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Soft Shadow Rendering based on Real Light Source Estimation in Augmented Reality

Zakiah Noh zakiahnoh@gmail.com
ViCubeLab,Department of Computer Graphics and Multimedia,
Faculty of Computer Science and Information System,
UniversitiTeknologi Malaysia,
81310 Skudai, Johor, Malaysia

Mohd Shahrizal Sunar shah@cs.utm.my
ViCubeLab, Department of Computer Graphics and Multimedia,
Faculty of Computer Science and Information System,
UniversitiTeknologi Malaysia,
81310 Skudai, Johor, Malaysia

Abstract

The most challenging task in developing Augmented Reality (AR) applications is to make virtual objects mixed harmoniously with the real scene. To achieve photorealistic AR environment, three key issues must be emphasized namely consistency of geometry, illumination and time. Shadow is an essential element to improve visual perception and realism. Without shadow, virtual objects will appear like it is floating and thus will make the environment look unrealistic. However, many shadow algorithms still have drawbacks such as producing sharp and hard-edged outlines, which make the shadow's appearance unrealistic. Thus, this paper will focus on generating soft shadow in AR scene, rendered base on real light sources position. The reflective sphere is used to create environment map image that can estimate the light source from the real scene and generate the soft shadows.

Keywords: Augmented Reality, Shadow, Soft Shadow, Reflective Sphere, Environment Map.

1. INTRODUCTION

Augmented Reality (AR) is part of mixed reality that mixes the physical world with virtual objects. This technology allows users to interact and control the environment with their actions. Azuma [1] defined three criteria of an AR system. Firstly, AR is a combination of real and virtual world. Secondly, AR is interactive in real-time, and finally, AR must be registered in 3D. Currently, developers of AR technology are working on broad areas of AR applications which are reliable to be used in real world application such as in cultural heritage [2][3], game, simulation, medical and education.

To achieve photorealistic rendering in AR, three problems have been identified, geometry consistency, illumination consistency and time consistency [4]. Consistency of geometry refers to the correct position of a virtual object in real scene location. Time consistency is the correspondence between real world and virtual world. Hence, it is important part to make a possible smooth interaction in real time. Meanwhile, consistency of illumination is to match the shading of virtual object with other object in real scene, where virtual object must cast a correct

shadow. Shadow is one of the elements that can add realism to an AR environment. To improve objects presence, it is important to provide more information of the size, position and shape of virtual objects in the real world.

Related techniques have been done since several years ago, where elements such as light source, object placement, luminance and the geometry of the environment were given high consideration onto creating a realistic shadow [5][6]. Without shadows, computer generated images will look unreasonable even with precise measurements of the light source and material properties [7]. Thus, this paper will focus on generation of soft shadow that can be rendered based on real light source estimation to produce a credible soft shadow in AR environment.

The rest of the paper is organized as follows: Section 2 gives brief explanations about related works in shadow in AR. Section 3 discusses the process of shadow implementation in AR environment and continue on with experiment in section 4. Experimental result will be discussed in section 5 and finally, section 6 will conclude about this paper and future work.

2. RELATED WORKS

Recently, computer graphics technologies have seen rapid growth and researchers involving in AR field have continuously trying to improve the quality of graphics system. Jacobs et al. [8] present the classification of illumination methods to be applied in mixed reality environment. Two categories of rendering method were stated, common illumination and relighting. Common illumination method provides a consistent lighting when virtual objects are added into real world, and does not allows any modification of the current scene. The method that used common illumination can be found in [9][10][11][12][13][14][15]. Whilst, relighting method allows the modification of the original illumination such as in [16][17].

Naemura et al. [18] proposed the concept of virtual light and virtual shadow. The concept of virtual shadow in this method is divided into four types: i) real to virtual shadow for rigid objects, ii) real to virtual shadow for non-rigid objects, iii) image-based virtual to virtual shadow, and iv) virtual to real shadow. These methods will project the shadow of real object onto virtual world and vice versa. A natural merge between real and virtual worlds will be obtained when the shading and shadows correspond between these two worlds. Sugano et al. [7] and Madsen et al. [19] highlight the importance of consistent shadows in AR environment.

Research which is related to performance of shadow can be found in [20][11][15]. These proposed approaches were designed to run in graphics hardware and offer the way to balance the performance without sacrificing the visual quality of shadows. Besides that, generating shadows using shadow maps [7][15] or shadow volume [12] can be developed at a low cost. Meanwhile, Haller et al. [12] proposed the concept of using shadow volume, which is focusing more on the shadow problems in AR system. The reality of AR world was improved with projected real shadows onto virtual objects and vice versa.

The survey of soft shadow classification method was done in [21]. This method can be applied to generate shadows in the context of AR environment. Jacobs et al. [13] and Madsen and Laursen [15] point the issues of double shadow in AR environment, where they had solved the overlapping between real and virtual shadow to produce realistic shadow. A real-time rendering solution to simulate color-consistent of virtual shadows in a real environment was presented by Jacobs et al. [13]. The rendering process in their proposed method has three step mechanisms; shadow detection, shadow protection and shadow generation, in which every step produces consistent shadows between real and virtual objects in real-time. To accomplish the successful shadow detection and shadow generation in their method, three requirements are needed: the geometry, the light source position and only hard or semi-soft shadows are allowed.

The credibility of shadow generation also can be achieved with correct estimation of light source position. The researches related to the light source position can be found in [5] [17][22], which all have the same direction, to propose a method that can create lighting for virtual object in AR environment to be as realistic as possible like in the real world. This paper is based on the research that estimates light source position to render soft shadows which is associated with the real world.

3. SHADOW GENERATION IN AR

This section will explain the detail process of generating realistic shadow. The framework was created to lead the development process of shadow and the method of soft shadow that will be used in this work will be explained.

Implementation

The problems in terms of consistency of geometric and photometric registration as described in [23] will be highlighted in the implementation processes. These problems need to be resolved especially when dealing with unrealistic fake shadows generation. Then, shadow will be rendered based on estimation of light source position in the real scene and get the correct-perception of user viewpoint. This result will produce the photorealistic rendering in AR environment. In this paper, the implementation of the proposed method involves several steps as illustrated in Figure 1.

The cameras will detect markers composed with reflective spheres in the real scene. Then, the relationship between the 2D marker and camera coordinate system will be determined using existing technique. This relationship is an important step to complete the geometric registration so that the virtual object is placed in the right position. After that, the system will detect the reflective sphere segmentation on the marker, which is painted with glossy black paint to avoid the dynamic range problem to create the environment map. Environment map will define the incoming light from all possible directions at some reference point.

