1. INTRODUCTION

With the improvement of technology, everything will be brought to near the foot of the preferred person. Although, it will be achieved like that, sometime the quality of the output or the satisfactory of the user may be reduced. When the e-Learning comes to the stage, it accompanies many advantages such as paper less environment, pay less to institutions, solve the location issues, advanced computer trainings provided at homes and access any material using web. Although it gives several benefits, every e-Learning virtual environment has some opportunities to improve [1]. The development of e-Learning products and the provision of e-Learning opportunities are some of the most rapidly expanding areas of education and training in both education and industry [2]. Currently universities are using cyber-space to provide interactive learning systems to students which can be made communication fast to grow up the knowledge in every field of study. Traditional classroom system will be completely transformed to virtual learning system or cyber-space learning in near future. Therefore the effectiveness of the cyber-space learning needs to be improved.

1. On-line Visualization of Student Facial Emotion in Virtual e-Learning Environment

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Abstract: Traditional education system continuously converts to the e-Learning method and three dimensional virtual environment becomes powerful way of delivering knowledge. Learning environment and non-verbal communication are highly influence to the performance of the student. Avatar is a graphical representation of the user in virtual world. It has only ordering connection with the student and Avatar, and virtual world seems some artificial atmosphere. In here, a system is developed to visualize the real user facial emotion through the face of the Avatar in virtual world. Extraction of the real user facial emotion, creation of emotion models in virtual world and establishment of connection between real world and virtual world are the major steps to accomplish the aim of this research. Real user facial expression identification system is constructed based on the Geometric feature-based method. Avatar changing system is implemented in virtual environment and it is included four basic facial expressions. Ultimately, the facial expressions of the real user are transferred to the virtual environment and it is appeared on the face of the Avatar. Facial emotion of the student is visualized through the Avatar in the Virtual Learning Environment. An experiment was conducted with this facial emotion system and it was carried on as a discussion. During the experiment, student discussed with their facial emotion with the live Avatar. The result of the experiment showed that, facial emotional Avatar is important to e-Learning and it is increased the reality of the learning environment. Further, it indicates that the engaging with three dimensions Virtual Learning Environment with facial emotion is very interesting thing and that is a plus point for future e-Learning.

Keywords: e-Learning, Facial expression, Virtual environment, Avatar, Non-verbal communication

When the e-Learning comes to the stage, it accompanies many advantages such as paper less environment, pay less to institutions, solve the location issues, advanced computer trainings provided at homes and access any material using web. Although it gives several benefits, every e-Learning virtual environment has some opportunities to improve [1]. The development of e-Learning products and the provision of e-Learning opportunities are some of the most rapidly expanding areas of education and training in both education and industry [2]. Currently universities are using cyber-space to provide interactive learning systems to students which can be made communication fast to grow up the knowledge in every field of study. Traditional classroom system will be completely transformed to virtual learning system or cyber-space learning in near future. Therefore the effectiveness of the cyber-space learning needs to be improved.

e-Learning has two different types of methods called Asynchronous and Synchronous. Asynchronous e-Learning, commonly facilitated by media such as e-mail and discussion boards, supports work relations among learners and with teachers, even when participants cannot be at the same time. Synchronous e-Learning, commonly supported by media such as videoconferencing and chat, has the potential to support e-learners in the development of learning communities. Both methods have several
advantageous and disadvantageous as shown in Table 1 [3]. Although e-Learning includes different categories such as Synchronous and Asynchronous, Synchronous e-Learning which has face to face layout is very important and effective than the other methods. Because Synchronous e-Learning is increases the student commitment and motivation to engage in education with quick responses with instant messaging or chat. In addition, students with a sense of presence in a Synchronous, online class will have a higher degree of satisfaction with the course [4].

