

Development and Evaluation of an Interactive Pen

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**Asia Pacific Journal of
Multidisciplinary Research**

Vol. 3 No. 4, 100-106

November 2015 Part IV

P-ISSN 2350-7756

E-ISSN 2350-8442

www.apjmr.com

Date Received: October 10, 2015; Date Revised: November 7, 2015

Abstract - *Technologies have reached the classroom. It is one of the means of teaching strategies nowadays. Multimedia projectors have become one of the teaching tools the teacher cannot bear without it. The concept of making this tool to be interactive and easier to use was far conceived by the researcher. The researcher's objective was to develop such tool and evaluate it according to its portability, simplicity, robustness, user-friendliness, effectiveness and efficiency. The respondents of the project were both the students and teachers of Batangas State University ARASOF-Nasugbu. The researcher has developed different prototypes for the interactive pen and tested in different environment and demonstrated the "know-how" of the project. The project was built using a simple infrared light emitting diode (IR LED), infrared tracker, and software which computes, detects and interact with the application program. Evaluation of the project followed the demonstration. The project got a high acceptance according to its portability, simplicity, robustness, user-friendliness, effectiveness and efficiency. The researcher is recommending the full implementation of the project in the Batangas State University ARASOF- Nasugbu and for better enhancement of the project by eliminating the pen.*

Keywords: *pen, interactive, teaching strategies, whiteboard, classroom*

INTRODUCTION

Computers have given a lot of progress in human life. It enhanced the way man lives, communicates, make friends and travels. Almost all corners of progression in the life of human being, there is a computer in it. It made things easy for everybody, from a snail mail to email, limited research sources in school libraries to Internet, typewriter to word processors, additions, subtractions, multiplications, divisions through the use of sophisticated calculators. It also offers comfortable way of living, from remote controlled appliances up to mobile technology, communication through antennas up to satellite system, wired technology up to wireless technology, and provides convenient working areas, from manual system to automated one, from a real system to a virtual system and from actual training to a simulation.

In education, the ways of teaching and instruction have become more advanced and sophisticated. Computers, application programs and other devices are just around. They were use as tools in teaching to motivate students to listen and participate in the class discussions and activities. But teaching methods doesn't just end there and the technology doesn't just

stop there. Classroom instructions were made more advanced with the use of overhead projectors in which sooner replaced by multimedia projectors. Multimedia projectors changed the way instructions are presented with the use of modern technology. Lectures and other instructional materials became more presentable than using manila papers, chalk board, markers and erasers. Those materials were now used as an option; the lecturers could used it to elaborate the lessons, by writing some important notes about the presentation or lessons or emphasizing some terms. Also, maintenance of the said materials is high due to their volatility feature.

The advancement of technology and those emerging technologies have gone so far. Technologies which man could think of are already available. Name it and the market has it. Pushing to the limit, the concept of availability and creativity will come to the picture. Concepts never end as the world grows older. Human's thought is as deep as the sea. It never stops conceptualizing on the things around. Merging those available technologies might produce another innovative product.

A concept on having an interactive whiteboard is far conceived by the researcher. The availability of the

technologies in the market makes the researcher eager to pursue the project. The idea is making the whiteboard a sort of a touch screen or simply emulating the mouse via a wireless pen which will be much cheaper than other multimedia devices. The researcher came up with this project “Development and Evaluation of an Interactive Pen”.

LITERATURE REVIEW

The study of Nielsen and Stenbacka [1] use the Wii device outside the gaming spectrum of the device. They used it in the as industrial tool and through that concept that the researcher grabbed an idea that it is possible to use the device also in education.

The study of the group of Brojan [2] about their thesis entitled “Wii Exceed: The Wii Power Trainer” have given the researcher the idea about the real time motion and the position data. Where in the researcher used them in the processing the x and y coordinates of the infrared pen.

One of the problems encountered by the researcher in the study is the writing gesture of the users and the study of Wii Write Group entitled Gesture Recognition explained that there are the what they called unique signatures each person makes when writing.

The study of Lourenço [3] of Rhodes entitled “Wii3D: Extending the Nintendo Wii Remote into 3D” which uses three infrared lights attached to the fingers of a user to trace the 3D motion. In this perspective, the researcher pop an idea on using the concept on attaching the infrared to the finger of the user.

The study conducted by Suhardi [4] about large group gaming where the controller is equipped with a motion and infrared sensor allowing the players to control the game by using their hand gestures or pointing at the screen. The idea was to use the hand gestures but the writing gestures perspective for the project’s objective to meet.