The system will use median cut algorithm, which presents a credibly complex lighting environment. This algorithm will produce a set of light sources [25] and will estimate the light source position in real scene from the environment map. The light sources are used to generate realistic shadows using projection shadow. Then, the soft shadow will be applied to get smooth-edges outline of shadows so that the shadows will look realistic. Finally, the 3D virtual object with the correct attached shadow is rendered in the real scene.

The setup of the system in this work is inspired from [5]. This setup consists of laptop or personal computer as a display device, camera to track marker and display virtual object as output video, 2D marker to display virtual object, 3D marker to estimate light source from the real scene and light as a light source for the system. 3D marker was constructed using the reflective sphere and 2D marker. Figure 2 illustrates the setup of the system prototype.

Median cut algorithm

The algorithm will split the environment map image into 2n regions based on latitude and longitude format. The regions that are already split have an equal light energy and each of them has a light source representation. The steps to split the environment map image are as follows:

1. The environment map of light probe is added to the region list as a single region.
2. Every region in the list will subdivide along the longest dimension so that its light energy is split evenly.
3. Return to step 2 if number of iteration is less than n.
4. The light source is placed at the center of each region and the color of light source is set to the sum of pixel values within the region [25].

The advantages of using this algorithm are it is efficient, fast and easy to put into practice. The algorithm is very practical to apply the merging of virtual object into the real scene.

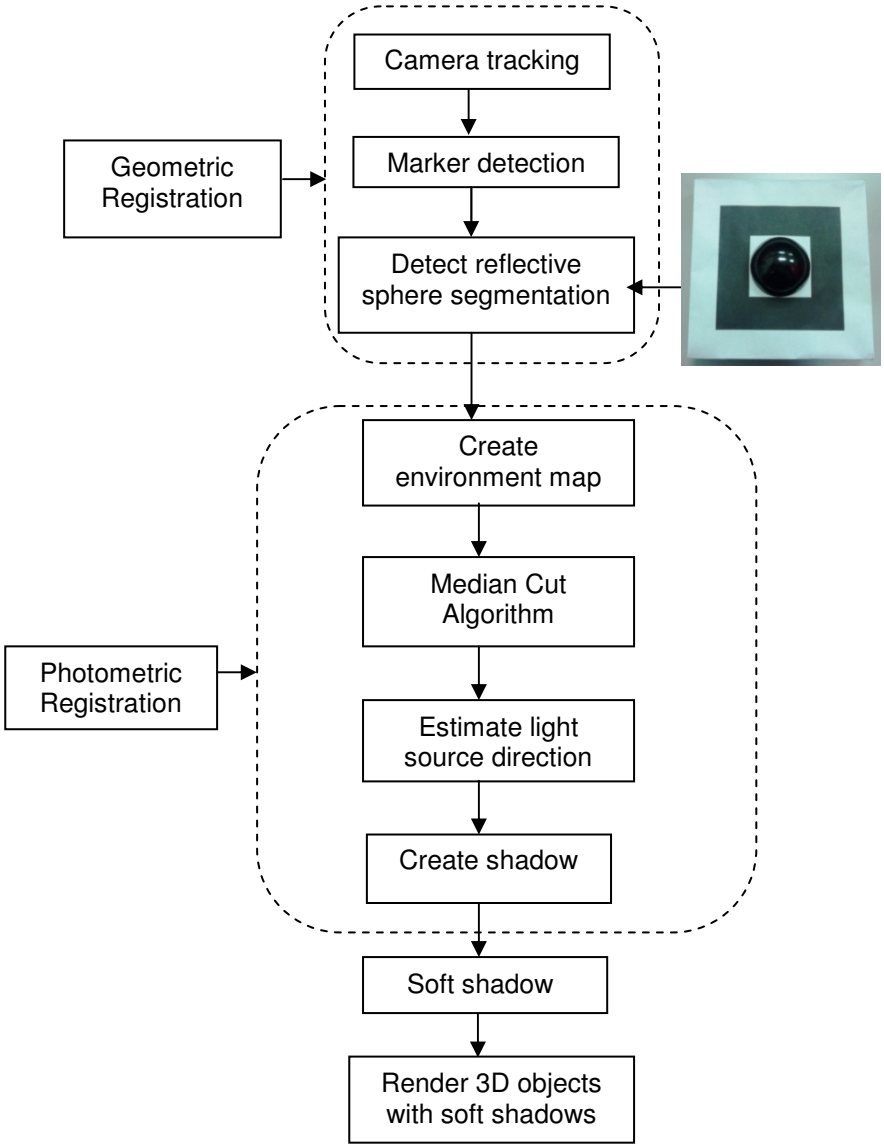

FIGURE 1: Frameworks of System Prototype.

FIGURE 2: Setup of the System Prototype.

Soft Shadow

The generated shadows are still unrealistic since they have sharp and hard-edges outlines of shadows, also known as hard shadow. To get a realistic shadow, the soft shadow method must be applied. The differences in appearance between hard and soft shadow is depicted in Figure 3.

FIGURE 3: Hard Shadow (Left) and Soft Shadow (Right) [21].

The soft shadow method that can be applied in this research is based on the concept of Heckbert & Herf's soft shadow [27]. The method will produce the number of hard shadows samples. These samples consist of the number of different dark color and size of the shadows, where the size slightly bigger than the size of the original shadow. The numbers of samples influence the quality of soft shadow. The higher number of sample used, the higher quality soft shadow will be generated and vice versa.

After few number of hard shadow samples have been produced, the samples will be blended together with different dark colors and sizes together with the original shadow. This process will be done by stacking each other starting from the less dark color with ends with original color of the shadow. Figure 4 shows the overlapping process of samples hard shadow.

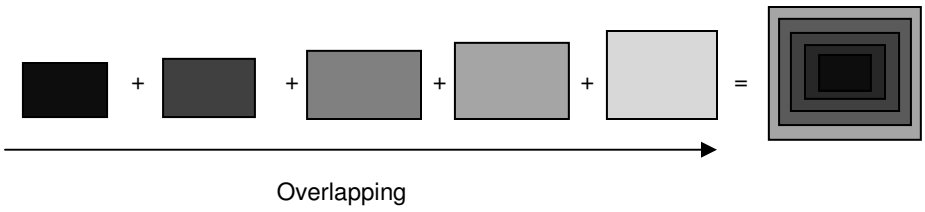

FIGURE 4: Overlapping Process of Samples Hard Shadow.

