction
ICT:	Information and Communication Technology

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IPGRI:	International Plant Genetic Resources Institute ()
IS:	Information Systems
IT:	Information Technology
ITM:	Iterative Triangulation Methodology
JDBC:	Java Database Connectivity
JKKNIU:	Jatiya Kabi Kazi Nazrul Islam University
JNI:	Java Native Interface
JNLP:	Java Network Launching Protocol
JSP:	Java Server Page
LKIM:	Lembaga Kemajuan Ikan Malaysia
MARDI:	Malaysian Agricultural Research and Development Institute
MC:	Multimedia Communication
MT:	Multimedia Technology
OPAPA:	Open Academy for Philippine Agriculture
OGC:	Open Geospatial Consortium
PC:	Personal Computer
PHP:	Hypertext Processor
PSSUQ:	Post-Study System Usability Questionnaire
QUIS:	Questionnaire for User Interaction Satisfaction
RAM:	Random-Access Memory
ROI:	Region of Interest
RS:	Remote Sensing
RT3D:	Real-Time 3D

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SE:	Software Engineering
SLR:	Systematic Literature Review
SOA:	Service Oriented Architecture
SR:	Systematic Review
SUMI:	Software Usability Measurement Inventory
TIN:	Triangular Irregular Network
UAV:	Unmanned Aerial Vehicle
UCD:	User-Centered Design
UI:	User Interface
URAIS:	Uganda Rural Agricultural Information System
VRML:	Virtual Reality Markup Language
VTK:	Visualization Toolkit
W3C:	World Wide Web Consortium
WebGL:	Web Graphics Library
WFS:	Web Feature Service
WWW:	World-Wide Web
X3D:	Extensive 3D

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List of Publications and Awards

Journals (Scopus Indexed):

- **Saha, G.C**.& Ruzinoor, C.M. (2019). A Conceptual Idea of Four Steps Four Layers Framework for Online 3D Visualization in Agricultural Application. *Journal of Computational and Theoretical Nanoscience*, 16 (5-6), 2172–2178.
- **Saha, G.C**.& Ruzinoor, C.M. (2019). Exploring the Potential of Web Based 3D Visualization of GIS Data in Coconut Plantation Management. *International Journal of Innovative Technology and Exploring Engineering (IJITEE),*8(5S), 147-153.

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- **Saha, G. C.,** & Ruzinoor, C.M. (2018, June). 3D visualization of GIS data in coconut plantation management: challenges and opportunities. In *IOP Conference Series: Earth and Environmental Science* (Vol. 169, No. 1, p. 012068). IOP Publishing.

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Peer-reviewed Journals:

- **Saha, G. C.,** & Ruzinoor, C.M. (2018). Coconut based farming systems: farmers, research, and industry viewpoints. *East African Agricultural and Forestry Journal.* Manuscript under review.

Conference Proceedings:

- **Saha, G. C.,** & Ruzinoor, C.M. (2019). Research on Online 3D Visualization System for Coconut Plantation Management and Monitoring. *In SMMTC Postgraduate Colloquium 2019*.
- **Saha, G. C.,** & Ruzinoor, C.M. (2018). Potential of Coconut Plantation Management using 3D Visualization of GIS Data: A Case Study of Southwestern Geographical Region. In 39th Asian Conference on Remote

Sensing (ACRS 2018) PROCEEDING. 15-19 October 2018 at Renaissance Hotel, Kuala Lumpur, Malaysia.

- **Saha, G. C.,** & Ruzinoor, C.M. (2018). A Study of Coconut Plantation Management Practice: Problems and Status. *In SMMTC Postgraduate Symposium 2018*.
- **Saha, G. C.,** & Ruzinoor, C.M. (2018). An Online 3D Visualization Technique for Coconut (Palm) Plantation. *UUM-UNS Doctoral Consortium, UUM, 1 May 2017*

Presentations:

1)	**Event**	SMMTC Postgraduate Colloquium 2019
	Year/Venue	1 April 2019 at School of Multimedia Technology and Communication (SMMTC), UUM, Malaysia.
	Title	Research on Online 3D Visualization System for Coconut Plantation Management and Monitoring.
	Researcher	**Saha, G. C.,** & Ruzinoor, C.M.
2)	**Event**	9th IGRSM International Conference and Exhibition on Geospatial & Remote Sensing
	Year/Venue	2018, Berjaya Times Square Hotel, Kuala Lumpur, Malaysia
	Title	3D visualization of GIS data in coconut plantation management: challenges and opportunities
	Researcher	**Saha, G. C**., & Ruzinoor, C.M.
3)	**Event**	39th Asian Conference on Remote Sensing (ACRS 2018)
	Year/Venue	15-19 October 2018 at Renaissance Hotel, Kuala Lumpur, Malaysia.
	Title	Potential of Coconut Plantation Management using 3D Visualization of GIS Data: A Case Study of Southwestern Geographical Region
	Researcher	**Saha, G. C.,** & Ruzinoor, C.M.

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4) **Event** SMMTC Postgraduate Symposium 2018

Year/Venue 18 March 2018 at School of Multimedia Technology and Communication (SMMTC), UUM, Malaysia.

Title A Study of Coconut Plantation Management Practice: Problems and Status.

Researcher **Saha, G. C.,** & Ruzinoor, C.M.

5) **Event** UUM-UNS Doctoral Consortium

Year/Venue 1 May 2017. at School of Multimedia Technology and Communication (SMMTC), UUM, Indonesia, Malaysia

Title An Online 3D Visualization Technique for Coconut (Palm) Plantation

Researcher **Saha, G. C.,** & Ruzinoor, C.M.

Awards:

- **Bronze Medal**
  - Innovative Research, Invention and Application Exhibition 2019 (I-RIA 2019)
  - School of Computing, UUM (SOC), UUM, Malaysia
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  - Team members: Ruzinoor, C.M., & Mahayudin, M. H.
- **Best Paper Award**
  - SMMTC Postgraduate Symposium 2018
  - School of Multimedia Technology and Communication (SMMTC), UUM, Malaysia
  - Title: A Study of Coconut Plantation Management Practice: Problems and Status.
  - Authors: **Saha, G. C.,** & Ruzinoor, C.M.

