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Application of low-cost interactive floors on special education and assistive technology

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Abstract: This research focused on the application of low-cost interactive multimedia tools for education and communication. This study used an interactive floor to utilize a new and different environment for special education and assistive technology needs. Based on the interactive technology and infrared emitter, participants could control tools by a micro-switch instead of a PC mouse. Users could sit on the floor and immerse themselves into their learning. Universal design and custom-made interfaces provide important perspectives to this study. The research findings can provide an innovative view on learning atmospheres that originate with an interactive floor. The design of the interactive content supports both special education and assistive technology students a new field of study. In these cases, the interactive technology depends on universal design, which focuses on participants' interactive abilities to transfer their technical capabilities into intuitive feedbacks.

Keywords: Interactive Floor, Multimedia, Infrared Emitter, Assistive Technology, Education

1. Introduction

In the past few years, the contribution of new interaction methods has become an important research field, and provides new resources to meet In the past few years, the contribution of new interaction methods has become an important research field, and provides new resources to meet users' needs[1]. The study focuses on an interactive floor that utilizes equipment for simple interactive skills (low-price devices)—such as infrared emitters, receivers, and application software—that participants use in classes. Additionally, counseling process could be enhanced by their use. Computer-based teaching materials are widely used in different fields, including entertainment, education, and physical training[2].Computer-based materials are especially important for the advancement of technology[3]. In the recent past, information technologies have progressed at an astonishing rate; interactive technology is a relatively new component in this field [4].

Computer-aided instruction is widely used in many fields, including computer sciences, design arts, industrial design, education, communication, and social sciences. Universal design is the primary goal, as it is easily operated by means of a straightforward guide and offers persons with disabilities more usable interfaces[5]. Applied interactive technology provides additional supports for visual and audio inputs and outputs[6][7]. Custom-made alternative devices are more expensive, but have been popular for added efficiency and flexibility [8]. Some research has combined studies of projectors and infrared receivers. Infrared emitters, used to design low-cost interactive walls or windows for persons with low computer skills[9], enable the design of content materials that increase user motivation[10]. This study, suitable for both the counseling process and basic education, is divided into two parts: (1) interactive content design and (2) how to setup low-cost interactive floor.

Information and communication technology is a modern engineering tool used in many fields that utilize interactive floors. Interactive floors are very popular in museums and other exhibit [11][12], but they are also used in many professional expensive projector setups. Usually, such ceiling-mounted projectors are installed and maintained only by professionally trained engineers. Because the projectors are more powerful and utilize the interactive skills of their users, they require professional programming only from

trained experts who maintain the equipment [13]. Additionally, because the equipment is very large and is not portable, it cannot be easily used in different applications. For these reasons, the focus of recent research has been on developing low-cost portable devices and creating interactive content that is easier to use in many different fields.

The study proceeds from case study practices. One case study was applied to the counseling process; a second case study was applied to basic education and special education learning. This study inspected the dissimilar process between the interactive assistive tool and a traditional tool. Participants took part in a workshop that utilized an interactive floor effect. The universal design applied an intuitive method and easy-operated software to create an innovative effect to enhance student retention of different activities. Students could not only feel the interactive experiment process, but also received a deep impression [4]. Human computer interaction (HCI) demonstrated the interactive content between users and computers. HCI studied the connection between humans and machines (reality or virtual), which involves a specialty in interactive systems for human use [14]. The aim of the HCI interactive floor is to create a different environment for participants who may have learning or physical difficulties. The aim of interactive design focus on HCI is to improve the process of operation for students with disabilities. Computer communication includes figures, forms, functions and texts, which can be combined to provide a proper communication method. Pictures are often used to provide information in many different fields, just as text messages are often accompanied by pictures [15]. Likewise, teaching materials, chemical engineering information, and industrial design can also utilize HCI rules [16]. This study created a different tool with an infrared emitter to support a prototype in assistive technology, hoping to increase the research and use of HCI rules in different applications.