Use of the different colors on text and other design of text on teaching and instruction foregrounds pedagogy and background technology [5]. Designing text in the pursuance of the project is just as easy as designing in the computer applications. The idea of adapting it is merely obvious and already installed once the system is up.

Making an optimal use of the interactive pen technologies the teachers should be offered [6]. In the project the adaptation of this idea will be use where

the researcher’s concept is to use the infrared LED as the interactive pen. The IR LED should be visible in the project for easy tracking of the position in the interactive board.

The case study teachers demonstrated contrasting approaches to designing and supporting activity in which pupils shared, evaluated and developed ideas using the IWB. Pupil manipulation of objects on the IWB was deemed desirable but – along with pedagogical interactivity – was constrained by systemic school and subject cultures, curricular and assessment frameworks [7]. Through this idea, the project will be more on the pedagogical use as much as possible since the target is for instruction and pedagogical strategies.

METHODS

Interactive pen was as much as interactive. This was the focus of the development. The researcher’s experienced in the instruction; the development was made in accordance to the hindrances in the instruction of using multimedia projectors and computer system in instruction. Research development started in the design stage where the lay-outing and data gathering occurred. Next was the developmental stage in which the gathered and filtered data and the designed lay-out were compromised. Trial and errors occurred in the development stage since it was the developmental part and the experimentation stage. Afterwards, testing the developed project was administered with the end users as the evaluators of the project. The project was started by gathering information about the infrared, Bluetooth, multimedia, whiteboard interactions, computer system’s connection with the Bluetooth devices and other related literature related to the project. Gathering the needed devices was next after the data gathering. Checking the availability of those devices needed in the development was obviously necessary for the researchers to go to the next stage. Lay-outing was done using the sketch and erase method for some designs needed in the project.

As conceptualized by the researcher, the first thing to design was the pointing device that mimics the chalk or the whiteboard markers in terms of writing and using as the writing tool. The plan was to use the infrared LED in this device where in it sends the X and Y coordinates onto the computer. It has switch that activate and deactivate the infrared LED.

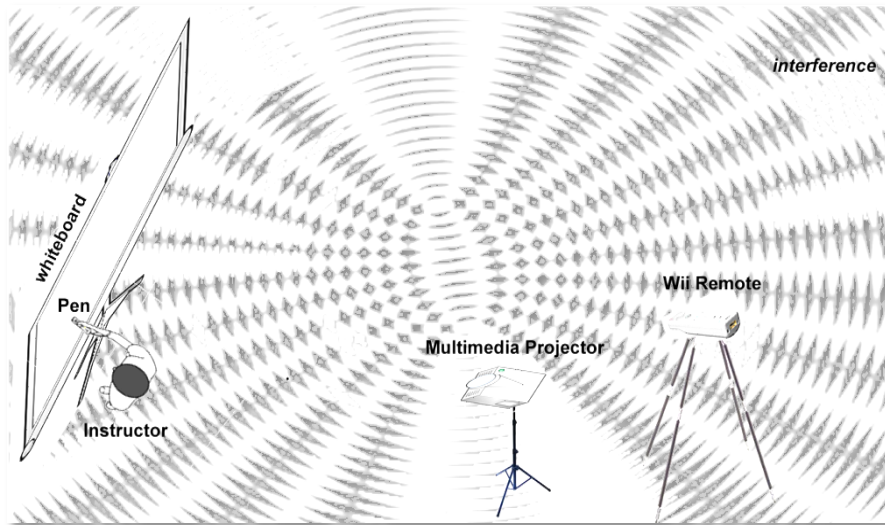


Figure 1. Conceptual Design of the Proposed Project

Figure 1 was the conceptual set up of the project where in the position of the different components must be documented and tested; the proper position of the components in the set up; the position of the user and whiteboard were considered; creation and formulation of the middleware of the project; distance of the components to each other was also in proper, and interference in the set up was considered since there was an Infrared use in the project.

Materials needed in this project were identified and gathered in the first stage, this includes the hardware and the software materials. The Bluetooth component wherein the possibility of using the embed Bluetooth of the laptop or buying the available Bluetooth dongle in the market, the infrared light emitting diode (LED), the multimedia projector, word processor and even some software for graphic editing needed during the development of the project were identified for the realization of the project. Setting up the components and/or configuring the devices was the next step and then gathering materials in the experimentation. Creation of the middleware for those components to act as one in the project was done using the object oriented programming language. Modifications and bogus data was use for experimentation or trial and errors. Formulation of the source code for the middleware was also in the process of trial and error part. Going back and forth in the design stage was done so that the modifications and configurations of the project will be ready for the next stage.