A Virtual Learning Environment is a virtual classroom as shown in Figure 1 that is allowed instructors and students to interact with each other via online. Virtual classrooms are cyberspaces where instructors and students teach and study their lessons at the same time. Virtual Learning Environment is the one way of providing Synchronous e-Learning. e-Learning of virtual classroom delivers the same content and labs as a real world classroom with a live instructor in real time via the Internet. It’s completely interactive and students talk with their instructor and peers. Although student can gather, exchange ideas or carry on different kind of activities in the virtual environment, opportunities are available to enhance the quality of delivering knowledge and create more preferable environment, opportunities are available to enhance the quality of delivering knowledge and create more preferable atmosphere for learning situation. The improvement of the connection between students, teacher and the learning environment is one of the chances to raise the efficiency

<table>
<thead>
<tr>
<th>Synchronous Learning</th>
<th>Asynchronous Learning</th>
</tr>
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<tbody>
<tr>
<td>Increases arousal and motivation</td>
<td>Helpful on complex issues</td>
</tr>
<tr>
<td>Learners are eager to give their input on an issue</td>
<td>Gives time to process information</td>
</tr>
<tr>
<td>Useful in discussing less complex issues</td>
<td>Most of the time is spent on subject</td>
</tr>
<tr>
<td>Excellent for social interaction and discussing multiple topics</td>
<td>Improves work efficiency of time committed to tasks</td>
</tr>
<tr>
<td>Time spent off subject can be significant</td>
<td>Interaction is limited to non-interactive media</td>
</tr>
<tr>
<td>May spend time discussing issues not relevant to the topic</td>
<td>Students feel distant or separated from group</td>
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</table>

In general, there are two approaches to represent the face and consequently the facial features to perform facial expression analysis: the Geometric feature-based method and Appearance-based method [9]. The Geometric feature-based method presents the shape, texture and/or location information of prominent components such as the mouth, eyes, nose, eyebrow, and chin, which can cover

Figure 1: Virtual Classrooms

Table 1: Synchronous and Asynchronous Learning

2. RELATED WORK

2.1 Facial expression recognition

Human-computer intelligent interaction (HCII) is a developing field of science intended to supply natural ways for humans to use computers. When the computer interacts with humans, it needs to have the communication skills of humans to become delighted user. One of these skills is an ability to understand the emotional state of the person. There are many ways that humans display their emotions. The most natural way to display emotions is using facial expressions [8].

In general, there are two approaches to represent the face and consequently the facial features to perform facial expression analysis: the Geometric feature-based method and Appearance-based method [9]. The Geometric feature-based method presents the shape, texture and/or location information of prominent components such as the mouth, eyes, nose, eyebrow, and chin, which can cover
the variation in the appearance of the facial expression. On the other hand, using image filters like Gabor wavelets, the Appearance-based method generates the facial feature for either the whole-face or specific regions in a face image.

Recently researchers have demonstrated that Geometric feature-based method provides similar or better performance than Appearance-based approach in Action Unit recognition [10]. However, the Geometric feature-based method usually requires accurate and reliable facial feature detection and tracking, which are difficult to accommodate in many situations.

Another research uses feature points that are automatically tracked using Hierarchical Optical Flow method [11]. The feature vectors are used for the recognition and it is created by calculating the displacement of the facial points. The displacement of a point is obtained by subtracting its normalized position in the first frame from its current normalized position. There is a proposed feature-based method, which uses geometric and motion facial features and detects transient facial features [12]. The extracted features (mouth, eyes, brows and cheeks) are represented with geometric and motion parameters.

Although the facial expression recognition has been studied with much interesting in the past 10 years [13], it is still a challenging task. Limitation of the existing facial expression recognition methods are that they attempt to recognize facial expressions from data collected in a highly controlled environment which are given by high resolution frontal faces [14]. To reduce the controlled environment constraint and get the facial expressions in a short time period with the normal environment condition is our effort in the facial expression extraction section.