Compared with professional long-focus or short-focus projectors, the micro-projector–because it is very light and small in size–is a portable device that is easy to set up on a ceiling. Infrared receivers with special cameras detect the infrared light and are also small in size. Because both of these devices are portable and light, this low-cost combination can be set up and taken down in only 10 minutes. With an infrared emitter, an infrared receiver can be used to detect the projector. Just like a PC mouse, the infrared emitter is a low-cost custom-made device. This interactive floor design can create a new method for displaying teaching materials. The design of the interfaces on the floor uses an intuitive design to enhance children's motivations. In addition, participants can enjoy the tools in many different circumstances.

This study also focused on the issue of rehabilitation, which can sometimes be a boring training process. For example, children with cerebral palsy need to train their muscles and they must engage in rehabilitation to keep the tension balanced in their muscles. Cerebral palsy is a brain cell wound in children, which might require psychological and social adjustment, as well as learning active functions, walking functions, and how to do some daily living tasks. Because the cell plasticity is related to high tension in the brain, and if the medical rehabilitation for cerebral palsy is started in childhood, training and rehabilitation with early intervention could keep the balance of muscle tension [17]. There are many reports of rehabilitation treatments that use gaming programs of the Wii or Xbox to assist children by using interactive games [2]. Children with cerebral palsy who have weak computer control can use custom-made products (usually at a high cost) to make use of gaming programs—for example, an infrared camera that can be used as a detecting and tracking systems. This study used the Wii remote infrared cameras, so that the users who do not understand the electronic engineering could still set up the simple and lightweight system. Teachers or parents can then create interactive content or applied programs for children with cerebral palsy in order to enforce their rehabilitation treatment.

2. Method

A traditional interactive whiteboard is a large interactive display (approximately 72") that uses a computer and projector. A projector projects the relative images on the board's surface on which users operate the computer via a special function pen. The whiteboard is traditionally hung on the wall or mounted on a stand [18]. Interactive whiteboards are often used in elementary school classrooms, in the weather forecast reports, or stock analysis programs on television [19]. However, the cost of traditional interactive whiteboards is very expensive. Because the weight of the whiteboards is very heavy, interactive whiteboards are usually fixed in one place and users are rarely able to move them to different place.

The study uses Smoothboard software and a Wii remote. With infrared light, the Wii remote can track the relative position of infrared light to create output on a basic interactive whiteboard. The Wii remote is the primary controller for the Nintendo Wii console. In this study, the controller is not only used for Wii gaming, but it is also part of a low-cost interactive whiteboard. The controller setup uses an infrared camera that can detect infrared light.

Fig. 1. demonstrates how the Wii remote detects and tracks the infrared light. In this study, the content was designed by an applied program that used the interactive whiteboard to apply the designed teaching materials. The research is based on two types of infrared detectors: the Wii remote and an assistive tool for the interactive whiteboard. With the use of a laptop, the two devices could make a low-cost interactive virtual interface. In Figure 1, the device is combined with a micro-projector (a TouchFairy) on the ceiling. This study used Wii remote instead of TouchFairy. The Wii remote is a slim and lightweight handheld tool; a TouchFairy is nearly the same size. Both of these devices are small and light, about the size of a cell phone; and they can both be portable and easy to set up in many

varied environments.

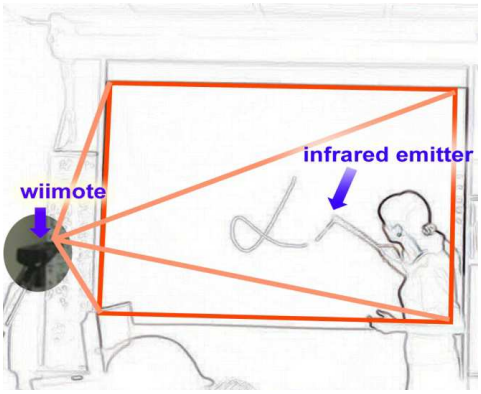

Figure 1. *The basic wii-interactive whiteboard.*

The infrared detectors include high-resolution, high-speed infrared cameras and infrared filter lenses used to track the infrared light emitter. This setup was the focus of some studies in which the equipment was arranged on the floor instead of on a wall or at a window.