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CHAPTER ONE
INTRODUCTION

1.1 Background Information

The coconut palm is one of the world's most important agricultural crops and the production of coconut oil or copra plays an important role in the economy. Known as the "tree of life", it is spoken of with great worship because of its cultural significance, economic impact, and the many great uses of the exotic tree. The name "Coccus nucifera*"* concern for happiness to the family Arecaceae (Kuber & Lakshmi, 2019). Like other major coconut growing countries, coconut farming is of a significant economic importance to the country. Coconuts are cultivated globally in a range of 12.29 million hectares in 93 nations. The industry produced 11.04 million metric tons of copra (on an equal basis). In recent years, there has been a 'boom' of coconut products consumption, thus reducing palm oil demand, resulting in negative effects on biodiversity, soil, and water (Khodifad, 2016; Thomas, Krishnakumar, & Jerard, 2010). Because, oil palm has negative impacts on biodiversity (Ashton-Butt, A., Aryawan, A. A., Hood, A. S., Naim, M., Purnomo, D., Wahyuningsih, R., ... & Foster, W., 2018).

Not only that coconut is ranked one of the worlds' top ten most useful trees, but coconut is also the world's most versatile natural products. For instance, in Malaysia, "coconut is the fourth important industrial crop after oil palm, rubber, and paddy in terms of total planted area" (Sivapragasam, 2014). In spite of its amazing history and the multipurpose utilization of coconut products, in reality, the coconut growers worldwide are facing major challenges. There are a number of different factors which

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Appendix A

Nomination Letter for Data Collection from Personal Interview

Date: January 24, 2018

Dear **En. Zulkifli**

UITm, Arau, Perlis

Subject: Nomination Letter for Data Collection

With regards to the above statement, I'm Dr. Ruzinoor Che Mat Senior Lecturer of Universiti Utara Malaysia would like to give my concern to Gonesh Ch Saha Ankon to conduct a personal interview as part of his PhD research.

He is currently my PhD student which working on research entitled "**A NEW FRAMEWORK OF ONLINE 3D VISUALIZATION TECHNIQUE FOR COCONUT PLANTATION MANAGEMENT**" as part of his PhD research. During his study, he has demonstrated the ability to work independently with great creativity and enthusiasm. With his good progress and consistently working smart, he has successfully completed his proposal defense with minor revision in 2nd Semester. He is now in 2nd year of his study. I am writing this letter to give my high possible support and nomination to Mr. Gonesh Ch Saha Ankon for conducting personal research interview. The purpose of this interview is to know the status of coconut plantation in Perlis, to reveal the major problems facing coconut growers and to examine what management practices are needed at this moment. It's also essential to examine what can be done to avoid the problems observed

Thank you again for the opportunity to nominate such a special and impressive young man. I wish him all the success.

Sincerely,

Dr. Ruzinoor Che Mat
Senior Lecturer,

Universiti Utara Malaysia

School of Creative Industry Management and Performing Arts
Universiti Utara Malaysia

Universiti Utara Malaysia

Appendix B

Outline of Research and Field Observation

Dear Participant:

I would like to enlist your help. I am a graduate student in School of Multimedia Technology and Communication (SMMTC) at Universiti of Utara Malaysia (UUM). I am conducting a study on a new framework of online 3D visualization technique for coconut plantation management as part of my PhD research. The purpose of this preliminary study is to know the status of coconut plantation in Perlis, to reveal the major problems facing coconut producers and to examine what management practices are needed at this moment. I also want to examine what can be done to avoid the problems observed.

Overview

Good agricultural practices can guide the efficient, safe, environmentally-sound production of food of acceptable quality (Ramdwar, 2012) in a sustainable manner. The aim is to provide options and so assist coconut farmers in their decision of the most appropriate management level for their circumstances. Success of coconut plantation establishment starts with the good plantation management. Various observations, reports and studies reveal that most farmers do not practice proper management and this lack of good agricultural practice obviously impacts negatively on the productivity and income generation of their plantations. Coconut farmers must ensure what they know about the status of his farm to take the appropriate management decision. Contrary, the study didn't discover any existing research straightforwardly explores to the online visualization technique for plantation management of coconut farming. This research technique will enable farmers to have access to system which will allow them to more efficiently manage their coconut fields to enhance crop yields.

Research Objectives

The objectives of the research study are:

1) to identify the relevant factors related to online 3D visualization technique for coconut plantation management.
2) to design and develop a new framework of online 3D visualization technique for coconut plantation management.
3) to develop a prototype of online 3D visualization technique for coconut plantation management.
4) to evaluate and validate the new framework of online 3D visualization technique for coconut plantation management.

Expected Outcomes

The new online framework-based 3D visualization technique for managing coconut plantation has a potential of assisting coconut farmers in: -

1. Settling on a choice and giving order to their worker
2. Viewing their cultivating estate in online 3D condition
3. Dealing with their cultivation more adequately by using this new technique

In addition, this new technique can be also applied in other agriculture industries. It can help farmers on enhancing their plantation management through online 3D visualization technique.

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Appendix C

Personal Interview Questions

Question 1: Can you brief a little bit about your coconut plantation?

Question 2: What about information of the tree? Are they been recorded? For example, its location, status, age, distribution of water, solar radiation and soil type, selection of unproductive and old coconut tree, dead leaves, weed control, pests & disease control and so on?

Question 3: How long is the distance between each of the coconut palm tree that been planted?

Question 4: What are the important things that need to be monitored for everyday work routines?

Question 5: Is there a change in the crop situation compared to the last surveillance?

Question 6: What kind of change?

Question 7: Is there any serious pest or disease outbreak?

Question 8: Where are normally all the pest and diseases identifiable?

Question 9: What management practices are needed at this moment?

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Question 10: Can you explain about the management system that normally being used by other organization/company?

Question 11: We're doing a research on using online 3D visualization technique to manage coconut palm plantation. Have you ever used and know any online system that can monitor the coconut palm tree or manage the plantation like this before?

Question 12: If we made a system that can view and display the data of coconut palm trees by navigating through coconut palm plantation in 3D environment, does it will help the management?

Question 13: What are the strategies formulated for coconut plantation in the future?

Appendix D

Expert Review Request on a Framework of Online 3D Visualization Technique

Sub: Expert review request on a new framework of online 3D visualization technique

Dear Sir,

I am a graduate student in School of Multimedia Technology and Communication (SMMTC) at Universiti of Utara Malaysia (UUM) and currently conducting a study on a new framework of online 3D visualization technique for coconut plantation management as part of my PhD research. I am interested in your expertise which is in Computer Science and Information systems. With the expertise you possess, I will be glad that review my new framework which I named a new framework of online 3D visualization technique for coconut plantation management (O3DVS). I would like to enlist your help. The purpose of this expert evaluation is to review the proposed framework in a few dimensions as stated in the reviewing form.

