Creating Application for Interactive Learning on Musical Instrument Sound

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***Abstract*—** The objective of this study is to design the interactive applications that can help children to learn toward interactive media on the musical instruments and allow a user to interact with the sounds of musical instruments with fun. The five key cards are used to activate all musical sound from the instruments which are Guitar, Piano, Violin, Bass and Drums. Animation and game are used as fun medium in learning, activated by the RFID cards to start game-based learning. The performance evaluations are made on 4 related aspects which are Content, Screen graphic design, Design aspect and Interaction design (UI). Results of quality assessment were found to be at a high level in overall. The users' satisfaction on three aspects of Media, Device and Interaction were made by using a survey and found to be at high level for all aspects.

***Keywords*—** Musical Instrument Sound, Application Design, Interactive Learning

I. Introduction

Nowadays, modern media equipped with smart technology has played an important role in making our life more comfortable and having more perspective to things surrounding us. Transferring intentional information from source to specific targeted audience group and getting back a response is a main work in media. Exhibition is one of interaction that can use media technology to get the audience's insight feedback on their presentation or commercial products. By making exhibition more interesting and innovative in presentation and reaching the targeted audience, an interactive presentation is a better way of receiving the feedback from targeted audience group. A communication system that responds to human interaction through the adoption of technology must be coupled with appropriate education and influence of new technology. In the recent decade the learning skills in students rely on technology that can facilitate and promote learning by making it easier to access information resources and technology can support the interactions of learner while using it, promoting learning, and facilitating it as a means of learning new things around us.

When the human being is satisfied with the stimuli that passes through the auditory nerve, the eye, and the ear, the process of learning and recognition occurs. What human perceives via seeing, hearing or feeling, is information to the preparation of media for design and creation of the capacity to respond to stimuli which is a part of the interaction or interactive media today. The interactive media can help us to improve our learning or imagination to be more interesting, allowing user to interact freely with media. For the reasons mentioned above, interactive media can be used to promote the creative thinking process and skills, to enhance cognitive skills, to get our attention with sound and video. In this work the development of game based musical instrument matching is proposed as supplement to help promote learning in kids to recognize the sounds of musical instrument and match them with those instruments.

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II. Related Work

The Kinetic Xylophone was proposed as an interactive musical instrument that can play with a motorized mallet from the operator's gestures without touching it but waving your hand instead. This is therefore an interactive musical instrument that can be played by anyone, children, or people with disabilities. Researchers C.G. Oh et al. explained how the physics can be used in the fundamental modeling paradigm to perform the synthesis of musical instruments [1].

The interactive virtualization applications and digital waveguides (DWGs) have been applied in a form of difference-time domain schemes (DFTDs) and wave digital filters (WDFs) which have created a model of Virtual Guitar and Virtual Bell Xylophone. The results of the experiment showed that Physics modeling for the synthesis of the real-time musical sound of instruments is well suited for interactive virtual reality. M. Karjalainen and T. Maki-Patola [2] have created an interactive music system tailored to the needs of composers and performers involved in the composition and performance of music and acoustic instruments. It has been noted that density, phrase length, pitch stability, etc. have been analyzed in this study. The results of the experiment showed that different sound generators and playback manipulation techniques are used to create the greater diversity in music [3].

J. Borchers and M. Muhlhauser [4] proposed a form of listening to music called attachments, which detects the earpiece of the ear. Sound projected to the ears of the listener by both speakers and recreation with servo motors are used. That is a form of depth-based detection. It can provide precise positioning for speakers to distribute sound to audiences and use the user-proposed music attachment format. It does not require a

headset and music can be listened in a suitable environment using stereo effect. The results showed that users could easily choose the music according to the mood they wanted. By employing reliable functional body movements and user's good responsiveness [5], both adopted music learning computer aid to develop interactive learning materials to help learners to perform musical instruments. This is especially true in lessons related to music lessons at school. Prototypes of web music, visual learning, auditory and experimental effects were designed for the lesson for learners. The results showed that it can promote the joy of learning and an interest in music, which cannot be realized with real instruments and music lessons.

K. Takano and S. Sasaki) [6] has made music from a melody optimized for the feelings of multiple users based on a parallel distributed interactive genetic algorithm (DIGA). With the exchange of emotions between users, each user can get to know the feeling of others. The result from testing for the effectiveness of the DIGA in creating melodies showed that the performance was higher in the final and similar melodies were obtained through an emotional exchange to determine the efficiency of the synchronous method of exchange of music.

K. Nomura and M. Fukumoto) [7] analyzed the mood of the song. In the emotional perception model and research, interactive technology is an integral part of human-computer interaction, multimedia technology, and computerized music research. This research is of the great importance in promoting digital media and ability of the emotional interactions of entertainment innovation and the emotional human-computer interaction [8].