Similar to making a low-cost interactive floor setup, this design may assist many different groups in their training and learning processes. The interactive virtual floor in this research needed a computer, an infrared receiver (Wii remote or TouchFairy), an infrared emitter, and a micro-projector.

2.1. Equipment

The infrared detector and micro-projector should be mounted from the ceiling. Because this study focuses on portable devices to suit multiple environments, the weight of the setup is a limiting principle of this study. Therefore, a portable micro-projector is a good solution.

Fig. 2. indicates how the participants applied the infrared emitter to a tool that they wanted to use, such as a toy truck or a mop. This setup is easy to use, because only an infrared light and button battery were needed to make the infrared emitter work. Therefore, it was easy to transfer the technology to different tools for different needs. Additionally, the low-cost interactive floor was good for users, because they did not need to worry about when they used the interface– they always face the floor with the projector behind them, and they did not need to worry that the light of the projector would be a burden for the users. By doing this, users could upgrade their regular floors to interactive floors. The participants in the experiment could sit on the ground and hold an infrared pen like a mouse for PC.

The aim of this research was to help participants learn to use simple and lightweight devices that were easy to setup and easy to move. This kind of device could easily be applied in many different environments. Devices could be combined to make something look different and give a positive motivation to an exhibition, thereby creating an outstanding effect for the users. This research is especially appreciated by many professionals who devote their research to interactive whiteboards using infrared technology.

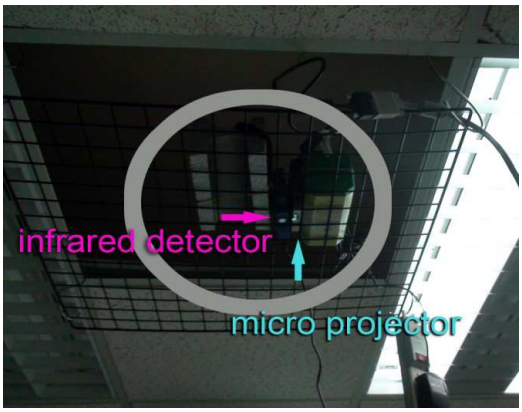

Figure 2. *Set up on the ceiling of interactive floor.*

Infrared emitters could be easily created to function like the left button of PC mouse, and the cost of a single infrared emitter is only about a quarter dollar. It is a very low price and could be designed for different tools. Therefore, this study was able to receive immediate feedback from multimedia. The theory was applied to two methods. One method used a computer connected to a micro-projector, a Wii remote, and an infrared emitter. The second method used a computer connected to a micro-projector, an infrared detector, and an infrared emitter. The application of the infrared emitter worked like the click of the left button of a PC mouse, and the participants could control the device easier than they could a computer mouse. The interactive floor supplied an intuitive method for communication.

2.2. Participants

This research could be used to design interactive teaching materials, or–in another project direction–to make a low-cost interactive floor. This study, therefore, is divided into two steps. The first step is to invite teachers and occupational therapists to develop relative interactive multimedia, such as an interactive game or interactive teaching materials. They would choose the relative interactive games or interactive teaching materials that fit best with their participants. The researcher demonstrates how to choose the relative materials for different needs. The second step has teachers or occupational therapists arrange the devices in the schools, allowing children to use the new interactive tools. Teachers or occupational therapists observe the entire process and record the participants' behavior in order to revise their interactive context.

3. Case Reports

Because different participants require different resources, this study tried to apply the simple setup of a custom-made learning process to different contexts. The contexts are customized to fit and improve the individual needs of different fields. The range of this application could be applied in many more fields, including industrial design, fine arts, exhibition, architecture, education, assistive technology, rehabilitative instruments, and many others.

This study focused on the low-cost and portable devices of computer assistive technology, which provides easy setup and easy use concepts in the design contents. Because of the interactive concept, participants could control for their desired effects of the multimedia show on the floor, which enables them to enhance the intended effect of their interactive content.