4. EXPERIMENT

This section discussed the experiment of rendering soft shadow in AR environment. The experiments were conducted using three samples hard shadow in which every sample has different number of hard shadow.

Testing Platform

In this experiment, the laptop and camera device with specification specified in Table 1 and Table 2 were used to conduct the experiment processes. The results from this experiment are discussed based on Frame per Second (FPS) and the appearance of the soft shadow on the display screen measured the quality of soft shadow.

Processor	Intel® Core ™2 Duo CPU T7250 @ 2.00GHz
Memory (RAM)	3.00 GB
Graphics Card	NVIDIA GeForce 8400M GS
Operating System	Microsoft Windows XP Professional

TABLE 1: Specification of the Laptop for Display Soft Shadow.

Type	Aloha Digital PC Camera
Frame rate	VGA, 30 Frame/Sec
White Balance	Automatic
Megapixels	up to 8 megapixels
Over View	Glass element lens
Connectivity	USB 2.0
System Requirements	Windows 2000, Windows XP, Windows Vista

TABLE 2: Specification of the Camera.

Soft shadow process

The soft shadow was generated based on the concept of Heckbert & Herf's soft shadow [27] as described in previous section. This technique used two parameters to produce the soft shadow which is length and gap factors. The length factor determines the length of soft shadow from the original hard shadow. Meanwhile, the gap factor determines the distance between hard shadows in the sample. Figure 5 illustrated the concept of Heckbert & Herf's soft shadow [27] with length and gap factors.

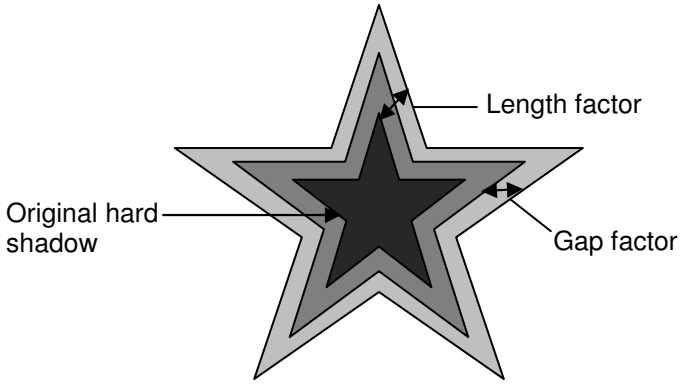

FIGURE 5: Illustration of Soft Shadow with Length and Gap Factors.

5. RESULT

This section will discuss the result from the experiment of rendering soft shadow in AR environment. The quality of shadow appearance is important to produce realistic AR environment. In this experiment, three samples of hard shadow are being used which consist of five, seven and ten shadows in each samples. Every sample will be measured in terms of their performance based on FPS and the number of the light source used in median cut algorithm.

(a) (b)

FIGURE 6: Shadow of Computer Generated Object Based on Real Light Position.

The median cut algorithm was used to estimate real light source position from the real scene using the environment map. Figure 6 (a) and 6 (b) show the shadow that render based on different position of real light source. The object with green color is a computer generate object and object with white color is the real object. These figures show the computer generated object produce shadow that are in the same direction of real shadow. Thus, these make the AR environment more realistic. The object in this experiment also can be applied to more complex geometry objects and render multiple objects in the one AR environment.

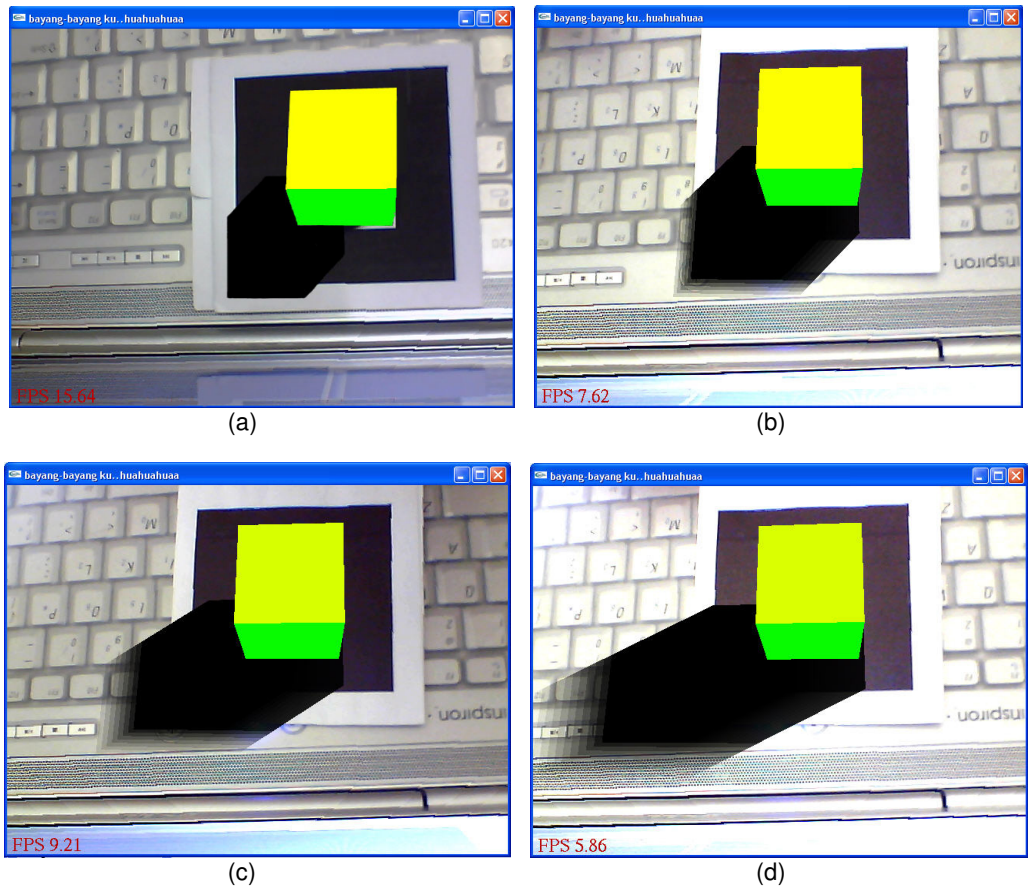

FIGURE 7: Comparison of Appearance Hard Shadow (a) and Soft Shadow Generation (b)(c)(d).