2.2 Non-verbal communication and Education

Communication is a critical thing in every field including education, so it has to be carefully handled. Above all, in any education system, non-verbal communication is valuable, because it makes notable impact on outcomes for student response and their behavior [15]. When the instructor conducts the lessons with facial expressions, the student performance can be raised by 86% [16]. In addition, non-verbal communication covers the highest area in communication process. Based on the Mehrabian’s communication model, communication includes three parts and facial liking owns the highest portion (55%) [17].

The specificity of virtual learning environment is that, beyond direct text/voice/video messages, users may communicate in other ways: exchanging objects, moving in the space. These are often called ‘non-verbal’ communication, but this term is slightly inappropriate when the commands are verbal (e.g. users have to type “move”, “give object to Bill”, “Smile”). These new forms of social interactions are less known, but they view them as the main avenue for the development [18]. In addition, proposed method is available to bridge real world and virtual world through commercial mobile phone sensors and they consider basic activities such as flying, sitting and walking [19]. Further, e-Learning model was built to improve students’ learning experience by customizing learning material delivery based on students’ emotional state and it is detected from biophysical signals. Experiments were indicated the superiority of emotion aware over non-emotion-aware with a performance increase of 91% [20].

Emotional Avatar in virtual world and body gestures affection is not only for the education but also they affect to the e-commerce field [21]. Particular facial expressions and body gestures when being used individually by a human-like Avatar were more attractive and increased users’ interest. The presence of Avatars with facial expressions has been shown to be the key factor in the generation of positive feelings that have been linked to various considerable outcomes, such as increased user confidence, improved interface friendliness, and perceived trustworthiness. Users appeared to be more confident, showing higher levels of content understanding, and devoting less mental work, due to their exposure to a human-like character that speaks, and expresses several emotions simultaneously. In addition, as the attractiveness of expressive Avatars cannot be ignored, all users felt that the system was obviously very intelligent and had a pleasant appearance [22].

Based on the previous findings, emotional Avatar is made huge effect to their relevant fields and non-verbal communication is very important to education field. Although there are different types of Avatars are built and researches in the field of non-verbal communications are done in real world, no any system to visualize the real student’s facial emotion in the field of e-Learning. This is an effort to establish non-verbal communication in e-Learning with real time and that is not only for the instructor but also for the all participants.

3. FRAMEWORK OF THE SYSTEM

Visualization of real user facial emotion through an Avatar face in virtual world is the major challenge of this research. Two approaches were considered to achieve that target.

1. Transferring facial expression (FET).

Identifying the facial expression of the real user and transferring it to virtual world.
2. Transferring facial image (FIT).

Transfer a face image of the user directly and no need to identify the facial expression of the real user.

When the FIT method is used, facial expression of the real user can be reflected obviously in virtual world with the face image of the real user. But it has some issues in the aspects of technical and education. The system should be engaged with two worlds and transferred data. When the image is being transferred, it is taken much time to complete the process than transferring text in technical side. If the process has big time gap, the final target is difficult to achieve. The FET method has several benefits than FIT method in the education aspect. The FET method is consisted with the human computer intelligence interaction which is lack in FIT method. In the FET method has an intelligence interact between students and computers through understanding the emotional state of the student. In addition, this intelligence interaction increases the effectiveness of the education through analyzing the stored student facial expression information and it can be reused for the future decision making which is difficult to achieve using the second approach. Therefore the FET method is suitable to visualize the real user facial expression in virtual world and it is consisted three major steps as follows.

- Identification the real time emotion of the student
- Avatar adjustment in virtual world
- Creating a bridge between real world and virtual world