There are four case studies within this study:

3.1. Case 1 Report

Case 1 demonstrates how to use the Wii remote and infrared emitter to make both a low-cost whiteboard and an interactive floor. Many YouTube videos show that the low-cost interactive whiteboard is good for children to use, but some presentations were better suited to on-floor presentations instead of wall presentations.

Case 1 applied interactive floor presentation to the process of a group discussion. The equipment was combined with portable gadgets, including a micro-projector, an infrared receiver, a laptop, and an infrared emitter. Because the setup used a projector in a dark environment, the researcher first put white paper on the ground to avoid distracting effects from the presentation.

Fig. 3. shows how the participants sat on the floor to discuss their pets; the multimedia design provided an interactive effect. When the participant touched the part of one kind of animal, the intuitive feedback was the animal's sound and related words shown on the floor.

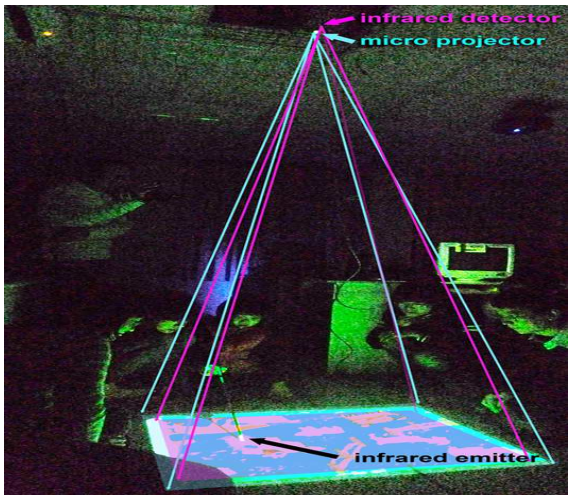

Figure 3. *The concept of low cost interactive floor.*

Group discussion is defined as a “talk therapy” and includes a small number of participants, generally 6 to 10 people. There is a variety of types of communication, and each member could have the role either of participant or observer. Group style could be open or closed. Group discussion may define a specific issue (such as the use of alcohol to understand psychotropic drugs), or there may be no specific issue, such as relational interactive groups, depending on the contract of the duty among the group’s members. Group discussion could be part of a treatment plan, usually in supportive psychotherapy, individual depth psychotherapy, cognitive behavioral therapy, and can assess the feasibility of the group discussion. In this case, the study was designed for a group discussion in which participants sat in a circle on the floor and talked to each other. They then received relative data from the interactive floor. This was a closed group of participants in which it was not easy to distinguish who was the leader and who were participants.

This environment allowed the participants to relax their stress, and they could talk with less pressure. For this case study, the teaching materials were designed on the topic of general food issues. The participants could sit comfortably in whatever posture they liked.

As the group discussion progressed, the participants supported each other during the conversation, even though they may have been more accustomed to watching videos than using interactive multimedia applications. This study involved a multimedia approach to observe the participants’ intervention in an interactive mode.

3.2. Case 2 Report

The participant attached an infrared emitter to a mop made of rust-proof, lightweight aluminum and with an adjustable telescopic handle. The user could adjust the length of the mop handle to best fit the user. The infrared emitter was attached to the mop head. An emitter can be easily used on all types of hard floors. In this case, it was used only on a large sheet of white paper so that the experiment would have a more dramatic effect (a dark floor is a difficult environment for results, just as the micro-projector could not clearly display the content).

The participant is a six-year-old girl who is a first-grade student. This study adjusted the length of the handle so that the user could easily and effectively operate the mop. Using this method, the mop was transferred into an interactive mop. Because the interactive mop has a left button of a PC mouse, images showed the floor in real-time when the user held the mop and cleaned the floor. This technology is very common in amusement parks and museums, but the equipment is always very large and fixed to ceilings. This study, however, applied small, portable equipment that was easy to set up. When the participant swept the floor, she could easily see the reflections on the floor.