Figure 7(a) shows the result of hard shadow that was generated from the system in AR environment. The appearance of hard shadow has proved that it is not realistic because it has sharp and hard-edge outlines. Meanwhile, Figure 7(b), (c) and (d) show the result of soft shadow being generated from Heckbert & Herf's technique [27] with different samples of hard shadow. Sample 1 consists of 5 layers of hard shadow, sample 2 consists of 7 layers of hard shadow and sample 3 consists of 10 layers of hard shadow. From these results, we can see that the number of hard shadow layers influenced the quality of shadow appearance. The quality of soft shadow becomes higher with the large number of hard shadow layer and less quality with small number of hard shadow layer.

The experiment also measures the performance of the system based on FPS. Figure 8 illustrates the graph of comparison performance between the three samples of hard shadow used in the experiment. In this graph, the result of FPS depends on the number of light source used in the median cut algorithm. The graph shows the FPS will be decreased with the increasing number of light sources. It is because every light source renders the samples of hard shadow which involved a lot of computation.

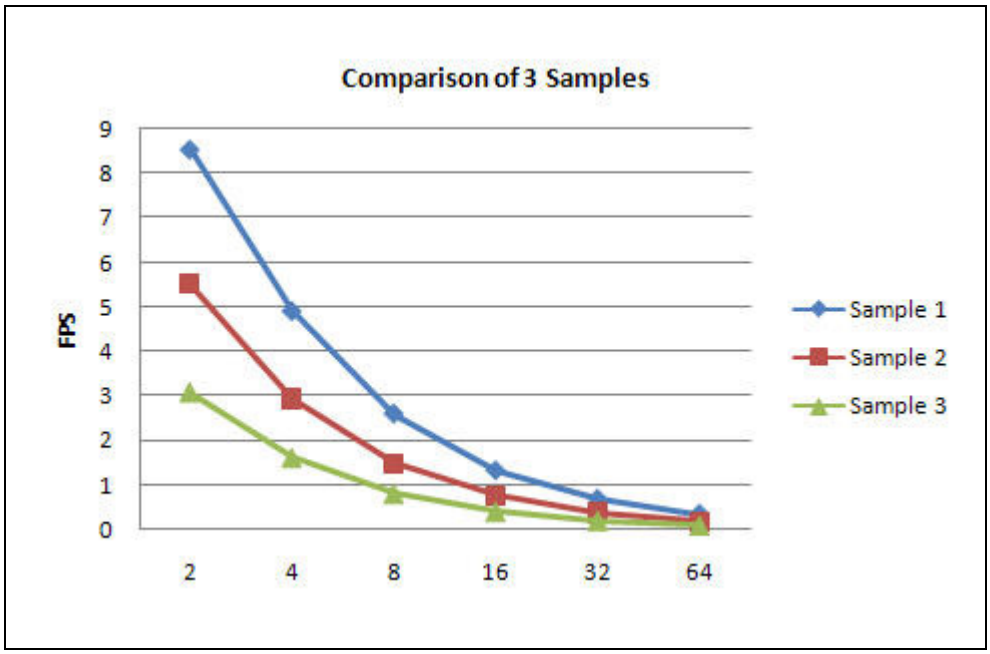

FIGURE 8: Comparison of 3 Samples of Hard Shadow Layer.

Apart from that, the samples used in the experiment influenced the performance of the system. From the graph, sample 1 with five layers of hard shadow produced the highest FPS compared to sample 3 which contain ten layers of hard shadow. This means with the higher number of hard shadow layers, the high quality will be produced but the performance becomes low. It is contradictory with the small number of hard shadow layer with high performance but produce low quality of soft shadow appearance.

Thus, to achieve realistic soft shadow in AR environment, it involved a large number of hard shadow layer. Since higher computational will decrease the performance of the system, the optimization techniques is needed such as Level of Detail (LOD), Culling, Octree and others. These techniques will increase the performance of the system.

6. CONSLUSION & FUTURE WORK

The method to create soft shadow in AR is presented in this paper based on the concept of Heckbert & Herf's soft shadow [27]. Compared to hard shadow, the purpose of soft shadow is to add realistic on appearance of shadow in AR environment. This is because hard shadow still has drawbacks such as sharp and hard-edge outlines that are deficient in the appearance of shadow. In this paper, soft shadow was rendered based on estimated light source from the real scene. The estimation of real light source is important to create credible shadow. However, the experimental result shows the high quality of soft shadows will reduce the performance of the system. In future works, the development of method to improve the performance of the system without sacrificing the quality of the system must be applied to produce realistic AR environment.

7. ACKNOWLEDGMENTS

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Enhancing Multimedia Communication Components in Instructional Consulting Service Online: Students' Perspective and Perception

Abd Hadi Abdul Razak ahadiar@uum.edu.my
UUM College of Arts and Science
Building of Information Technology, Universiti Utara Malaysia
Sintok, 06010, Kedah, Malaysia

Ang Ling Weay ling_weay@yahoo.com
UUM College of Arts and Science
Building of Information Technology, Universiti Utara Malaysia
Sintok, 06010, Kedah, Malaysia

Abstract

Online consultation - one of the advancement of communication technology in consulting service is conducted electronically in various contexts such as online medical consultation, IT consulting and online financial service consultation. It enables participants communicate in synchronous and asynchronous way [1]. However, implementation of this technology in instructional consultation in higher education is not fully integrated. This may due to lack of investigation, analyzing and proper strategy planning on problem encountered by students and lecturer. This paper discuss about the limitations of typical instructional consultation and students' perspective and perception on conducting consulting service online. The potential benefits of communication components for students in higher education are determined by investigate their perceptions and perspectives on implementation of communication technology for online instructional consultation. The limitations of typical instructional consultation that elicited from literature review are included in this quantitative research study in order to investigate precisely students' response pertaining to instructional consulting service in higher education. Data was solicited from a sample of 130 students in College of Arts and Science (CAS), College of Business (COB) and College of Law, Government and International Studies (COLGIS) in Universiti Utara Malaysia (UUM) via simple random sampling method. Student's response to five point Likert-type scale anchored by the terms Strongly Disagree (1) to Strongly Agree (5), Not Important (1) to Extremely Important (5) and Never (1) to Very Often (5). The finding of the research revealed that students were generally positive about potential of multimedia communication tools for traditional consultation system in higher education organization.

