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An Interactive System for Concurrent Engineering Design

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Abstract. The methods in delivering engineering design have gone through evolvement where the effectiveness of conventional methods is decreasing. However, the importance of concurrent engineering design approach has tremendously increased due to the ever competitive world today. This is the reason why engineering designers are concern about the methods of delivering design and one of the recent interests is using interactive system to deliver design. In this paper, the construction of interactive system will be discussed followed by the experimental setup. Experiments will be conducted in the form of performing few selected tasks with the interactive system and comparison will be made with the conventional design approach. Comparison will be done by collecting feedback through questionnaires from the participants who are involved in the experiments. Feedback will be analysed to identify the feasibility of interactive concurrent engineering design system.

Introduction

A number of studies associated with the concurrent engineering have been revealed in a literature survey. Consideration of the factors associated with the life cycle of the product during the design phase is described as concurrent engineering (CE) by Abdalla [3].Product functionality, cost, quality, manufacturing, assembly, testing, maintenance and reliability are the factors that are included. Aspects such as product quality and cost are specified during its design stage which makes concurrent engineering so important. The concurrency of the activites is not the only essence of CE because the cooperative effort from all involved teams which leads to improving profitability and competitiveness is also involved. Concurrent engineering affects the product life cycle through the consideration and integration of various design and manufacturing activties [4]. Concurrent engineering will lower design changes which directly lowered cycle time and production cost due to the bringing of downstream process expertise into the design stage. The lack of communication among distinct design activities inhibits concurrent engineering's implementation although much success has been attributed to it. The integration of design environment is important for designers to evaluate the manufacturing processes. It is described by Ranky [5] that concurrent engineering is a systematic integration of product design and manufacturing process by using state-of-the-art computer system. The downstreaming manufacturing processes of the product life-cycle in the initial design phase can be considered and evaluated by a designer within CE.

Literature Review on Interactive System

A low cost interactive whiteboard which is using the wii remote to utilize a flat surface as the screen and Infrared (IR) pen as an interaction tool with the screen has been developed by Lee [11]. Tests have been conducted in schools by using this system. However, when using the IR pen to interact with the screen the user's body might unintentionally block the screen and creates disturbances for the wii remote to interact with the infrared source [11]. This problem was solved by searching for an ideal location to place the wii remote so that the range of detecting the infrared source is wider. In this case, the disadvantage is the time consuming setting up process [11].

When a group of learners are working together for some teaching/learning methods to complete tasks, solve problems or creating a product it is termed as collaborative learning. E-learning or ODL (open and distance learning) has been enhanced by developing an interactive media. It is meant for solving certain education related problems especially distance learning problem [8]. However, there is different between personally learning and teaching with online electronic tutorials. That is the reason why some learners who prefer personal interaction will require asynchronous messaging for the sake of social interaction. It is also more interactive and lively to include video conferencing as well [6]. On the other hand, WebCL (web collaborative learning) is mainly for teachers to create web-based learning. WebCL is helping teachers in such a way that collaborative learning is supported by allowing teachers to take part in collaborative activities that are available online [7]. Next, the popularity of interactive whiteboard and electronic whiteboards is increasing as a supportive tool for collaborative learning. The availability of these whiteboards contributes to improving the collaborative learning by developing firm conceptual thinking and confidence in children [7]. It is also proven that interactive whiteboard was used to assist the teaching of primary school students with Autism Spectrum Disorders (ASD) [9] because these types of students play their toys in different ways compared to ordinary children. The social intellectual development and thinking is affected by the way of the child is playing. Interactive whiteboards have many advantages but at the same time they have disadvantages as well. Firstly, the amounts of applications that are readily available to be used with the interactive whiteboards are limited. Next, the shadow that covers the writing or diagrams on the board when the light from the projector is being blocked creates some difficulties for the viewers to see the materials that are being delivered. Finally, the cost on interactive whiteboards is higher than the conventional whiteboards and this may discourage teachers to use interactive whiteboards [8].