Testing and Evaluation

Connecting and configuring the developed project and setting it up in the classroom were the next move. Testing the interactive ability of the project was conducted so that the main objective was met. Checking the distance and angle where the system work and also finding the right and perfect distance to install the project, the configurations of the merged technologies to function properly, the devices connected in the project and the bug free software if they are working hand in hand. Testing the connections and reliability of the project in the classroom instruction and/or teaching was also conducted at this stage. Time to time, testing was made a routine in this project.

In the experimentation, trial and error was use and the tabulation of data and results for documentation and reference purpose. Presentations were run on the project and tested it if it was as presentable as the old way of using the multimedia projector.

Evaluating the project was done to test its portability, simplicity, robustness, user-friendliness, effectiveness and efficiency. In the evaluation process, the researcher distributed the validated evaluation form. The respondents of the project are the 89 faculty members of the target area which is the Batangas State University ARASOF Nasugbu using the Sloven's Formula with 6 percent margin of error.

Statistical Treatment

The gathered data from the evaluation form were tallied and put into tables and computed and analyzed the results. Different formulas for computation process were carefully chosen.

The researcher used the Likert Scale as shown in Table 1.

Table 1. Likert Scale with Equivalent Score and Interval

Score	Interval	Verbal Interpretation
5	4.21 – 5.00	Strongly Agree
4	3.41 – 4.20	Agree
3	2.61 – 3.40	Neither Agree Nor Disagree
2	1.81 – 2.60	Disagree
1	1.00 – 1.80	Strongly Disagree

Table 1 represents the Likert Scale used in the evaluation of the project. It includes the interval, equivalent numerical value or score and the verbal interpretation. This served as the guidelines in determining and interpreting the evaluation of the respondents.

Design

The project was simple in design, simple in a sense that the user could use it as easy as making presentation. The pen made by the researcher is as much as possible handy and easy to use. The researcher made three designs of pen so that the evaluator could evaluate using different pen. Depending on the taste and perception of the user, the researcher made an option of having three designs.

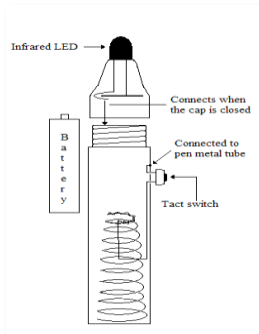


Figure 3. First Pen Design

Figure 3 was the first pen idea where the infrared light was in the tip of the pen. The switch was put on the side so that the user could easily push the button during the discussion.

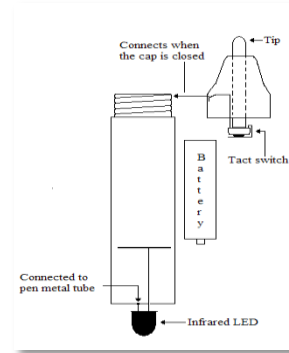


Figure 4 Second Pen Design

Figure 4 was the second idea of the pen where the infrared light was in the back of the pen. The idea was for the infrared light to be more visible to the infrared camera.

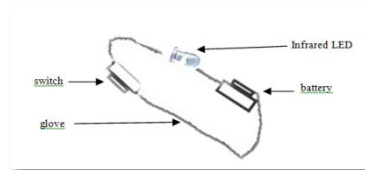


Figure 5. Third Pen Design

Figure 5 was the third idea where in it would be like the touch screen. The glove allowed the user to wear it and touch the projection on the board.

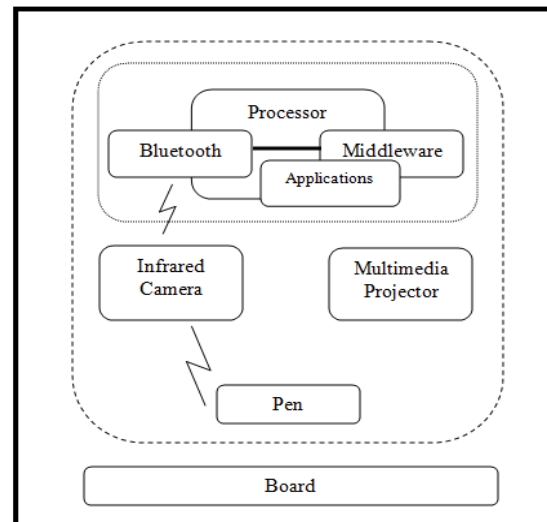


Figure 6. Project Flow

Figure 6 is the project flow wherein the processor processes everything in the project. Processor starts the Bluetooth driver for it to be activated. The

processor also connects with the multimedia projector for reference. The Bluetooth device connects via the Bluetooth driver of the processor. Executing the middleware for the project to work and function as target. The infrared pen in this stage is ready to use.