This case aimed at using simple and lightweight assistive technology that included a micro-projector and infrared light emitter to teach the participants, especially children, a new method to practice using a mop.

This case aim at using simple and light weight assistive technology that included of micro projector and infrared light emitter, participants, special for children are offered with fresh method to practice how to used the mop.

Fig. 4. shows that the infrared emitter could be used on other tools, like gloves, toy cars, or rags to train users to complete different activities. The signals will transfer to the laptop and then the relative effect would be showed on the projected floor immediately.

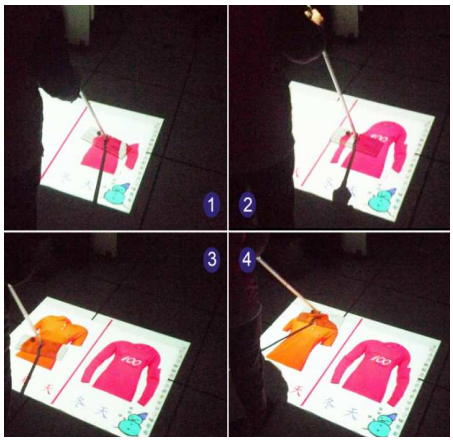

Figure 4. *The effect is like an image scratch from a mop.*

3.3. Case 3 Report

Case 3 is a special design for children in a resource class to enhance their motivation and develop their use of intuition to complete their work.

The infrared emitter transfers to a single foot switch that uses Wii remote control software. This single foot switch can be programmed to perform functions like normal left mouse clicks.

Using a virtual interface on the ground and an infrared light emitter (a board, for example) could create a simple interactive design that could be used to enforce the applicative field. This research case study provides a demonstration.

Fig. 5. demonstrates how the children were asked to stomp the board with their foot. When the participants stomp the micro-switch on the board, the user heard the reflections that the picture showed.

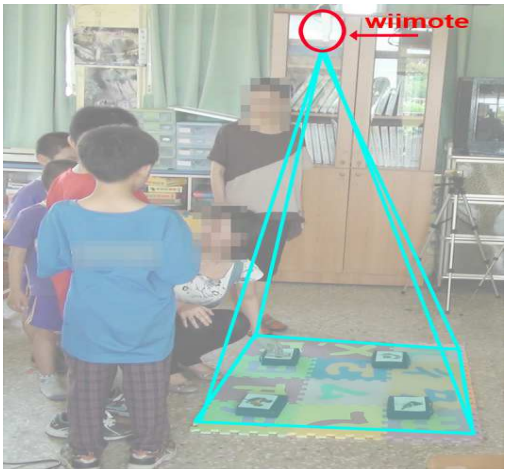

Figure 5. *A single foot switch board.*

In Case 3, there were four participants in the resource classroom. The researcher placed four single foot switches on the floor (a single foot switch with an infrared emitter). The participants made a circle and sang a song. When the song was finished, the teacher asked the participants to stomp a board. In the game process, the research offered the children a chance to play a game while enhancing their skills and concentration.

3.4. Case 4 Report

Fig. 6. shows the design created by two researchers: Ming-Chi Lin, a teacher who works at the National Tainan Special School, and Li-Jun Shih, a therapist who works in the Chi-Mei Medical Center (Liouying branch).

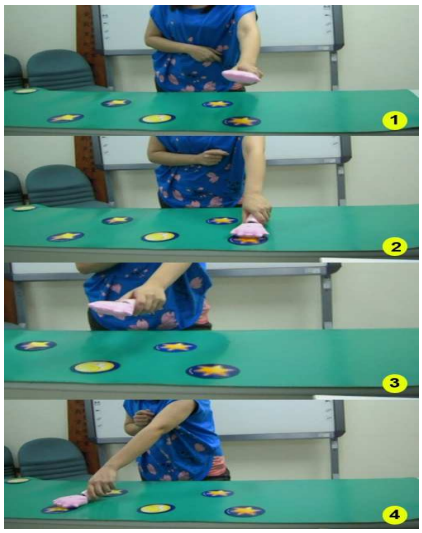

Figure 6. *Occupational therapist show how to use on rehabilitation.*

Because children with physical disabilities often face challenges when trying to control tools and their physical action abilities are often weaker than other persons, Lin and Shih designed a micro-switch to control the infrared emitter.