Keywords: Instructional Consultation, Real time communication technology, face to face consultation, online instructional consultation, Yamane's (1967) formula.

1. INTRODUCTION

Instructional consultation is commonly recognized as a problem-solving model systematically designed around school IC [2] with the purpose in solving academic and behavioural problem encountered by students. Accompanying with the rapid growth of technology advance, the need of providing consulting and information delivery service online are increasingly concerned, not only in financial service [3] or

business context [4] but also telemedicine consultation that are widely studied by many researchers [5]. According to [4], conducting of consultation service online help to keep the cost to a minimum while offering competitive service on client's demand as well as enable the staff work from client location regardless the working place. At the early phase of conducting consulting service online, asynchronous technology such as email and forum discussion are more commonly employed as collaboration tools among these virtual team staff compared with synchronous technology that enhance the collaboration on real time [23].

At present, as the advantages of synchronous communication technology had been acknowledged, many organizations started to blend this technology advance as part of e-consultation, enable the participants to communicate in synchronous and asynchronous way [1]. As a result, web conferencing platform that mushroomed developed and adopted to fulfil demand of organization, to provide support and enhance collaborative on real time and delayed time, to overcome the time and space constraints that burden face to face consultation. More specifically, video conference component engender high social presence that absence in text-based mediated communication, enable conveying of information through non-verbal cues such as facial expression, gesture and body language. This directly will reduce a sense of isolated feeling as inhibited from virtual environment.

However, in education context, even though there are many suggestion regarding with provide consulting service online [24] & [25], but yet the used of communication technology is not fully implemented as an essential support for instructional consultation in higher education. Shifting of typical instructional consultation towards virtual consultation is not simple. Since there is lack of investigation, analyzing and proper strategy planning on issues encountered by students and lecturer for instructional consultation in higher education. There is lack of quantitative research for study mentor-mentee system in education context [6]. Furthermore, there is no standard and common consultation process as a guideline in designation of consultation process. Many researchers have their different perspectives on the typical consultation processes. For example, consultation processes may different related to consultation purpose, and the tasks and actors involved [2]. While some researchers present that designation of e-consultation platform should support consulting processes as in face to face consultation [7] & [8] and more specifically the task involved [9], [10] & [11]. Thus, It can be seen that designation of online instructional consultation model should be look as academic problem-solving consultation based on overall aspects: the consultation process, the tasks perform on each phase and actors involved. Before making decision on whether which communication tools are appropriate to be implemented, a preliminary study on students' perspective and perception towards conducting consultation service online are conducted.

2. BACKGROUNDS

From literature review, there are 3 majors problems on typical consultation in higher education identified which regarding with the difficulties faced when participants are at a distance, ineffective time management [12] & [13] and last, but not least, the problem on recording consultation session and management of recorded document in systematic and effective way for later references and review.

Mentor-mentee system in higher education in Malaysia is to provide advisement and guidance regarding students' academic matters and personal problem. A lecturer can schedule a consultation time to meet with their students. However, it does not guarantee that students can meet their mentor being on time. They may face the situation in which one or more members are at physically separated environment. Research on the higher education in Malaysia conducted by had found that majority of students show their unsatisfactory on the mentor-mentee system on difficulties to meet with their supervisor for consultation [14]. This may due to sometimes, lecturer may have conduct emergency meeting, attend to the outstation seminar and may not meet their students for a period of time. This indirectly leads to student frustration when the people they rely on solving urgent problem are probably at a distance. The other reason related, travelling and recovering from a remote location are time-consuming and costly endeavour [15]. It is not always promptness for working adults that take part-time course especially postgraduate student, have family commitment or job commitment to travel to a remote location just to meet their lecturer. Loss of human contact indirectly cause decrement in interactivity among participants when they are at a distance. These difficulties with long distance travel, time as well as cost spending on travel may reduce with accessible and usable of ICT in field. Nonetheless, time management as the key ingredient to determine the successful of consultation process or may lead to consultation frustration

especially when in synchronous discussion [16]. Communities do exist successfully without effective time schedule management but those communities that are designed around time management are provided with much greater flexibility. Observation on the mentor-mentee system in higher education in Malaysia shows that insufficient time and inconsistent consultation time schedule by lecturer or staff of the faculty cause student lack of enthusiasm to meet with their mentor [12] & [13].

The third problem related to second problem in which recorded documents are needed for future review or references. Effective and systematic way in recording meeting and organization of recorded document is essential in community and work organization. Usually, meticulous students may take note during consultation session. However, it is not always promptness for them to do so as hand writing take longer to be produced rather than read or speech. If they attend to take note, but on the same time, they may not focus on discussion and information delivered. This circumstance may due to human limitation in performing multi-task simultaneously [17] .Lack of focalization in content delivered during consultation may cause difficulties especially in making decision.

Hence, regarding with the problem addressed, building consensus on instructional consultation processes in higher education and define the communication technology that best suit the participants' requirement is important. Human are not all alike. Thus, this research emphasizes more on human factors. In order to explore more deeply on students' behaviour, attitudes and goals on typical consultation, their perspective and perception towards implementation of multimedia components is investigated.

3. OBJECTIVES

The specific aims of the study are threefold as below:

a) To analyze students' problem on face to face instructional consultation in higher education

b) To analyze students' attitudes and behaviour towards face-to-face consultation in higher education.

c) To analyze on students' perceptions on online communication tools.

4. METHODOLOGY

This study attempts to focus on several aspects of instructional consultation service that can be measured:

Sample Characteristics

Respondents (Students)	College of Arts and Science (CAS)	College of Business (COB)	College of Law, Government and International Studies (COLGIS)	Total
Diploma Lepasan Ijazah	841	-	-	841
Diploma	67	-	-	67
Bachelor Degree	5977	10556	2578	19111
Master	2229	2144	248	4621
PHD	373	690	169	1232
Total	9487	13390	2995	25872

TABLE 1: The Approximate Total Population of Students in UUM for 2009/2010 Sessions

Table 1 shows the total population in Universiti Utara Malaysia (UUM) was estimated at 25872 students for 2009/2010 sessions. Obviously, it is impossible to collect all the data from wide and diverse range of

population in UUM. According to [18], it's necessary to determine the accurate sample size in order to obtain the meaningful result. Thus, Yamane's formula was applied by draw the identical sample from the large population in Universiti Utara Malaysia (UUM). Figure 1 shows the Yamane's formula for determining the sample size of student's population (n=25872) with 90% confidence level and error limit of 10%.