Development

Using the design and ideas in the design stage, the researcher comes up with the three prototypes.

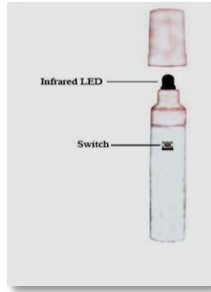


Figure 7. First Pen Prototype

Figure 7 is the first pen prototype in accordance with the first pen design. The push button of this pen is in the side of the pen and the user should push it to be able to activate the pen. This prototype requires the user to have advance knowledge on how to use the pen. The user should know when to turn on and off the button for better output in the project. The infrared pen activates when it is turned on.

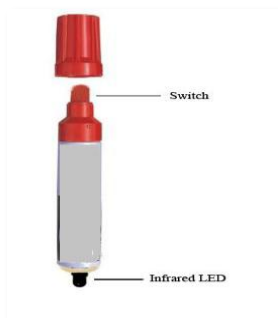


Figure 8. Second Pen Prototype

Figure 8 is the second pen prototype based on the second pen design. The push button of this pen is in the tip of the pen so that the user could use just like the natural pen. It requires the user to push the pen on the board for the switch to be pushed. It is much suited for the discussion for it does not require the user to pause to think if he or she should push the button or not. There is no need for advance knowledge

on how to use the pen. The user may use it as long as the power source of the device still in tack.



Figure 9. Third Pen Prototype

Figure 9 is the third pen prototype based on the third pen design. The push button of this pen is in the tip of the finger glove. This looks like a literal touch screen in the process.

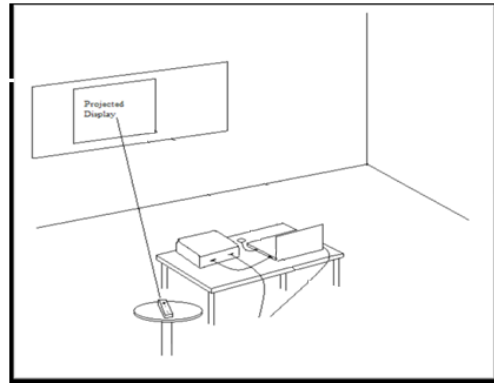


Figure 10. Set up A of the Project

Figure 10 is the Setup A of the project wherein the infrared camera is placed in the left side of the set up with at least 45 degree angle. This set up is intended for left-handed people. It is for easy tracking of infrared emits by the infrared pen use by the user.

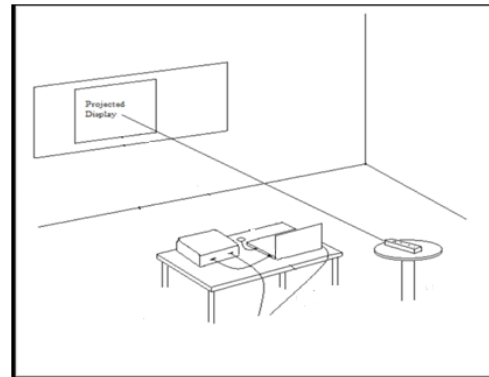


Figure 11. Set up B of the Project

Figure 11 is the Setup B of the project wherein the infrared camera is placed in the right side of the set up with at least 45 degree angle. This set up is intended for right-handed people. It is for easy tracking of infrared emits by the infrared pen use by the user.

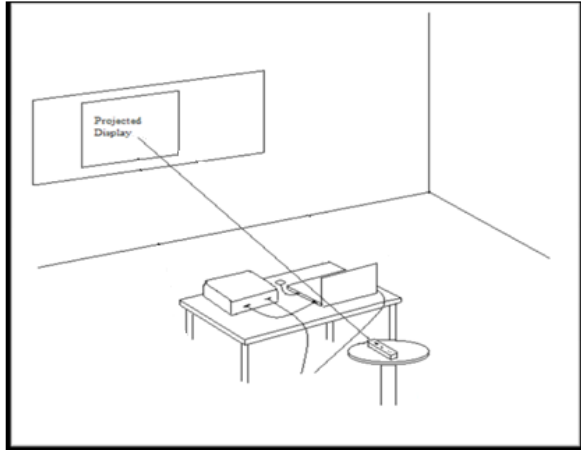


Figure 12. Set up C of the Project

Figure 12 is the Setup C of the project wherein the infrared camera is placed in the center of the set up. This set up is the better set up among the three setups. In this setup the pen is inverted where the infrared led is visible in the infrared camera.