If you agree please fill up the attached consent form and return back to me after which I will send to you the appointment letter officially from UUM together with the proposed deigned framework and the instrument (questionnaire).

For your information, the proposed designed framework is in the form of figure which is illustrated on a single page of paper. With the expertise that you have, it is expected to take 20 to 30 minutes for you to review.

Hope to hear positively from you shortly.

Thanking you in advance for your time, assistance, and cooperation.

Thank you.

Kind regards

Gonesh Chandra Saha

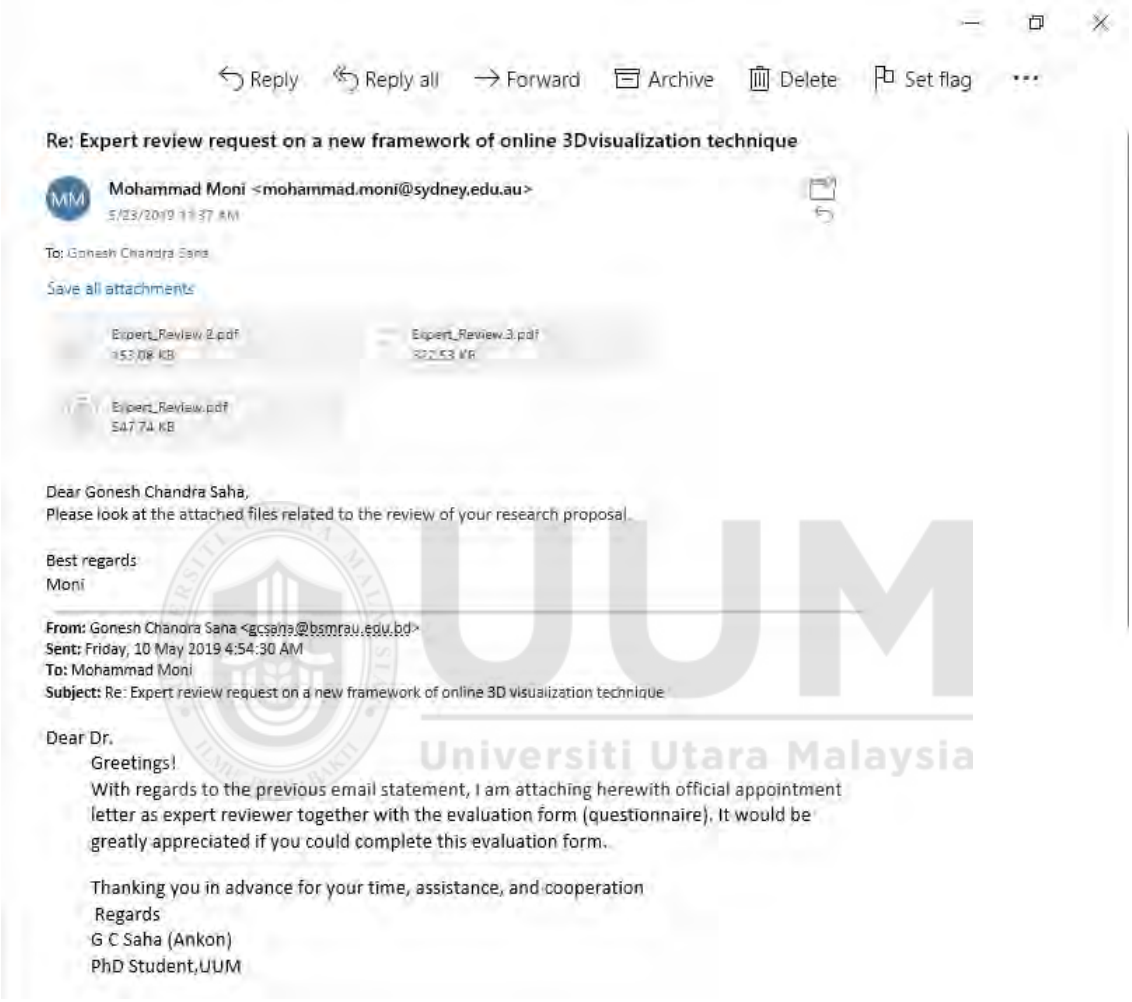
PhD Student

Universiti Utara Malaysia (UUM)

Universiti Utara Malaysia

Appendix E

Sample of Experts' Invitation Email



Reply Reply all Forward Archive Delete Set flag ...

Re: Expert review request on a new framework of online 3Dvisualization technique

MM **Mohammad Moni <mohammad.moni@sydney.edu.au>**
5/23/2019 11:37 AM

To: Gonesh Chandra Saha

Save all attachments

Expert_Review 2.pdf
153.08 KB

Expert_Review 3.pdf
322.53 KB

Expert_Review.pdf
547.74 KB

Dear Gonesh Chandra Saha,
Please look at the attached files related to the review of your research proposal.

Best regards
Moni

From: Gonesh Chandra Saha <gcsahs@bsmrau.edu.bd>
Sent: Friday, 10 May 2019 4:54:30 AM
To: Mohammad Moni
Subject: Re: Expert review request on a new framework of online 3D visualization technique

Dear Dr.
Greetings!
With regards to the previous email statement, I am attaching herewith official appointment letter as expert reviewer together with the evaluation form (questionnaire). It would be greatly appreciated if you could complete this evaluation form.

Thanking you in advance for your time, assistance, and cooperation
Regards
G C Saha (Ankon)
PhD Student,UUM

Universiti Utara Malaysia

Appendix F

Sample of Appointment Letter for Expert

PUSAT PENGAJIAN PENGURUSAN INDUSTRI KREATIF DAN SENI PERSEMBAHAN
SCHOOL OF CREATIVE INDUSTRY MANAGEMENT AND PERFORMING ARTS
Universiti Utara Malaysia
06010 UUM SINTOK
KEDAH DARUL AMAN
MALAYSIA

UUM
Universiti Utara Malaysia

Tel: 604-928 6404/6405
Faks (Fax): 604-928 6465
Laman Web (Website): scimpa.uum.edu.my

[redacted]

[redacted]
Research fellow and Conjoint Lecturer,
University of Sydney,
Darlington Campus,
Australia.
Email: [redacted]

Sir,

APPOINTMENT AS EXPERT REVIEWER FOR A NEW FRAMEWORK OF ONLINE 3D VISUALIZATION TECHNIQUE FOR COCONUT PLANTATION MANAGEMENT

Thank you for agreeing to involve as an expert in PHD study, particularly for reviewing and evaluating a new framework with the following details:

Student Name :	**Gonesh Chandra Saha**
Matric No. :	**900549**
School :	**School of Multimedia Technology and Communication, UUM**
Research Title :	**A new framework of online 3D visualization system for coconut plantation management**

For your information the student will use the framework for his research. Therefore, he needs your expertise to review the proposed model in a few dimensions as stated in the reviewing form. Your cooperation, time, and assistance are greatly appreciated.