$$n = \frac{N}{1 + N(e)^2},$$

n= sample size
N= Population
e=level of precision/ acceptable sampling error

Substitution:
N= 25872
e = 90% confidence level or 10% acceptable sampling error

n= 25872/(1+25872(0.10)(0.10))
= 99.614
≈ 100

FIGURE 1: Yamane's Formula (1967)

Based on table of determining the sample size and margin of error developed by Yamane [22], 100 obtained responses are needed for population of 25872 students in UUM. Thus, in order to compensate for non-response or non-returned questionnaires [22], the sample size is increase to 30% in which 130 students was chosen from College of Arts and Science (CAS), College of Law, Government and International Studies (COLGIS) and College of Business (COB) in Universiti Utara Malaysia (UUM). Of all 130 questionnaires distributed randomly, only 108 questionnaires were returned and 6 were missing values, results a response rate of 78%. A reliability analysis (Cronbach's Alpha) was employed for each dimension. The results show satisfied results (higher than 0.60) ranging from the lowest 0.678 to highest 0.878 for dimensions as stated in table 2.

Dimension	Cronbach's Alpha
Students' Problem on Consultation	0.678
Importance of Features for Online Communication Tools	0.852
Students' Behaviours Towards Face to face Consultation	0.878

TABLE 2: Cronbach's Alpha for All Dimensions

The first part of questionnaire showed that respondents consisted of 37% students from College of Arts and Science (CAS), 38% students from College of Business (COB) and 25% students from College of Law, Government and International Studies (COLGIS). The population mainly consisted of undergraduate students (74%) while 26 % are postgraduate students.

5. ANALYSIS AND FINDINGS

5.1 Problem Faced During Face-to-Face Consultation

Figure 2 shows that out of 108 respondents in Universiti Utara Malaysia (UUM), 54.7% of them encountered with problem in consultation with their lecturers. Out of 58 students that encountered with difficulties, majority of them (43.1%) meet their lecturer for sometimes while only 1.7% of them never meet their lecturer for consultation.

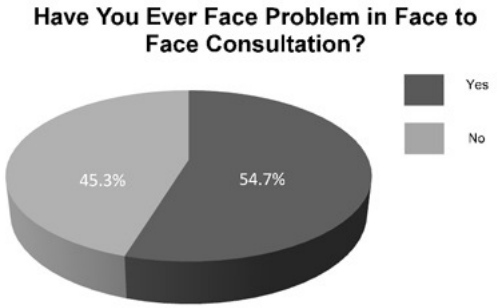

FIGURE 2: Respondents by Problem in Face-to-Face Consultation

Table 3 shows five dimensions of frequency for students perceived problems on face-to-face consultation in higher education environment. From the mean analysis, it is clear that the score are between 2.60 and 3.31. This means that students give the score above the middle point of 2.50 where a Likert-scale between 1 and 5. The median score also indicate that the score are distributed closer to normal distribution.

Scale							
Problems	**NA 0**	**NI 1**	**2**	**3**	**4**	**5**	**N= 58**
Frequency (%)	5.2	12.1	20.7	43.1	17.2	1.7	**Mean = 2.60**
Ineffective Time Management (%)	1.7	19.0	10.3	41.4	22.4	5.2	**Mean = 2.79**
Constraint by Distance (%)	1.7	10.3	13.8	56.9	15.5	1.7	**Mean =2.79**
Record Consultation Session (%)	1.7	12.1	19.0	39.7	10.7	6.9	**Mean =2.86**
Emergency Consultation (%)	1.7	22.4	8.6	41.4	17.2	8.6	**Mean =3.31**

Note: 0-Not Applicable; 1-Often; 5-Never

TABLE 3: Students' Behaviours and Attitudes towards Face to face Consultation in Higher Education

Of these five dimensions of perceived problems, most of the students (56.9%) encountered with problem in meet their lecturer when both of them are at a distance sometimes. Only 1.7 % of them are not

constraint by distance. 94.8 % of students having timing problem in which majority of them (41.4%) having insufficient time or ineffective time management. Observation on the mentor-mentee system in higher education in Malaysia show those students' insufficient time and inconsistent consultation time schedule by lecturer or staff of the faculty cause student lack of enthusiasm to meet with their mentor [6] & [13]. Whereas 48 students (82.8%) having the problem in record consultation session or take note during consultation session. It is significant to note that students concede that they always conduct emergency consultation with lecturers (mean – 3.31). There are relatively high-level percentages (22.4%) of students (with the scale "very often") to meet their lecturers for emergency consultation as compare to other 4 dimensions with the same scale.

5.2 Importance Features of Online Instructional Consultation

Figure 3 and table 4 present students' perceived importance of features of multimedia communication components to be included in online instructional consultation model. The criteria are measured in term of means and standard deviation by using scale of 1 (Not Important) to 5 (Extremely Important).

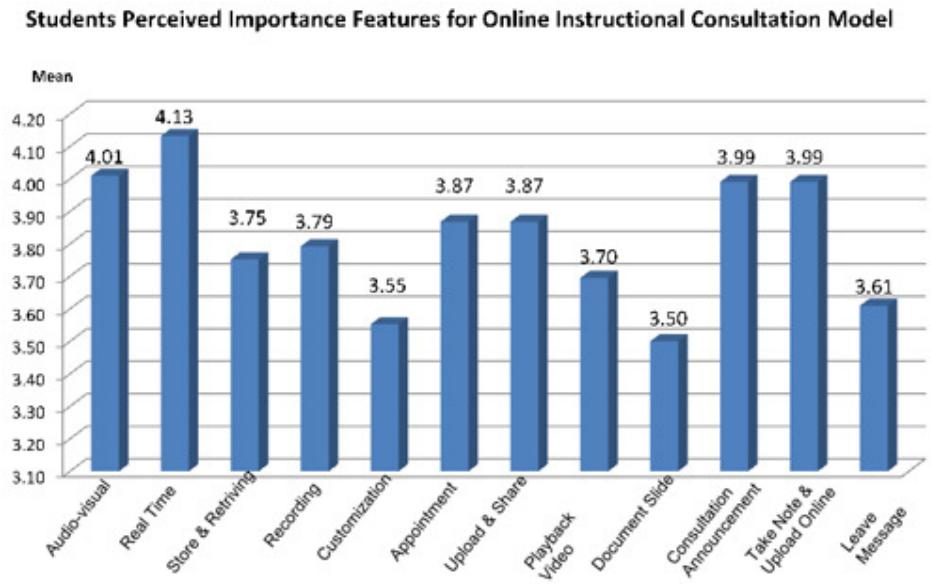

FIGURE 3: Students Perceived Importance Features for Online Instructional Consultation Model