In order to enhance the Wii remote receiver, Lin redesigned the surface of infrared emitter. The two researchers flattened the infrared bulb's surface from its original semi-spherical shape to improve the original design. This tool's micro-switch was longer than a normal micro-switch; the handle of the tool was bold and wrapped in a soft material. This case studied rehabilitation aids for children of moderate physical disabilities who had poor hand coordination skills.

Because the tool diameter was larger than that of a generally used pen, the children were able to hold it more conveniently. And because children with cerebral palsy often have poor motor control, it was an ideal choice to cover the entire tool in soft material. In the rehabilitation, the reaching movement exercises are used to improve hand-eye coordination for the children. The infrared emitter was placed in the "start" mode. Because the infrared emitter utilizes invisible light, we could not judge whether or not it was working through the camera. That is why it was started in the "work" mode.

Fig. 6. shows the designer, who is an occupational therapist from the Department of Rehabilitation Medicine. The designer shows how she designed this tool for children with cerebral palsy. This case shows how she put some general

cardboard pieces on the desktop to encourage the children to take a tool to press a specific spot. Those cardboard pieces have no particular function; their main purpose is to guide children to take tools and press within the range. When the children complete this task, the micro-switch is started. Accordingly, the infrared emission, which makes the Wii remote receive the message, then transfers the message to the computer which broadcasts the corresponding sound.

4. Conclusion

Experiment feedback is very important and refers to the process of receiving input or output from the study. It is very important for the application of results to the real world. The character focuses on interactive effects and intuition feedbacks. The Wii remote was used to create an easily setup interactive floor that can provide teachers, parents, occupational therapists, rehabilitation therapists, and general business persons with more opportunities to join and advance this study. For children, for example, researchers could study intuition feedbacks from the interactive effects, which further enhance their intention and concentration on the learning process.

Interactive technology is very common in our world. It is not only applied to gaming, but is also used in many different fields. Some of the research in this field focuses on how to make huge, amazing environments, but those applications are expensive and do not promote technology that most people can use. One special aspect of information and communication skills is their use to sustain the promotion of these skills and equipment to be used in different environments, especially for the groups that do not have adequate resources. Interactive applications rely on user-centered design and user-friendly applications, which are easier for users' to setup and arrange when transferring their professional knowledge in a practical and friendly interface. This study anticipates more research in many different fields that study how to spread the use of low-cost concepts into different environments. Participants will be able to receive more information from different stimulus media.

Living in the age of advanced technological environments, users in different fields often need more convenient methods to enhance their living conditions. By making use of innovative ideas, users are able to improve their lives. In this study alone, the participants concentrated on learning the content. Because most people use laptop computers, using multimedia in the learning content makes it easier to enhance the participants' learning of general activities. From the methods used in this study, some participants feel that rehabilitation treatments are no longer so difficult and boring.

Many interactive floors require professional experts to build the environment and service the hardware and software. This technology requires both a high threshold display and many resources. This study demonstrated a use that requires fewer resources while still building a simple and useful interactive floor. This study's researchers focused on sharing some low-cost device concepts and hope the concepts are used to extend similar research in different fields.

Interactive multimedia presentations have become a basic and essential component of digital instruction. The infrared technology interface can also assist participants when they try to apply the concepts to different courses.

This multimedia content was shown through multiple senses, which allowed the content to be viewed in an impressive presentation or exhibit. Users could also choose a display style (visual or auditory), depending on their environment and needs. In addition, information interface designs are more advanced, allowing users to operate the devices with intuitive methods. Interactive media interfaces for users have become common in many fields. Their low cost and easy setup give users another method by which to enhance their thinking and vision.

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