Games are entertainment activities and various interactive mediums for collaborative games such as iGame Floor. iGame Floor or the interactive floor is a floor platform meant for gaming entertainment. The games are designed towards supporting collaborative games and interaction movement for children [10]. One of the applications that is being used with iGamefloor is Stepstone which is a multi-player and co-located learning game. In this game, children can select to play in a team to accumulate the highest score to win. Games can also be played by two teams competing with each other. The advantage of this game is that there is an option for teachers and students to edit the game. When the children are enjoying this game, they can gain improvement in collaboration and learning abilities [10].

Experimental Approach

This research was conducted by identifying 20 voluntary participants to take part in the testing of the interactive whiteboard using Wii Remote. The participants were students from Universiti Teknikal Malaysia Melaka (UTeM). The participants were given 15 minutes to carry out a set of tasks designed to obtain the feedback regarding the feasibility of the interactive whiteboard. In fact, the tasks do not need as long as 15 minutes to complete but the students should be given ample time to complete the tasks comfortably so that accurate results are obtained. The main objective of these tasks is to compare the difference between using a mouse and a keyboard and a Wii remote. However, the participants are not performing the tasks by themselves only. Each task will be supervised and instructed by the researcher himself and then the feedback will be obtained from the students on the spot to avoid inaccuracy in results.

Setting Up an Interactive Design System. The task of setting up the interactive whiteboard will be started by connecting the Wii remote to the computer via the Bluetooth dongle. The buttons “1” and “2” on the Wii remote should be pressed simultaneously to trigger the connection. If it’s done correctly, the blue lights at the bottom of the Wii remote should be flashing and that means that the Wii remote is sending out signals to search for Bluetooth devices. Next, the Bluetooth dongle attached to the computer will be activated to detect the Wii remote. The framework of the interactive

whiteboard is shown in Fig. 1. When the Wii remote has been successfully connected to the computer through the Bluetooth devices the next task will be identifying the most ideal location to position the Wii remote. The positioning of the Wii remote has a simple guideline which is to position it far enough from the display screen so that it can sense the whole screen. Meanwhile, positioning the Wii remote too far away will cause it to lose its tracking range.

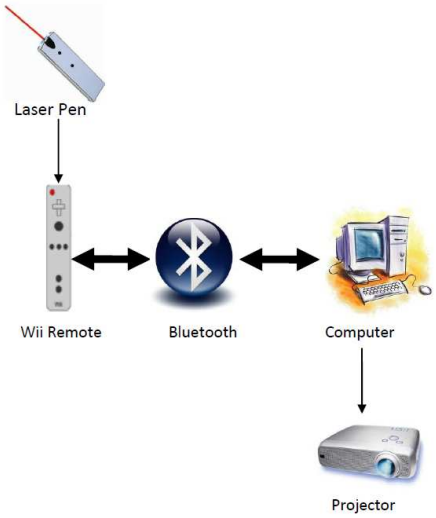

Fig. 1 Interactive design system framework

Task Peforming. The participants were asked to perform a few tasks to compare between a mouse and a keyboard and the Wii remote system. A scenario where targets will be displayed on the screen is shown in Fig. 2. The participants will be asked to move the pointers over the target by using the mouse, keyboard arrows and Wii remote system (Infrared LED pen). However, the experiment will be started with only one target followed by an increment of one more target and lastly a total of four targets will be displayed. Questionnaire will be conducted by the end of the experiment.

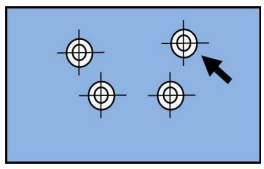

Fig. 2 Pointer movements

Results and Discussion

Pointer movement is the easiest task but is being performed most of the time during a presentation session. Thus, this feedback obtained from this task is very crucial to determine how feasible the Wii remote system is. The responses from the participants are plotted into graphs to show their perception towards the Wii remote system as compared to the mouse and keyboard. From Fig. 3, there is not any significant trend shown on the participants' preference because majority of them rated "neutral" for both the mouse/keyboard and Wii remote system. However, from Fig. 4 onwards until Fig. 6 where the number of targets has been increased there is an obvious trend which showed the participants' preference over the mouse/keyboard as compared to the Wii remote system. The participants' rating for the Wii remote system shifted from "neutral" to "unintuitive" whereas the rating for mouse/keyboard shifted from "neutral" to "intuitive" and "very intuitive". Majority of the participants however did not rate the mouse/keyboard as "very intuitive" as compared to "intuitive" when the number of targets has been increased. This shows that when the number of targets has been increased the participants also face minor difficulties in using the mouse/keyboard. Nevertheless, based on the trends shown by the graphs, it is clearly exhibited that for the pointer movement task, the participants preferred to use the mouse/keyboard than the Wii remote system.