The skeleton of the proposed system is indicated in Figure 2. To achieve our objective, basically computer and web camera are the most important equipment. Students log into virtual world and carry on different kind of activities as a human computer interaction. When the student works with his computer, a real time webcam image of the student is obtained by a webcam including his entire face area. That video is considered as the input of the facial expression extraction system and relevant facial emotion of the student is determined in a short time period as the human computer intelligence interaction in this process. It is transferred to the virtual world through the server and http protocol instantly. With the help of the Internet, appropriate facial expression is transferred to the Virtual Learning Environment within a small time gap between the real user and Avatar. Ultimately, the facial expression of the real user is appeared instantly through the Avatar in the virtual world. Real time information of the student is visualized in the e-Learning class within short time duration through this system. When the real user changes the facial expressions, it is appeared through an appropriate Avatar instantly. Therefore it is a real time operation to create a live Avatar with mirror technology. It is very helpful for the learning process because of its special e-Learning characteristics of self-regulation. The teacher can cover student’s activities through the direct and indirect observation via this system. In the indirect observation, the stored data of the facial expressions can be observed and obtained for the better decisions of the future effective learning sessions.

3.1 Facial expression identification system

This is the initial step to make more realistic learning environment and create live Avatar in virtual environment. Geometric feature-based method is applied to identify the
emotions of the student. Shape, texture, and size of the face components are important to recognize the facial emotion through the Geometric feature-based method. With the help of the web camera, the video which is included face of the student must be obtained during the learning session. The video is consisted a set of images which have sequences from start to end. Then the image analysis has to be done for extracting the facial emotion.

After obtaining the real-time image, face of the user need to be detected. Face recognition method is prepared with the help of Haar-like features [23]. Including those features, classification can be built to identify whether the face or face components are included or not within the given image area. Using that procedure, image classification is done whether face is included or not. The relevant steps to detect the emotion of the student are indicated in Figure 3. If there is no face in the image, then procedure must be started from the beginning. If the face is identified, then the next step has to be performed. Next task is to detect the face components such as eyes, nose, and mouth. It is important to roughly determine the relevant places within the face area for each face component to increase the efficiency. Otherwise everything is wasted finding face components throughout the whole image. Therefore face area can be divided into five parts starting from \( x_1 \) to \( x_5 \) as shown in Figure 4. The values are positive because they represent the distances. Those areas can be set based on the interesting regions to identify each face components (Eyes, Nose, etc.) within the face area.

\[
x_i = \{x_i | x_i > 0 & 1 \leq i \leq 5\}
\]

In here, the value of \( i \) named from top to bottom of the image such as top, eye, nose, mouth, and bottom. Each \( x_i \) has a value of 18.18, 15.15, 6.66, 26.66, and 33.33% respectively. After defining the relevant area, the classification is applied for the specific areas to find whether each face components is included or not within the given region. Having detected the face and face components, behavior of those components have to be analyzed. To accomplish it, face variables should be gathered. Ten face variables which are shown in Figure 5 are obtained to determine the behavior of the face components. Such as eye height, eye width, nose height, nose width etc. When the system is started, user or student has to stay until for its first ten frames capturing with their neutral state. During the first ten frames capturing, the behavior of the face components are obtained and then calculated the average value of each face variables in neutral state.

After ten frames capturing with face components, the facial expression can be determined. Appropriate facial

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**Figure 3:** Major steps to identify facial expression.

**Figure 4:** Face detection and Identify face components
expression can be obtained through comparing the face variable data in the neutral state and current face variable data.

When the system is implemented, some limitations have been noticed. When the user is wearing a high density frame glasses or some accessories such as ear rings and hats may reduce the detection rate of the face components. Most of the times, student has to direct their face towards the monitor of the computer. Because face area or face components are necessary to determine the facial emotion. Distance between the computer and the user should be nearly constant during the learning session. If the distance is changed with high values, the size of the face components may be changed and expression may be uncorrected. At the same time, the system is taken less than one minute to determine the first facial expression. During that time, the user has to stay at their neutral state and that is a weak point in this process.

In this process, environmental condition is not highly affected to the system. Controlled environment condition is not necessary to obtain the relevant expression. After obtaining the first expression, it is easy to identify the expression of the user and it takes averagely one second. With this process, the aim can be achieved through reducing the controlled environment constraint and got the facial expressions in a short time period with the normal environment condition.