No	Variables	Number of Respondents				
		Valid	Missing	Mean	Median	Std. Deviation
Q1	Ability to deliver information clearly in audio-visual form.	106	2	4.01	4.00	0.910
Q2	Ability to deliver information in real-time	106	2	4.13	4.00	1.052
Q3	Ability to store and retrieve consultation document and agenda record	105	3	3.75	4.00	1.133
Q4	Ability to record consultation session	106	2	3.79	4.00	0.933
Q5	Ability to customize profile online	105	3	3.55	4.00	0.940
Q6	Ability to make appointment online	106	2	3.87	4.00	0.947
Q7	Ability to upload and share document online.	106	2	3.87	4.00	1.005
Q8	Ability to playback video online in video player	105	3	3.70	4.00	1.136
Q9	Ability to view document online in slideshow	106	2	1.75	4.00	1.272
Q10	Ability to get consultation announcement online.	106	2	3.99	4.00	0.889
Q11	Ability to take note online and upload note for sharing.	106	2	3.99	4.00	0.856
Q12	Ability to leave message online	105	3	3.61	4.00	1.122

TABLE 4: Students' Perceived Importance Features of Multimedia Communication Components

From table 4, mean analysis is to determine the average score of the 12 variables which rating the level of importance of different function and features to be included in multimedia consultation components. It can be seen that students provide the score between 3.50 and 4.13. Students provide the score above 2.50 indicates that they are strongly feels that all the proposed function and features are important and may take into consideration when design the multimedia communication components. The high score mean (4.13) for variable "ability to deliver information in real-time" and variable "ability to deliver information clearly in audio-visual form" with score mean (4.01) indicates that students concede dynamic two way communication with immediate feedback, as well as deliver information in visual and verbal cues.

The lowest mean score (mean-3.5) for variable "ability to view document online in slideshow" resulted. It is significant to note that students concede that it's not as important as other features as denotes by students to be included in online consultation model. This may due to they probably need document downloaded, store in hard disk and view them when they are offline instead of playback the consultation document online.

5.3 Students' Attitudes and Behaviour toward Face-to-Face Consultation in Higher Education

Respondents were asked to indicate their level of agreement and disagreement with the statements regarding with consultation in higher education. Their responses are present in table 5 and figure 4.

No	Variables	Number of Respondents		Mean	Median	Std. Deviation
		Valid	Missing			
Q1	I know my problem very well and can present my problem clearly to lecturer face to face.	101	7	3.17	3.00	1.025
Q2	I involve actively by give many opinions during consultation session.	105	3	3.05	3.00	0.942
Q3	The consultation decision can be made without delayed to later consultation	106	2	2.37	3.00	0.764
Q4	It is always promptness for me to take note while lecturers deliver the information.	106	2	2.20	3.00	1.129
Q5	I always record my consultation activities into logbook.	106	2	3.59	4.00	1.226

TABLE 5: Students' Behaviours and Attitudes towards Face to face Consultation in Higher Education

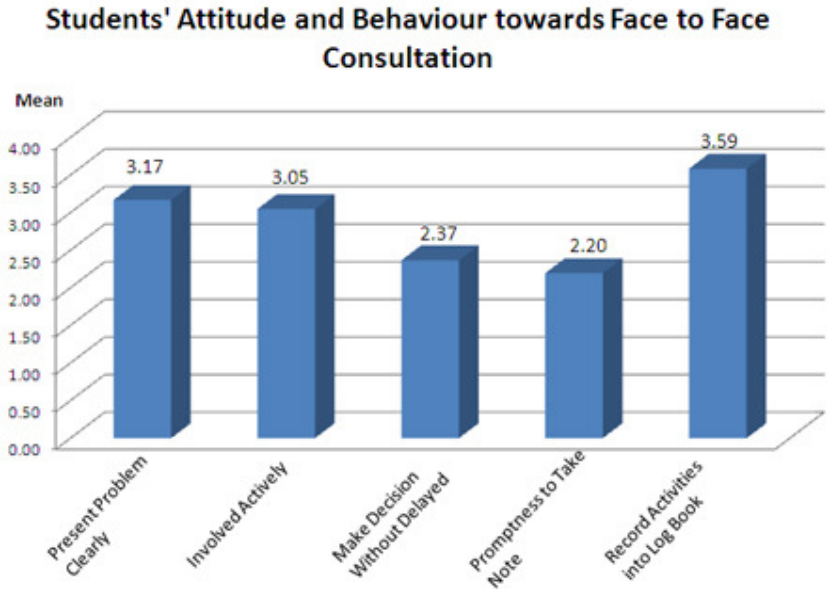

FIGURE 4: Students' Behaviours and Attitudes towards Face to face Consultation in Higher Education

Based on in-depth analysis of students' behaviour on face-to-face consultation, 5 questions were constructed. Table 5 shows the relative students agreement and disagreement on the statements. Strong evidence with the high mean score (mean-3.59) shows that most of the students agree that they always record their consultation activities into logbook. However, when asked about whether involve actively in face-to-face consultation, they neither agreeing nor disagreeing (mean-3.05).

On the other side, most of the students claim that they are not always promptness to take note while lecturer delivers the information during consultation session (mean-2.20). This circumstance may due to human limitation in performing multi-task simultaneously [17]. A lower mean value (2.37) denotes that most of the consultation session may sometimes terminate before decision being made and perhaps delayed for later consultation.