Thank you.

"ILMU BUDI BAKTI"

Sincerely yours,

ASSOC. PROF. DR. RUZINOOR BIN CHE MAT
School of Creative Industry Management & Performing Arts (**SCIMPA**)
UUM College of Arts and Sciences,
Universiti Utara Malaysia (UUM)

Universiti Pengurusan Terkemuka
The Eminent Management University

Universiti Utara Malaysia

Appendix G

Expert Review Form

SCHOOL OF MULTIMEDIA TECHNOLOGY AND COMMUNICATION

COLLEGE OF ARTS & SCIENCES

EXPERT REVIEW

EVALUATION OF A NEW FRAMEWORK OF ONLINE 3D VISUALIZATION TECHNIQUE FOR COCONUT PLANTATION MANAGEMENT

Dear Prof./ Dr./Sir/Ma,

I am **Gonesh Chndra Saha** and currently pursuing PhD program in Multimedia at Univeriti Utara Malaysia (UUM), Malaysia. I am delighted to inform you that you have been selected to participate in this research on the reason as follows:

1. Your qualification either in Human Computer Interaction (HCI) or Machine Applications or Multimedia or Software Engineering (SE) or Information Systems (IS) or Computer Science (CS) or any related areas, and /or
2. You have been researching / teaching in Multimedia or Visualization or HCI or Agricultural Application or IT or CS areas for at least five years.

My PhD research proposes **A NEW FRAMEWORK OF ONLINE 3D VISUALIZATION TECHNIQUE FOR COCONUT PLANTATION MANAGEMENT**. As part of this research, this study adopts a new framework of online 3D visualization technique for coconut plantation management that I specifically deigned to be usable in assisting plantation managers to make good decisions,

The framework is part of the output for my second objective, in order to achieve the main objective of the study. Therefore, as part of the prerequisite for this research, I would like to humbly request your opinions, suggestions, and recommendations to review and improve our new framework of online 3D visualization technique for coconut plantation management listed in the review form below.

It would be greatly appreciated if you could complete this evaluation form. This booklet contains ten pages. Enclosed in the next pages is the consent form and evaluation form.

The information supplied will be treated as confidential and will be used for the research purpose, which will be reported anonymously in academic publications.

The following are the objectives of our study:

1) to identify the relevant factors related to online 3D visualization technique for coconut plantation management.
2) to design and develop a new framework of online 3D visualization technique for coconut plantation management.
3) to develop a prototype of online 3D visualization technique for coconut plantation management.
4) to evaluate and validate the new framework of online 3D visualization technique for coconut plantation management.

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I hope you are able to complete all the enclosed forms. Hereby, I would like to take this opportunity to express my heartfelt thanks to you for your cooperation, contribution and time to this study.

Please feel free to contact me by e-mail: gcsaha@bsmrau.edu.bd regarding any queries or my supervisor ruzinoor@uum.edu.my

Best Regards,

Gonesh Chandra Saha

Assoc. Prof. Dr. Ruzinoor Che Mat

CONSENT FORM FOR EXPERT REVIEWER

1. With the expertise and the existing knowledge that I have, I volunteer to be an expert reviewer for this study as proposed by Gonesh Chandra Saha, a graduate student from the Awang Had Salleh Graduate School, College of Arts & Sciences, Universiti Utara Malaysia (UUM) under the supervision of Assoc. Prof. Dr. Ruzinoor Che Mat.
2. I understand that the expert review process is designed to gather information and comments in improving the proposed framework.
3. I understand that no part of the proposed framework may be reproduced, stored in the retrieved system, or transmitted in any form or by any means, electronic, or otherwise, without prior permission from the researcher and his supervisors.
4. I understand that the researcher will not identify me by name in any report using information obtained from the questionnaire and that my confidentiality as a participant in this study will remain secure. Subsequent uses of records and data will be subject to standard data use policies which protect the anonymity of individuals and institutions.
5. I understand that this study has been reviewed and approved by the Awang Had Salleh Graduate School, College of Arts & Sciences, and Universiti Utara Malaysia.
6. I have read and understood the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.
7. I am given a copy of this consent form.

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Printed Name and Official Stamp	Date and Signature

Please read and go through the figure of the framework carefully. Once this is done, with the expertise you possess, please provide feedback for all questions in the provided spaces.