3.2 Creating a live Avatar with facial emotion

Normally, the Avatar in virtual world has not any facial expression and it is a barrier for making more realistic learning environment. Most of the applications are available to change the appearance, size, color or other attributes of the Avatar. But all the changes are only static and there are no ways to change the facial emotion instantly. Our aim is to create an Avatar with facial emotion which is appeared in real user. Therefore, the Avatar with facial emotion is very important. This is the second major task to visualize the facial expression of real user in Avatar’s face. It can be done using two methods.

- Image based method
  It is based on the image animates system. Creating images of facial components with different facial features is the first step. Images are exported to the virtual world and it can be applied to the objects in virtual world. Then objects are attached to the Avatar. Finally, the image is appeared on the object and it looks like the face features of Avatar. It is completely pure method and wanted a small script part.

- Completely based on the scripts
  Effective way to generate emotion of Avatar and it is visualized in Figure 6. In this method, the Linden Script Language is necessary [24]. It is completely depended on the coding and not an image based method.

Through the above methods, basic facial emotion models were created in virtual environment. It is activated based on the commands. Most of the time, we used the script based method to make the alive Avatar in this process, because it has more naturalistic representation than the image based method.

3.3 Bridge between real world and virtual world

Having completed the previous two major activities, the last major activity is to transfer real world information to virtual world. Most of the time, data is transferred from virtual world to real world when evaluating the student activities during the learning sessions. But this time, the direction of data transfer need to be changed. It is possible to transfer data to virtual world using http method. Therefore http protocol is prepared to transfer facial emotion and facial data among two worlds. Result of the facial emotion of real user is obtained from http protocol and the acquired data is transferred to virtual environment through the server. This http protocol is provided some advantageous to this system as follows.

- Provided facial information of the user to other parties including teachers or instructors as Figure 7
- Help to connect or transfer information among virtual world and real world

Figure 5: Face variables

Figure 6: Avatar face modifications
4. EXPERIMENT

Having completed this system, our aim is to identify whether this system is possible to implement in virtual environment and identify what are the positive features as well as drawbacks for the point of making better e-Learning world.

To accomplish that target, an experiment was carried on to evaluate the facial expression visualization system and identified the affection way of facial expression in education and virtual world. A questionnaire was prepared for wrapping those three sections.

Live Avatar with facial emotion is implemented in cyberspace learning place. As the initial step, a discussion was conducted with the real time facial emotion to introduce the facial emotion in virtual world learning environment. It was included two groups and each consisted with three members. Totally seven students participated in this event and the schedule was indicated in Table 2.

Five minutes introduction session was conducted to deliver the instruction to use this system and about the virtual environment. Each group had two sessions and took twenty minutes for each session. Discussion was conducted with their preferred topic among the participants with the facial emotions as shown in Figure 8. During the discussion, not only facial expression information but also student activities, chat communication and other relevant information were obtained. After the two sessions for each group, a questionnaire was delivered and gathered responses from participants.

5. RESULT AND DISCUSSION

The questionnaire which was given after the experiment consisted three parts namely “facial expression system”, “facial expression in education” and “facial expression in virtual world”. First part is consisted of six questions (q1 - q6) regarding the facial expression system. The summary of the evaluation of those questions are indicated in Table 3. According to that, engaging with three dimen-
sional Virtual Learning Environments is very interesting and fascinating activity for students. In addition, facial expression with virtual environment generates more suitable educational environment. Because of some constraints of the facial expression system, it indicates the low amount for user friendliness.

The second part of the questionnaire (q7-q11) is related to facial expression in education and it is shown in Table 3. During the conversation, non-verbal communication especially, facial expressions were very helpful to identify others’ actual idea and increased the involvement in discussion. When they obey the instructions of facial expression system, it was somewhat difficult to adapt to the learning. The attention to the learning can be increased when they were focusing to the facial expression of instructor and other participants.