5.4 Students' Perception on the Frequency used of Online Communication Tools

No	Variables	Number of Respondents		Mean	Median	Std. Deviation
		Valid	Missing			
Q1	Instant Messaging	108	0	4.17	4.00	1.032
Q2	Video Conferencing	108	0	2.93	3.00	1.257
Q3	Audio Conferencing	108	0	1.94	2.00	1.036
Q4	Forum Discussion	108	0	2.89	3.00	1.231
Q5	Email	108	0	4.22	5.00	1.097

TABLE 6: Students' Perceived on the Frequently Used of Online Communication Tools

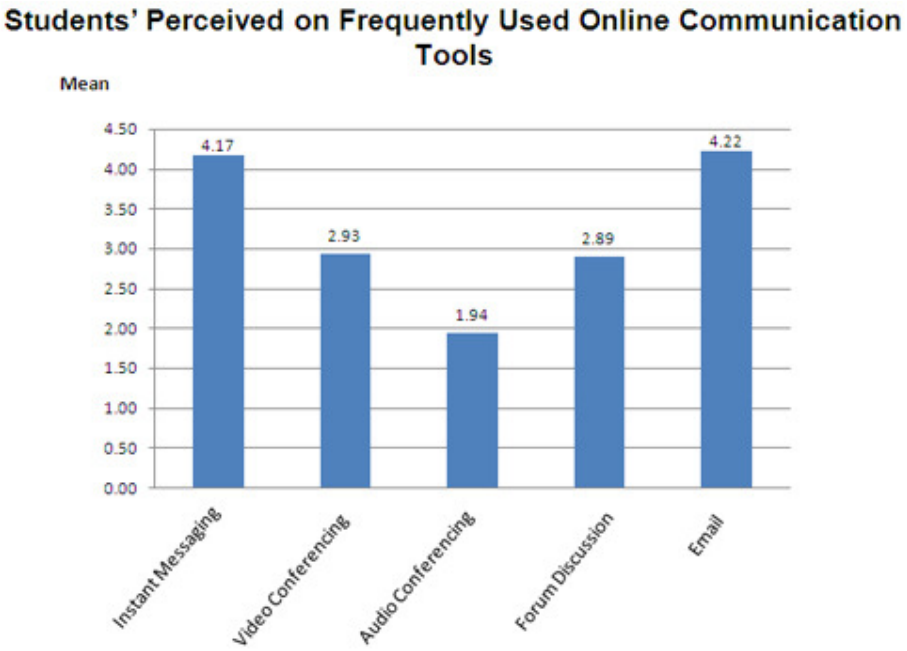

FIGURE 5: Students' Perceived on Frequently Used Communication Tools

Table 6 and figure 5 shows frequency use of online communication tools among students in Universiti Utara Malaysia (UUM). The criteria are measured in term of means and standard deviation by using scale of 1 (Never) to 5 (Very Often). In general, students are often using all the proposed online communication tools unless the audio conferencing with the low mean score (mean-1.94). A high mean value for students' response indicates that respondents were very often use email for online communication tools as compare to the other online communication tools. This followed by synchronous communication tools which is videoconference that provide the mean score 2.93. Even though synchronous online communication were found to offer a number of advantages over asynchronous online communication, however, email indicates the most frequently used by intended participants that do not expect immediate response to the proffered comment, for documents retrieval and submission as well as place comments for later viewing.

6. SUMMARY OF RESULTS

The finding of this research revealed that students were generally positive about potential usefulness of multimedia communication tools for traditional consultation system in higher education organization. 54.7% students report their consensus on the consultation problem as derived from literature review.

Almost 93% of them denote that they are willing to learn new technology that can assist them in consulting purpose even though some of them are not encountered with problem in traditional consultation.

Among the 12 specified important features of multimedia components, obviously it cannot denied that students' highly perceptions towards real time audio-visual communication tools with the high mean score value 4.13 for "ability to deliver information at real time" and mean score value 4.01 for "ability to deliver information clearly in visual and audio form" denotes that video conference are necessary to be included in online consultation model. This rich media (synchronous) convey information at high rate to resolve the ambiguity. These synchronous communication components would be the useful medium for conducting the emergency consultation but in situation in which both the students and instructor are available on the specific time. The media richness and social presence level of video conference component would provide high intimacy and immediacy feedback [19] & [20]. The facial expression and gesture movement allow the participants to access participants understanding. Even though the degree of intimacy and immediacy of video conferencing is not as high as face to face communication, however, it is the most suitable multimedia component that can represent more warmth and a sense of sociability when communicate online.

The high mean value for online communication tools that frequently used by students are instant messaging and email denotes that real time synchronous communication tools are not the only one that dominate the way we communicate online but combination used of these communication tools may facilitate the online consultation effectively. Students perceived instant messaging and email more satisfying and easy to use as they had experience about it and may included in online instructional consultation application. Besides that, email is predicted to better process uncertainty information. Students may sometimes communicate through video conference even though it is a new matter in real time communication context and its advantages are yet to be discovered. Similarly, a high mean value for the usage of online communication tools (mean-2.93) denotes a favourable response towards the use of synchronous videoconference. In contrast, the lowest mean score are audio conference (mean-1.93). Both of these online communication tools are synchronous when the participants aware of the dynamic two ways communication more or less in real time, differing only as video conference are in visual and verbal cues, provide look as the "look and feel" that does not exist for audio conference. Audio conferencing participants may feel inhibited when cannot "see" each other at remote sites. Besides that, students denoted that get the updated consultation announcement online is important as well as the ability to make appointment online.

Dealing effectively with online communication technology not only the potential usefulness of this ICT tools but also related with students' attitudes and behaviours towards the instructional consultation in institution of higher education. Their interactivity indirectly affects the successfulness of online learning [21]. For these reasons, students' attitudes and behaviours were examined. The results (as in figure 4) show that means score value for all the four variables did not achieve at least 4.00 which denote the degree of agreement. Low mean value (2.20) of variable "I involve actively by give many opinions during consultation session" indicates that students mostly disagree that they contribute actively towards the consultation session. Presumable over talkative or passive participants may cause lack of interactivity and poor communication among participants that lead to consultation frustration. Instead of play the role as consultant that initiate the consultation session and terminate the session, lecturer should be given the authority to control students' speaking order during online collaboration.
Overall, there is necessary to add in synchronous verbal and visual communication cues as provided in video conference to lead to the overall better online communication processes. Presumably, combination used of those synchronous and asynchronous tools may facilitate consulting service effectively.

7. CONCLUSION

Increasing concerned on the conducted instructional consultation online would help to generate motivation for researchers to study on the user requirements as well as bring a fresh perspective to existing issues. For the future research that regarding with online instructional consultation in higher education need to include analyzing on problem encountered by lecturer as well as their perceptions' on usage of communication tools for assisting consulting in higher education. Lecturers play an important role in control the way the student's reaction and communicate during online consultation session. Thus, their perspectives on the use of multimedia communication applications will be needed to be

emphasizing precisely for designation of online consultation system. As a conclusion, research in this context is essential if we are to understand the communication and collaboration environment more efficiently and thus learn how to improve the participant's quality of online consultation.

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