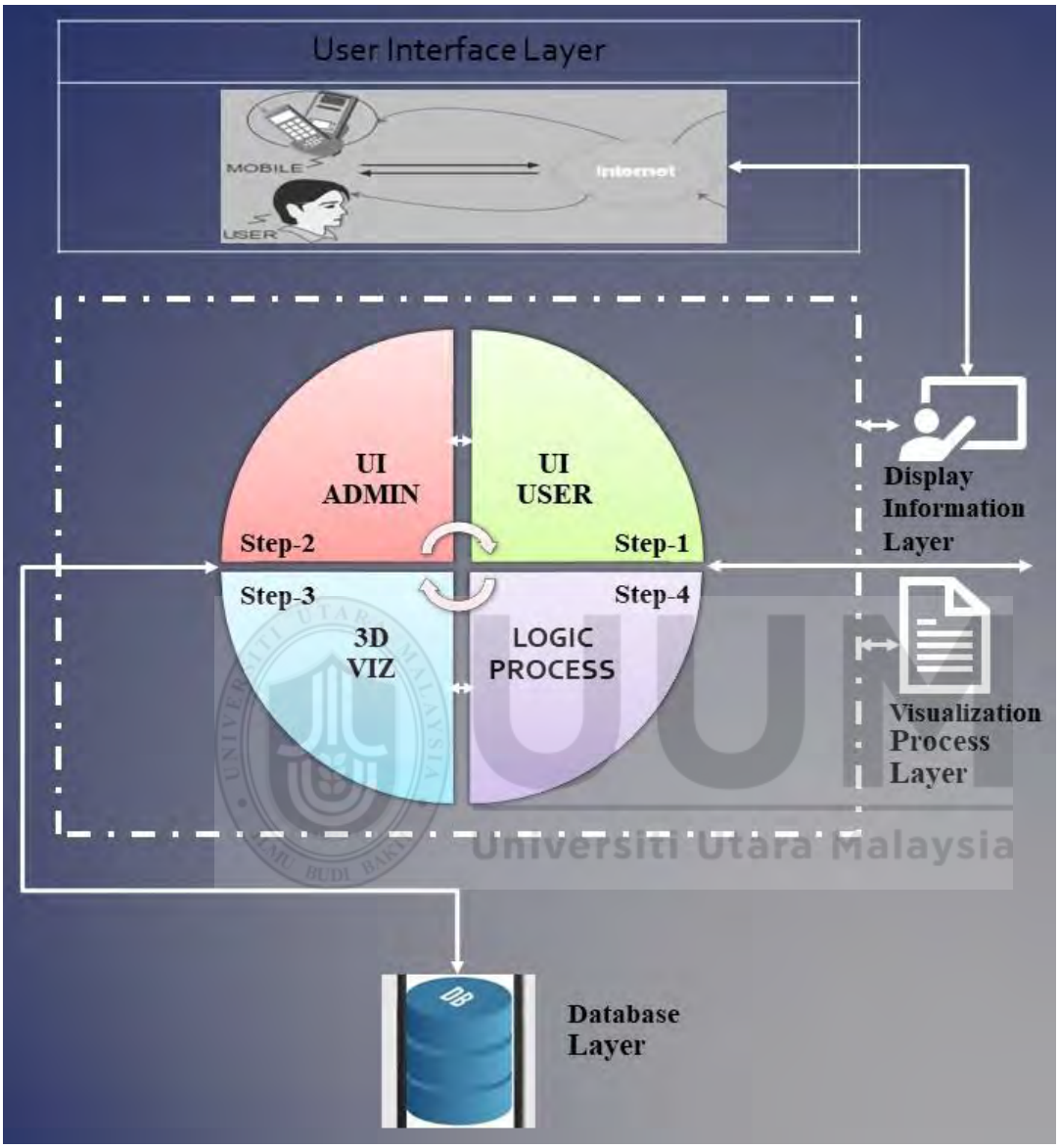

Figure 1: The new framework of online 3D visualization technique for coconut plantation management

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Based on the aforementioned framework (as depicted in the given handout). Please tick (✓) your choice

Main Components/ Terminology		Description	All proposed components and terminology are			
			Highly Relevant	Quite Relevant	Somewhat Relevant	Not Relevant
The framework comprises of four layers	User Interface Layer	This layer that takes into consideration inputting the information to the application through the web and creating the yield as 3D view and users can access the application through this layer. It has two segments: user and web respectively that connect virtual coconut farm view model				
	Visualization Process Layer	Responsible to enhance the viewing, monitoring, and dissemination of additional information. Links the viewing of monitoring information from coconut plantation.				
	Display Information Layer	This viewing layer in charge of visualization of the output and delivering the yield as 3D view. What's more, interfaces for bringing in/sending out and management of different parts of the platform ought to be created in this layer and fulfills the prerequisites presented in visualization				

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	Database Layer	3D data storehouse of all about major required information for the coconut plantation; an outside data interface which incorporates for correspondence with outer information management. It additionally makes adaptable for clients to pick the farm management information in view of their uses and preferences.				

Elements in the Following Components	**Description**	**All proposed components and terminology are**			
		Highly Relevant	**Quite Relevant**	**Somewhat Relevant**	**Not Relevant**
User Interface Layer					
Admin	The client can connect to the application as administrator by providing log-in credentials. This admin can edit database and update coconut tree information.				
User	The client can connect to the application as viewer just following URL link through internet. This user can also be connected to 3D VIZ step through internet interface where coconut plantation information being explored and visualized.				

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Elements in the Following Components	Description	All proposed components and terminology are			
		Highly Relevant	Quite Relevant	Somewhat Relevant	Not Relevant
Visualization Process Layer					
Step-3: 3D VIZ	The fundamental task of this step is to handle the core visualization procedure on the coconut plantation information requested by the upper layer component UI User through UI Admin step. This segment incorporates to Logic process for managing 3D visualization function.				
Step-4: Logic Process	This is the most important element in the whole system architecture. The function of this step is as the translator for the entire procedure in the framework. It controls the translation between various conventions and deals with the connection between each layer.				
Internet	This acts as sandwich interface between the external user and visualization core layer. The users (coconut farmers or plantation managers) or system admin can be connected through this interface to view or visualize the virtual coconut plantation area.				

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Elements in the Following Components	Description	All proposed components and terminology are			
		Highly Relevant	Quite Relevant	Somewhat Relevant	Not Relevant
Display Information Layer					
Step-1: UI USER	The role of this component is to request the 3D scene from the system. The entire processes start at this step for the process of generating 3D scene.				
Step-2: UI ADMIN	This is the step 2 segment of display information layer interact with UI User and 3D VIZ process for displaying plantation information. The UI Admin connects to multiple data sources from Database layer, integrates with workflows to manage service requests and remote procedure calls.				
Internet	This acts as sandwich interface between the database layer and visualization core layer. Encrypted data is passed through this interface. User can connect database to edit and update plantation information.				

Elements in the Following Components	Description	All proposed components and terminology are			
		Highly Relevant	Quite Relevant	Somewhat Relevant	Not Relevant
Database Layer					

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Encryption	3D objects are encrypted here before sending and reconstruction to the core visualization process. This element is directly interfering to internet interface to connect database layer. It ensures the security of the 3D images views.				
Database Retrieve	This element in Database Layer retrieves the essential plantation information for the system to work. It can connect API segment of the information store interface.				