The other six questions (q12-q17) are included in third part and it was discussed about the facial expression in virtual environment for the purpose of education as shown in Table 3. According to the user, the attractiveness and reality of the virtual education space are increased with three dimensional environments including facial expressions. During the education, facial expressions are helpful to understand the learning content with instructor expressions. Although e-Learning conducts in different places, gestures are very important for e-Learning.

There are several benefits can be acquired through the implementation of this system in cyberspace learning. Although virtual environment is utilized in learning, it is also considered the real world applications. With the facial emotions of the students and teachers, as well as the three dimensional characteristics in virtual world increase the reality of the learning place. Reality of the virtual environment may affect to the student thinking behavior, mind situation or performance. This system is acted as a tool which is provided facial information to their instructors. Based on this information, instructor can make better decisions to create effective discussion or lecture. With this system the connection between the instructor and student is increased than the normal Synchronous e-Learning class with non-verbal communication.

When the system is operated with two worlds, it is taken some time to transfer the relevant data. As shown in Table 4 and Figure 9, the initial time allocation for the facial expression identification process and it is taken averagely 1 second to recognize the facial expression of the user. Another 1 second to transfer it to the server and finally 0.5 second taken to transfer from server to Avatar. Totally it is taken 2.5 seconds to transfer real user information to virtual world. This process is engaged with the instant data instead of the stored data. Avatar is represented the real user information within 2.5 second and he is made the fair character instead of the user. This process works with real time information and it is taken very short time to visualize user information in virtual world.

6. CONCLUSION

Although e-Learning becomes the attractive and trending way of delivering knowledge, it is still based on the human computer interaction. This paper proposed a method to increase the fruitfulness of the e-Learning process through involving the intelligent interaction among human and computer. This method is utilized the facial expression of the students and instructors to involve the intelligent interaction between human and computer. Extracting facial expression of the student and instructor, based on the Geometric feature-based method is the initial step to establish the human computer intelligent interaction. Then, facial expressions are transferred to Virtual Learning Environment with the help of Http protocol through the server. The appropriate models for the Avatar are constructed in Virtual Learning Environment to indicate the facial changes of the real user. Visualizing facial emotion of the real user through the Avatar in Virtual Learning Environment during the learning sessions is successfully completed with HCII in e-Learning process. Instructor can observe the student behavior directly through accessing virtual environment and indirectly observe through the stored data in the server.

| Table 4: Time Duration to Visualize Facial Expression |
|-----------------|-----------------|----------|
| From            | To              | Average time (seconds) |
| Real user       | Facial Expression system | 1        |
| Facial Expression system | Server          | 1        |
| Server          | Avatar          | 0.5      |
| **Total time**  |                 | 2.5      |

Figure 9: Time duration for transfer facial data
Therefore, post analysis of the facial expression can be done by using this method and it is helpful to obtain future decisions regarding the e-Learning sessions.

The conducted experiment with the facial expressive Avatar is confirmed that the facial expressions are important to e-Learning and it is increased the attractiveness and the reality of the learning environment. Although some constraints of the facial expression system are affected to the behavior of the student, the involvement in conversation is reasonably increased and raised the conversation effectiveness. The Avatar with facial emotion is helpful to identify the learning facts and it is supported to capture the others non-verbal concepts. Further this experiment was shown that the students were willing to engage with education in virtual world and it was became very interesting thing for them. It is very good sign for future e-Learning world.

7. FUTURE WORK

This proposed method is identified that the facial expressive Avatar can be made a huge effect to the Virtual Learning Environment in a positive way. The Skelton has been developed and now it should be improved with studying facial expressions including muscular movements of a human in the future. When we developed the Skelton, only basic facial expressions of the student are evaluated. During the education time, there are many emotions are appeared on a human face such as sleepy, tired, dull moods etc. and those are very important to instructor to establish the strong and effective connection between students and instructor. Not only geometric facial features but also muscular movements of a face are needed to consider as a more important emotions. Identifying the most important emotions related to education and applying them to e-Learning environment is the future work of this study.

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