S. Chung and C. Wu [9] has proposed an interactive application design of digital musical instruments is used as a learning objective in ActionScript learning class. The class is grouped in pairs to solve problems of deigning a digital musical instrument, and it is eventually tested by the system usability scale (SUS). The test result showed that the usability was above the average of 77.60. Integration with qualitative analysis, recording, or saving files will improve usability [9].

III. Methodology

A. Color Theory

The diagram shows an illustration of all colors around a circle with the relationship of colors. The original primary colors consist of red, yellow, and blue colors. The different colors rather than primary colors can be made by a mixture of two equal primary colors. Mixing yellow and blue colors can create a new green color or mixing red with yellow for orange color or red with blue to create purple color.

Fig. 1. Color wheel

B. Game Design Theory

Arcade Games is a game that is built with gaming machine cabinets. Most of the time, this type of game usually takes a short time emphasizing the simplicity of the game. There is often a limited amount of time to play and no progress is recorded. The game will save only the highest score. These types of games often have the challenge of difficulty level, attracting players to keep coming back. Repeat and use psychological principles to tell. "Highest score" to find a way to break records. Computer games the game was made to be played on the computer can be divided according to the visual effects with 2D or 3D games.

C. Information of Musical Instruments

Musical instruments are devices or modified from other devices for music production or create sounds. Any device that can be used to produce music is called an instrument. The guitar is a stringed instrument organized as string instruments. Bass is stringed instruments in the international sense. The drum set is a percussion instrument. It consists of several drums and cymbals. The piano is an instrument performed by pressing a wedge (keyboard). Violin is a musical instrument that produces high pitch sounds in the classical string instruments.

D. Software

Computer language is any language that a user communicates with a computer or computers together, then computers can work according to that command with this term often used as a substitute for programming languages. C language is a flexible programming language and facilities for structured programming and permits variable scope and recursive. C# language is a multi-model programming language that uses the strong typing system and supports command-oriented programming. JavaScript language is language in the form of a prototypical programming language that always changes within the webpage. Unity is the game engine for creating games in the early days.

E. Hardware

1) Arduino Uno R3

On genuine Arduino platform from Arduino.cc Italy, designed for ease of use, AT mega 328 chip, running at 16 MHz, 32 KB flash memory, 2 KB RAM, board powered by 7 to 12 V. Programming on Arduino IDE software and programs via USB port.

Fig. 2. Arduino Uno R3

2) RFID RC522 Read/Write Module (SPI)

With Tag Card and Tag Key, the work of RFID relies on

radio waves. It is an integral component of the reader and the tag, where a unique tag is transmitted as radio waves when triggered. A tag is a piece of material that has an electronic circuit embedded inside it and it is capable of transmitting information to a reader via radio waves.

Fig. 3. RFID RC522 Read / Write Module (SPI) with Tag Card and Tag Key

3) *LED RGB*

The RGB LED inside the bulb has a total of 3 primary colors red, green, and blue LED inside with 4 connecting pins consisting of Common, R, G and B pins. The Common pin must connect to the ground with Logic 0.

IV. Implementation

A. *Operating Process*

First, collecting data information from electronic media source related to topic of study. Second, study and analyze data information about international instruments. Theory about creating graphics on the Windows OS. Theory of creating card data. Third, determine the design panel defining two external designs on the project. Fourth, content scoping on musical instruments and the musical sound made from instruments to create in application. The circuit and sensor are installed inside the unit shown in figure 4.