1. The connections and flows of all the component are logical? Yes [ ] No [ ]

2. The framework is usable for designing and implementing an online Yes [ ] No [ ]

3D visualization technique for coconut plantation management

3. Overall, the developed framework is readable? Yes [ ]

No [ ]

4. Overall, I am satisfied with the developed framework Yes [ ]

No [ ]

5. Please write your further comments and suggestions below:

_____

_____

_____

_____

_____

_____

_____

_____

_____

EVALUATION BY EXPERT

EXPERT /REVIEWER DETAILS

Highest educational level* : _____ Gender : ☐ Male ☐ Female

Years of Experience * : _____ Age: _____

Signature : _____

Name : _____

Qualification :

_____

Name and address of Institution/University/Plantation company:

_____

_____

_____

_____

Institution stamp: Date: _____

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Appendix H

Sample of Prototype Evaluation Invitation Email

A Survey of Prototype Evaluation for A new framework of online 3D visualization system for coconut plantation management Inbox ×

gcsaha@bsmrau.edu.bd May [redacted], 20[redacted], 10:02 PM (3 days ago)

to shaardan@lgm.gov.my, bcc: zuraidi, bcc: salihin, bcc: mfirdaus, bcc: helmy, bcc: mai.lgmpc, bcc: roslissim, bcc: affendi, bcc: farid, bcc: azrul, bcc: shahrul, t

Dear Sir/Prof/Ma/Dr.

Greetings and Good Day,

We are delighted to inform you that you have been selected randomly to participate in our research (**A new framework of online 3D visualization system for coconut plantation management**). The aim of the questionnaire is to evaluate the usability of developed prototype based on the new framework. We are interested in your expertise which is in Agricultural Science or Computer Science or Coconut Plantation Management or 3D Visualization Applications.
We would like to enlist your help. The purpose of this expert evolution is to evaluate the designed prototype in a few dimensions as stated in the questionnaire.

The information supplied will be treated as confidential and will be used for research purposes which may be reported anonymously in academic publication.

Please navigate the provided google form (https://forms.gle/htuh8pePPt3yq3Ab7)
link to provide feedback for all questions.

It would be greatly appreciated is you could complete the questions with honest and sincere. I would like to say thank you for your time and cooperation.

Yours Truly,

Gonesh Chandra Saha
Prof. Madya Dr. Ruzinoor Che Mat
Universiti Utara Malaysia (UUM)
Mobile: 0116240035

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Appendix I

Questionnaire for Prototype Evaluation

SCHOOL OF MULTIMEDIA TECHNOLOGY AND COMMUNICATION

COLLEGE OF ARTS & SCIENCES

Questionnaire for Prototype Evaluation

Measuring the usability of the developed Online 3D Visualization Prototype for coconut plantation management

Greetings and Good Day,

Dear respondents, we are delighted to inform you that you have been selected randomly to participate in our research (**A new framework of online 3D visualization system for coconut plantation management**). The aim of the questionnaire is to evaluate the usability of developed prototype based on the new framework.

The information supplied will be treated as confidential and will be used for research purposes which may be reported anonymously in academic publication.

It would be greatly appreciated is you could complete the questions with honest and sincere. I would like to say thank you for your time and cooperation.

Yours Truly,

Gonesh Chandra Saha

Section A: Respondent's Demographic

INSTRUCTION: Please explore prototype link (https://online3dcoconutplantationmanagement.home.blog/) and go through the application carefully.

Once this is done, with the expertise you possess, please provide feedback for all questions in the provided spaces. Please tick (✓) in the box and fill in the blank.

1. Gender: ☐ Male ☐ Female
2. Age ☐ 10-15 years ☐ 26-40 years
   ☐ 41-60 years ☐ 61 years and above
3. Educational level: ☐ Primary School ☐ Secondary School
   ☐ Diploma ☐ Bachelor's degree
   ☐ Master's Degree ☐ Doctorate Degree
4. Your experience on Agricultural Science or Computer Science or Coconut Plantation Management or 3D Visualization Applications: _____Months
5. Have you been working with coconut plantation? ☐ Yes ☐ No
   If Yes how long _____months. If No, please proceed to next questions.

Section B: Prototype Evaluation

INSTRUCTION: Please circle (O) on the scale of your choice.

Strongly Disagree	Disagree	Somehow Agree	Agree	Strongly Agree
1	2	3	4	5

Perceived Usefulness						
1. Developed prototype enables coconut plantation managers to make decisions more easily	1	2	3	4	5
2. It is easy to find the plantation information I need in prototype	1	2	3	4	5
3. The developed prototype is effective in helping the coconut plantation managers	1	2	3	4	5
4. Using prototype increase my productivity in managing coconut plantation	1	2	3	4	5
5. The prototype functions well based on the requirements	1	2	3	4	5

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Perceived Ease of Use

1. It is easy to learn and operate the prototype	1	2	3	4	5
2. I would find it easy to get prototype does exactly what I want	1	2	3	4	5
3. I feel comfortable and confident using developed prototype	1	2	3	4	5
4. I would find prototype to be flexible to interact with web	1	2	3	4	5
5. I feel excited when using the prototype	1	2	3	4	5

Satisfaction

1. The system is important for monitoring coconut plantation	1	2	3	4	5
2. It is delightful using the prototype	1	2	3	4	4
3. The prototype is easy to use for coconut plantation managers	1	2	3	4	5
4. I am likely to recommend the prototype to others	1	2	3	4	5
5. Overall, I am satisfied with the developed prototype	1	2	3	4	5

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Outcome/ Future Use

1. I was able to view my coconut plantation quickly using the prototype	1	2	3	4	5
2. I could effectively view the coconut plantation using the prototype	1	2	3	4	5
3. I was able to efficiently view the coconut plantation using the prototype	1	2	3	4	5
4. Based on current experience with using this prototype, I think I would use it regularly	1	2	3	4	5
5. I believe I could become productive using the prototype	1	2	3	4	5

END OF QUESTIONS

THANK YOU FOR PARTICIPATING!

Appendix J

Reliability Test Results

Reliability

Notes

Output Created		22-MAY-2019 01:50:15
Comments		
Input	Data	E:\Backup PROPOAL\After Proposal Defense\Data Analysis\DataAnalyze_Gonesh3_practice[1556].sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	30
	Matrix Input	
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the procedure.
Syntax		RELIABILITY /VARIABLES=P_USE1 P_USE2 P_USE3 P_USE4 P_USE5 /SCALE('Item_Usefulness') ALL /MODEL=ALPHA /STATISTICS=DESCRIPTIVE SCALE /SUMMARY=TOTAL MEANS.
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.18

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Scale: Item_Usefulness

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.713	.716	5

Item Statistics

	Mean	Std. Deviation	N
P_USE1	4.00	.983	30
P_USE2	3.77	1.006	30
P_USE3	4.07	.785	30
P_USE4	3.87	.860	30
P_USE5	3.97	.999	30