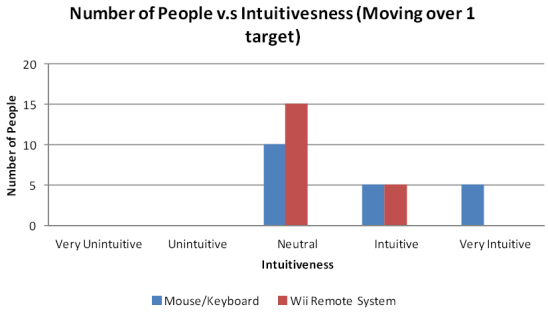

Fig. 3 Graph numbers of people versus intuitiveness (moving over 1 target)

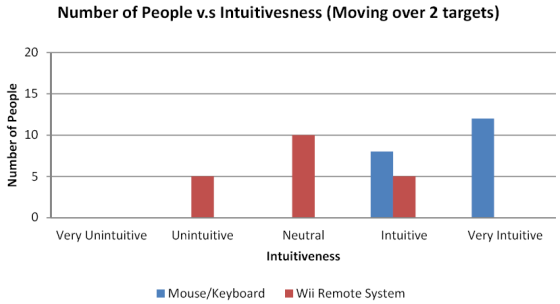

Fig. 4 Graph numbers of people versus intuitiveness (moving over 2 targets)

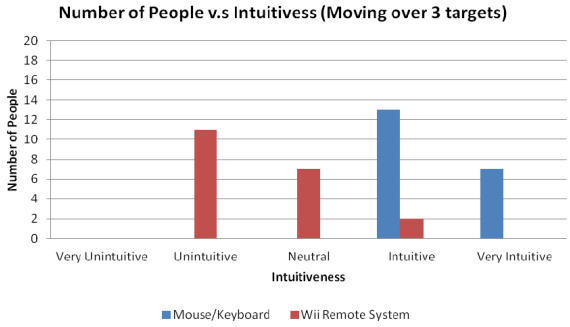

Fig. 5 Graph numbers of people versus intuitiveness (moving over 3 targets)

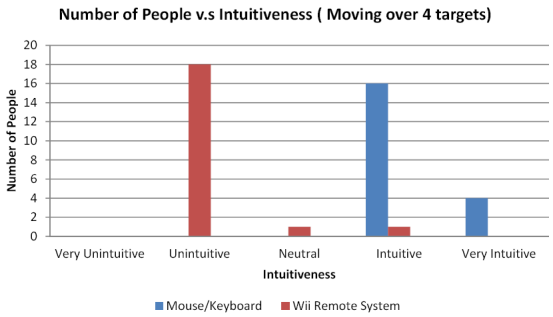

Fig. 6 Graph numbers of people versus intuitiveness (moving over 4 targets)

Conclusion

Experiments have been conducted on the preference of participants over the Wii remote system to be used for the interactive whiteboard. Results have shown both positive and negative feedback for the Wii remote system. However, it is worth to mention that this is a relatively new system to be adapted by the participants after being familiar with the conventional mouse/keyboard system. Another interesting point is the cost of the interactive whiteboard which is being used in the project is rather

low. The equipments needed are widely available in the current market. Thus, it is not impossible for learning institutes to use the interactive whiteboard in future. The results obtained from the experiment is very important regardless of the outcome because with these results, they enable further work to be done for enhancing the current interactive whiteboard so that the users can adapt more positively towards the system. All in all, the interactive whiteboard is a feasible idea to be adapted in learning institutes for enhanced learning environment and more productive outcome.

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