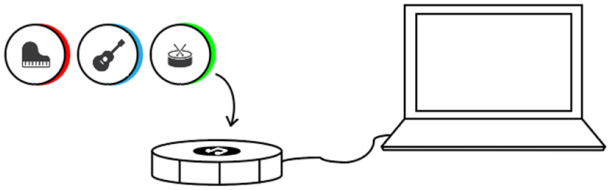

Fig. 4. Prototype of sensor unit interfacing with computer

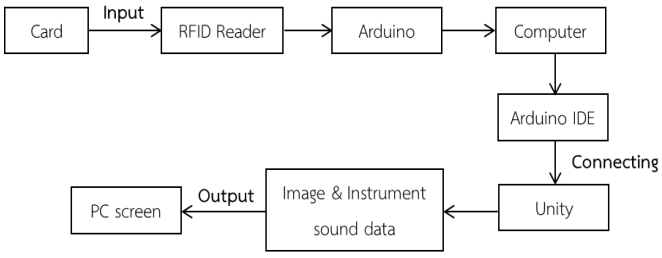

Fig. 5. Operation diagram of application system

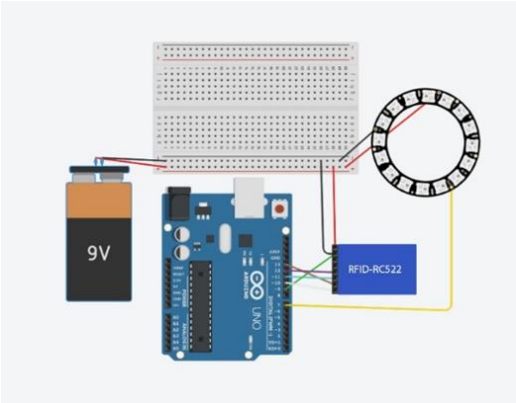

Fig. 6. The hardware circuit connection between Arduino, Sensor and LEDs

B. *Population and Samples*

The population consists of first a group of two experts with expertise in knowledge, ability, and design of media relations and second a group of 40 users as samples who give the opinion on the satisfaction toward playing the application system. The accidental selection method was used for the survey of the enjoyment of application system.

V. Results and Discussion

From the implementation of hardware and software embedded with the application system they were tested for the operation of interactive graphic media which combines with music sounds and colors to enjoy both graphic animation and programming game. The different color RFID cards labelled with pictures of musical instruments were designed as activating keys depicted in figure 7. There are five cards representing five different musical instruments which are guitar, violin, bass, drum set and piano in colors pink, yellow, green, purple, and blue respectively.

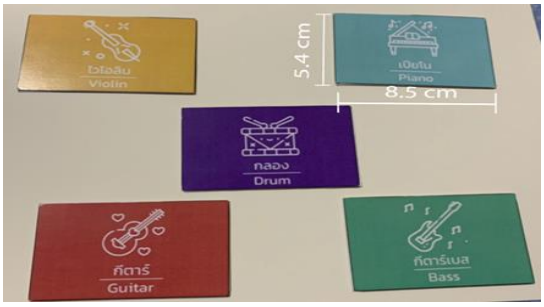

Fig. 7. RFID card design

When user taps a card on sensor, the Arduino IDE program writes commands to operate and receive data of the card from the sensor and send to the computer. It will select a set of numeric values (for example "100") from the card to display the next graphic screen Arduino interfaces with Unity program using the System.IO.Ports library which allows the Unity to read the serial port cards from Arduino board and to retrieve all values received from sensors unit and then display the main graphic screen as shown in figure 8.

Fig. 8. The main graphic screen

The application system was evaluated by three experts and the evaluation scores were found as Mean values and S.D. values listed in a Table of Overall Average for the specific assessments on Content, Graphic Screen Design, Graphic Design Aspect, and Interface Design (UI), respectively. The range of evaluation scores by expert starts from a minimum score of 0 up to a maximum score of 5. This application was also tested for the user's satisfaction on a group of twenty targeted users who used our application system and their satisfactions to application on Media and Interaction were collected via questionnaire, analyzed, and found to be (4.20, 0.20) and (2.59, 0.31) respectively. The interaction has lower mean value at average level which means the improvement is required for the modification of application.

For the Content in application, the average score of 4.20 was found from the experts' evaluation which is very high, and it can be interpreted as clearly understandable, very appropriate, and relevant for the audio and visual content. The average score of 4.70 was found at the highest quality level for the Graphic Screen Design with appropriate music, proportional scene, size, beautiful and colorful graphic design. For the Graphic Design Aspect, the high-quality score of 4.20 was found on the topic, easy to use, uncomplicated, and suitable for application. On the UI Design, the assessment score showed at 4.50 which refers to appropriate symbols for UI and clearly communicative for user to understand and size and proportion of UI are appropriate. The overall average score from all aspects of assessment made by the experts and satisfaction of users showed that the proposed application for interactive learning on musical instruments has a high quality which can help to promote the learner to understand about the musical instruments and their musical sounds.

TABLE I: OVERALL RESULTS OF QUALITY ASSESSMENT

Assessment list	X	S.D.	Quality level
1. Content	4.20	0.70	Very good
2. Graphic Screen Design	4.70	0.30	Best
3. Graphic Design Aspect	4.20	0.20	Very good
4. Interaction Design (UI)	4.50	0.20	Best
5. Satisfaction on Media	4.20	0.20	Very good
6. Satisfaction on Interaction	2.59	0.31	Fair
Average	4.02	0.32	Very good

VI. CONCLUSION

The design of interactive application on learning the musical instruments with 5 different kinds of international instruments was successfully made to collect the responsive feedback from users on satisfaction toward application. The survey results showed that all aspects related to design, usage and interaction including content have high scores with very informative and attractive satisfaction from users. From the resultant assessment by experts, it can be concluded that this proposed interactive learning application can be supplement of promoting an interactive learning in children on musical instruments with enjoyment. The future direction would be improvement made on hardware for more sensor units to cover more popular musical instruments and more interesting content in animation, screen, and display design for more attraction to user.

ACKNOWLEDGMENT

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