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	3.933	3.767	4.067	.300	1.080	.014	5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
P_USE1	15.67	6.851	.442	.434	.678
P_USE2	15.90	5.955	.636	.613	.590
P_USE3	15.60	7.421	.481	.416	.665
P_USE4	15.80	7.269	.449	.381	.674
P_USE5	15.70	7.114	.371	.360	.708

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Scale Statistics

Mean	Variance	Std. Deviation	N of Items
19.67	10.092	3.177	5

```
FREQUENCIES VARIABLES=P_USE1 P_USE2 P_USE3 P_USE4 P_USE5
  /NTILES=4
  /STATISTICS=STDDEV MINIMUM MAXIMUM MEAN
  /BARCHART FREQ
  /ORDER=VARIABLE.
```

Scale: eofuse2

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.743	.746	5

Scale: Aman

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.857	.860	5

Scale: Aout

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.838	.843	5

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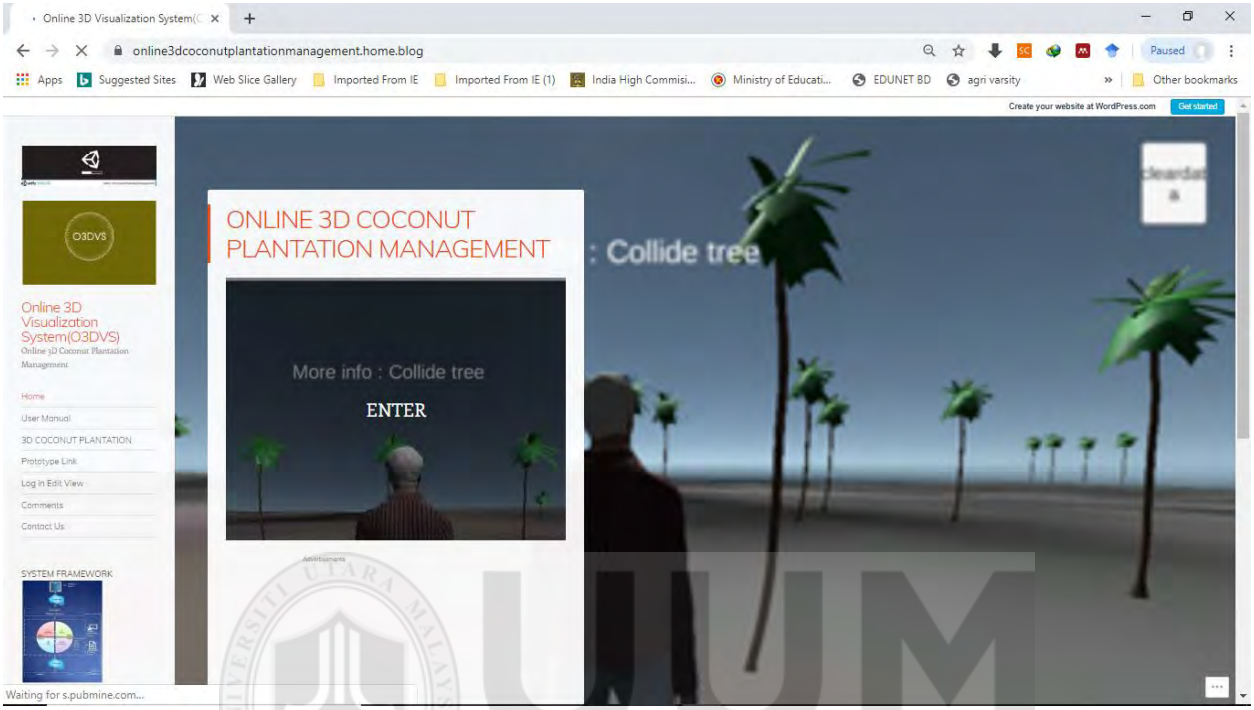
Appendix K

Screenshot of Prototype Web Interface



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Appendix L

Evaluation by Experts in Bangladesh

(Expert 1)

I hereby certify that the **Online 3D visualization prototype for monitoring coconut plantation** has been produced by Gonesh Chandra Saha from the College of Arts and Sciences, University Utara Malaysia. It has been checked by me in terms of the monitoring coconut plantation by using developed prototype and the general comments are as follows:

General Comments:

I am one of the managers of coconut plantation in Jessore district of Khulna division from the south-western region, Bangladesh. During my knowledge of the application provided by the researcher and through my five years of experience after managing the plantation, brief of my comments below:

1- The application is a new idea and the users also can view the management information depending on the present status of the trees.

2- This helps the farmers or plantation managers in monitoring their trees with accurate information.

3- The farmers can access the system anywhere they like and take decisions on the spot.

4- Based on all of this advantage, the farmer or manager can work more effectively without going directly to the plantation site.

5- The system was easy to handle.

The system consists of several menus, which can be accessed by simply web browsing skills.

6- I suggest make it applicable for other crops as well.

and making decisions on the problem that possibly arise. Thank you to the researcher for the effort and attention to this segment of society.

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Appendix M

Evaluation by Scientific Officer in Japan

(Expert 2)

I hereby certify that the **Online 3D visualization prototype for monitoring coconut plantation** has been produced by Gonesh Chandra Saha from the College of Arts and Sciences, University Utara Malaysia. It has been checked by me in terms of the monitoring coconut plantation by using developed prototype and the general comments are as follows:

General Comments:

Through the study of the application, its tools and its impact on our students with special needs (hearing impaired) and responses to their actions show us the following:

1. The idea of the application is a great concern settling on a choice and giving order to their worker
2. Viewing their cultivating estate in anytime and at anywhere thereby allowing farmers to effectively monitor their plantation operations
3. Dealing with their cultivation more adequately by using this new technique
4. Due to its online availability, the plant of the area will be view virtually and improved work efficiency
5. It will assist farmers to increase their income by reducing working time.
6. It is also beneficial to the society, as it helps to assist in decision making

In addition, this new technique can be also applied in other agriculture industries. It can help farmers on enhancing their plantation management through online 3D visualization technique.