Presentation of Data

Table 2. Evaluation of the Project from the Faculty Members

Criteria	WM	Verbal Interpretation
Portability	4.78	Strongly Agree
Simplicity	4.43	Strongly Agree
Robustness	4.16	Strongly Agree
User-friendly	4.42	Strongly Agree
Effectiveness	4.48	Strongly Agree
Efficiency	4.31	Strongly Agree
Average Weighted Mean	4.43	Strongly Agree

Table 2 shows the frequency distribution on the evaluation of the project gathered from the faculty members. It presents the result of the computation of ratings of the respondents according to score in terms of portability, simplicity, robustness, user-friendly, effectiveness, and efficiency.

Based on the computation, the project is rated Strongly Agree in all criteria with a weighted mean of 4.78 in portability, 4.43 in simplicity, 4.16 in robustness, 4.42 in user-friendly, 4.48 in effectiveness,

and 4.31 in efficiency. These ratings fall in the Strongly Agree respectively.

Having these results, it is discovered that the interactive pen is acceptable garnering an average weighted mean of 4.43 from the faculty members.

Table 3. Frequency Distribution of the Data Gathered from the Evaluation of the Project from the Students

Criteria	WM	Verbal Interpretation
Portability	4.82	Strongly Agree
Simplicity	4.55	Strongly Agree
Robustness	4.49	Strongly Agree
User-friendly	4.8	Strongly Agree
Effectiveness	4.76	Strongly Agree
Efficiency	4.75	Strongly Agree
Average Weighted Mean	4.7	Strongly Agree

Table 3 shows the frequency distribution on the evaluation of the project gathered from students. It presents the result of the computation of ratings of the respondents according to score in terms of portability, simplicity, robustness, user-friendly, effectiveness, and efficiency.

Based on the computation, the project is rated Strongly Agree in all criteria with a weighted mean of 4.82 in portability, 4.55 in simplicity, 4.49 in robustness, 4.8 in user-friendly, 4.76 in effectiveness, and 4.75 in efficiency. These ratings fall in the Strongly Agree respectively.

Having these results, it is discovered that the interactive pen is acceptable garnering an average weighted mean of 4.7 from the students. These also mean that the respondents found out how easy it is to setup and install the project in different computer systems and environments as the project portray its simplicity and portability features. Usefulness and competitiveness of the interactive pen have been also noticed by the respondents as well as the strong connection of the setups of the project, these are the interactive pen's effectiveness, efficiency and robustness features respectively.

Analysis of Results

During testing, the researcher analyzed results as the testing progressed. Solving and analyzing the problems arose during testing was done by the researchers. The project was then analyzed even during the experiment stage. Based on the results of testing, the researcher seen the advantages of using the second pen prototype and the third pen prototype

combining with the set up c. Distance of the infrared camera must not exceed 20 feet.

Getting the reviews of the presentation technology available in the market, one of the edges of using the researcher's project is its portability feature, mentioning also the inexpensive price of the project.

CONCLUSION AND RECOMMENDATION

The objective of the study was to develop an interactive pen (iPen). The project was appraised based on the following criteria: Portability, Simplicity, Robustness, User-friendly, Effectiveness, and Efficiency.

There were three set ups and three prototypes used by the researcher during the experimentation for better testing and results. Setting up the three set ups and tested the distance, writing gestures and possible interferences. The researcher made a research also on the available presentation or interactive whiteboard technology available in the market. Analyzing those available interactive whiteboards and comparing them to the researcher's project resulted to two distinguished feature of the project which is portable and inexpensive.

The faculty members' level of acceptability of the project in terms of portability, simplicity, robustness, user-friendly, effectiveness and efficiency is Strongly Agree in which the researcher perceived it as highly acceptable. The students' level of acceptability of the project in terms of portability, simplicity, robustness, user-friendly, effectiveness and efficiency is Strongly Agree in which the researcher perceived it as highly acceptable.

There are three prototypes and three setups of the projects and those prototypes can be used in any setups, therefore it will only depend on the user on which prototypes he is comfortable to use and which setups he is comfortable with. The project is much cheaper than the interactive whiteboards available in the market. Considering the overall rating which is Strongly Agree, the project has high acceptance of both the teachers and the students therefore it could be of high utilization in the classrooms of Batangas State University ARASOF-Nasugbu, Batangas, Philippines.

The researcher is recommending the full implementation of the project in the institution. The

researcher is recommending for further study the elimination of the pen and suggesting gestures as the means of interaction.

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