Appendix N

The Prototype Pseudocode: Coconut Plantation with 16 Trees

(Unity)

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
public class cameraviewer : MonoBehaviour {
	public GameObject northview;
	public GameObject southview;
	public GameObject westview;
	public GameObject eastview;
	public GameObject charview;
	public GameObject orthoview;

	// Use this for initialization
	void Start () {
		northview.SetActive(false);
		southview.SetActive(false);
		westview.SetActive(false);
		eastview.SetActive(false);
		charview.SetActive(true);
		orthoview.SetActive(false);
	}
	// Update is called once per frame
	void Update () {
		if(Input.GetKeyUp(KeyCode.Keypad1)||Input.GetKeyDown(KeyCode.O))
			{
				//viewortho
			northview.SetActive(false);
			southview.SetActive(false);
			westview.SetActive(false);
			eastview.SetActive(false);
			charview.SetActive(false);
			orthoview.SetActive(true);
			}

		if(Input.GetKeyUp(KeyCode.Keypad2)||Input.GetKeyDown(KeyCode.P))
			{
				//viewnorth
			northview.SetActive(true);
			southview.SetActive(false);
			westview.SetActive(false);
			eastview.SetActive(false);
```

```
                charview.SetActive(false);
                orthoview.SetActive(false);
            }

        if(Input.GetKeyUp(KeyCode.Keypad3)||Input.GetKeyDown(KeyCode.L))
            {
                    //viewsouth
                northview.SetActive(false);
                southview.SetActive(true);
                westview.SetActive(false);
                eastview.SetActive(false);
                charview.SetActive(false);
                orthoview.SetActive(false);
            }

    if(Input.GetKeyUp(KeyCode.Keypad4)||Input.GetKeyDown(KeyCode.K))
            {
                    //viewwest
                northview.SetActive(false);
                southview.SetActive(false);
                westview.SetActive(true);
                eastview.SetActive(false);
                charview.SetActive(false);
                orthoview.SetActive(false);
            }
if(Input.GetKeyUp(KeyCode.Keypad5)||Input.GetKeyDown(KeyCode.I))
            {
                    //vieweast
                northview.SetActive(false);
                southview.SetActive(false);
                westview.SetActive(false);
                eastview.SetActive(true);
                charview.SetActive(false);
                orthoview.SetActive(false);
            }

if(Input.GetKeyUp(KeyCode.Keypad6)||Input.GetKeyDown(KeyCode.M))
            {
                //vieweast
                northview.SetActive(false);
                southview.SetActive(false);
                westview.SetActive(false);
                eastview.SetActive(false);
                charview.SetActive(true);
                orthoview.SetActive(false);
```

```
                                        }
        }
}

#Collider
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.UI;

public class collider : MonoBehaviour {
        public Text infoall;

                void OnTriggerEnter (Collider other)
        {
                                if (other.gameObject.name == "pokok0")
                {
                        print("ini pokok satu laa");
                        infoall.text=PlayerPrefs.GetString("tree1");
                }

                if (other.gameObject.name == "pokok1")
                {
                        infoall.text=PlayerPrefs.GetString("tree2");
                }

                if (other.gameObject.name == "pokok2")
                {
                        print("ini pokok tiga  laa");
                        infoall.text=PlayerPrefs.GetString("tree3");
                }

                if (other.gameObject.name == "pokok3")
                {
                        infoall.text=PlayerPrefs.GetString("tree4");
                }
                if (other.gameObject.name == "pokok4")
                {
                        infoall.text=PlayerPrefs.GetString("tree5");
                }
                if (other.gameObject.name == "pokok5")
                {
                        infoall.text=PlayerPrefs.GetString("tree6");
                }
                if (other.gameObject.name == "pokok6")
                {
```

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```
                infoall.text=PlayerPrefs.GetString("tree7");
            }
            if (other.gameObject.name == "pokok7")
            {
                infoall.text=PlayerPrefs.GetString("tree8");
            }
            if (other.gameObject.name == "pokok8")
            {
                infoall.text=PlayerPrefs.GetString("tree9");
            }
            if (other.gameObject.name == "pokok9")
            {
                infoall.text=PlayerPrefs.GetString("tree10");
            }
        }

        void OnTriggerExit(){
            infoall.text="please get close to tree for information";
        }
        // Use this for initialization
        void Start () {
            infoall.text="please get close to tree for information";
        }
        // Update is called once per frame
        void Update () {
        }
}

using System.Collections;
using System.Collections.Generic;
using UnityEngine;
public class deleteallplayerpreff : MonoBehaviour {

        public void padamplayerpreff()
        {
                PlayerPrefs.DeleteAll();
        }
        // Use this for initialization
        void Start () {
        }
        // Update is called once per frame
        void Update () {
        }
}

using System.Collections;
```

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```
using System.Collections.Generic;
using UnityEngine;
public class deleteplayerpreff : MonoBehaviour {
	// Use this for initialization
	void Start () {
	}
	// Update is called once per frame
	void Update () {
	}
}
```

(PHP)

```
<?php
   // create the connection to our database with following values: location of our databse
   // (with xampp it's "localhost"), next is the login ("name" and "password").
   // if the connection can not be established we get an error message, that we've entered after "or
die"
   $sql_connect = mysql_connect("localhost", "hafsaruz_hafiz", "DIGIMON@2") or die ("no
DB Connection");
      // after we're logged in, we can call our database
   mysql_select_db("hafsaruz_unitydb") or die ("DB not found");
      // now we simply get the scores and sort them by their value. we also add a limit of 5, so we
only
   // select the 5 highest values. The * means we search through every value.
   $query = "SELECT * FROM users LIMIT 10 ";
      // now we store our selected values into a result variable
   $result = mysql_query($query);
      // this will select the whole row we found the score at
   //$num_results = mysql_num_rows($result);
    // at the end we will get 5 rows with only the name and score values in each row
   //if ($row =5)
   //{
      // $row = mysql_fetch_array($result);
       //the echo command is used as the returned value for our Unity Script
       //echo $row['x'];
 //echo $row['x']. "," . $row['y']. " ," . $row['z']. ;
//echo "," . $row["x"]. " ," . $row["y"]. " ," . $row["z"]. "<br>";
while($row = mysql_fetch_array($result)){
echo $row["alldata"] . "/";
//echo $row["y"] . "/";
//echo $row["z"] . "/";
//echo $row["scaley"] . "/";
}
   //}
   // we're done now, so we can close the connection
   mysql_close($sql_connect);
```

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```
?>
<?php
   // create the connection to our database with following values: location of our databse
   // (with xampp it's "localhost"), next is the login ("name" and "password").
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       //echo $row['x'];
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//echo "," . $row["x"]. " ," . $row["y"]. " ," . $row["z"]. "<br>";
while($row = mysql_fetch_array($result)){
echo $row["x"] . "/";
echo $row["y"] . "/";
echo $row["z"] . "/";
echo $row["scaley"] . "/";
}    //}    // we're done now, so we can close the connection
   mysql_close($sql_connect);


?>
```

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