Original Article

An indicated area prediction system for exhibitions

Thaís Watanabe (MBA in Solutions Architecture, FIAP–Paulista College of Information Technology and Administration, watanabethais@live.com)
Shogo Ohya (Graduate School of Engineering, Kanazawa Institute of Technology, b6700542@planet.kanazawa-it.ac.jp)
Kaname Takano (Graduate School of Engineering, Kanazawa Institute of Technology, b6701749@planet.kanazawa-it.ac.jp)
Takashi Kawanami (College of Engineering, Kanazawa Institute of Technology, t-kawanami@neptune.kanazawa-it.ac.jp)

Abstract

Nowadays, museums and exhibitions are exploring new ways to enhance the customer experience. For that purpose, new technologies like Internet of Things are used. In this paper, an indicated area prediction system for indoor exhibitions using Internet of Things is presented. Furthermore, the paper will present and discuss a real case of study, placed in a temporary jacket record exhibition during the 2017 edition of Kanazawa Institute of Technology festival, located in Kanazawa, Japan.

Keywords

museum, exhibition, sightseeing, customer experience, internet of things

1. Introduction

Over the years, museums are looking for new ways to show exhibitions and are using new technologies like augmented reality and internet of things, which allows the visitor to have an improved and natural iterative experience. Moreover, to provide the visitors with the educational information of the exhibition in a simple and enjoyable way [Gimeno et al., 2011].

This research intends to improve the experience by offering a better interaction with the exhibition contents and displaying and announcing the information about the exhibits remotely in many devices like monitors, tablets and even a smartphone, by only pointing at the exhibit.

Not only for museums, this research can also be used in many areas such as travel and shopping. For example, sightseeing maps hung on walls in some train stations, to show recommended restaurants, parks, etc. nearby. Also, for increasing the shopping experience in supermarkets and stores without the need to have large hardware and powerful equipment.

2. Related projects

Text descriptions are still popular in museums and exhibitions while aural descriptions support guidance of the visitor's attention [Krejtz et al., 2012]. However, iterative content provides opportunities for enriching the customer experience [Stock et al., 2006].

Virtual museums are one of the promising approaches for providing stories and messages for museums and galleries [Kim et al., 2013]. Although virtual museums allow users to interact with the contents using Virtual Reality technologies, depending on the budget of the museum, it is not possible to afford a 3D augmented reality to the exhibition, since to develop 3D contents takes time and powerful hardware equipment.

Thinking about the display as market shelves, the grocery network Tesco in South Korea plastered in the glass walls of subway stations with pictures of their products, laid out just as they would be in a traditional shop. The 'shelves' featured QR codes—squares filled with a black and white pattern, unique to the product in question, they are a more versatile successor to the bar code—which could be scanned by the traveler's mobile phone, building up a shopping basket in the few minutes before the train arrives. [Telegraph UK, 2011].

3. Proposed method

3.1 "That?" Guess System

"That?" Guess System (from Japanese あれ? Are?) is a system programmed in C++ and uses a formula, in Equation (1) and Figure 1, to discover which direction the user is aiming at the moment using the Microsoft Kinect sensor [Ohya et al., 2017].

$$\vec{p} = \vec{a} + t\,(\vec{b} - \vec{a}) \tag{1}$$

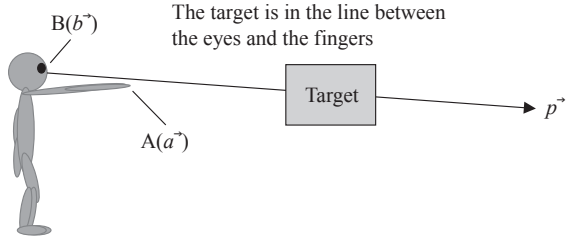

Figure 1: How to find the pointing direction

The system is always calculating the distance between a line of the direction and an object, as shown in Equation 2. If the distance is within X cm and at the minimum distance, we found the target, as shown in Figure 2. In this study, we assumed that the distance from the center of the target to the edge is 15 cm × 15 cm, so we set to 15 cm in X.

$$D = \sqrt{(lx - tx)^2 + (ly - ty)^2 + (lz - tz)^2} \tag{2}$$

Kinect sensor detects the position of the eyes and the fingers, see Figure 3. However, the position of the eyes changes when

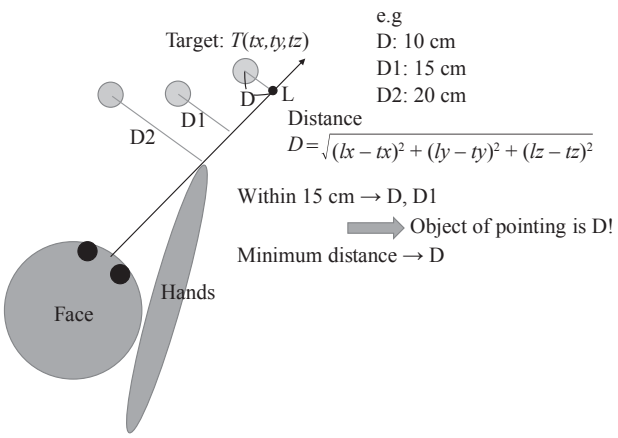

Figure 2: How to find targets by pointing

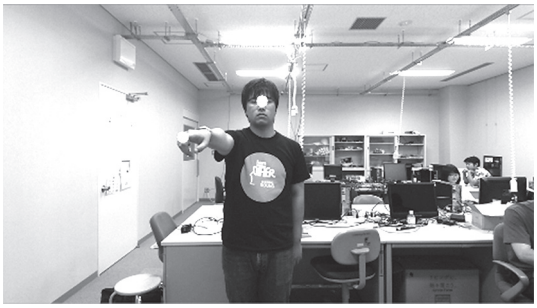

Figure 3: Eyes and fingers are detected by Kinect sensor

a hand hides part of a face. This causes an error that wrongly detects the direction. In order to reduce this error, we studied the position of eyes when both hands are under the waist before detecting the direction.

3.2 Additional hardware

In this study, we integrated the existing "That?" Guess System with a hardware based in the display of LP jackets available at the PMC–Popular Music Collection in Kanazawa Institute of Technology, as shown in Figure 4.

Figure 4: The LP jackets display at PMC

One section of the display available at PMC has 30 jackets. To easily know which jacket the user is pointing at, we added pointing guide hardware using 4 ESPr Developers and 30 pieces of LEDs to the "That?" Guess System. ESPr Developer, which is a development board of ESP-WROOM-02 microcontroller, controls the LEDs. While the user is pointing, an LED illuminates the surface of the desired jacket.

As shown in Figure 5, the anode side of the LED's are connected to respective resistance and the cathodes connected to ground of ESPr Developers. The ESPr Developer digital pins used are 0, 2, 4, 5, 12, 13, 14 and 15.

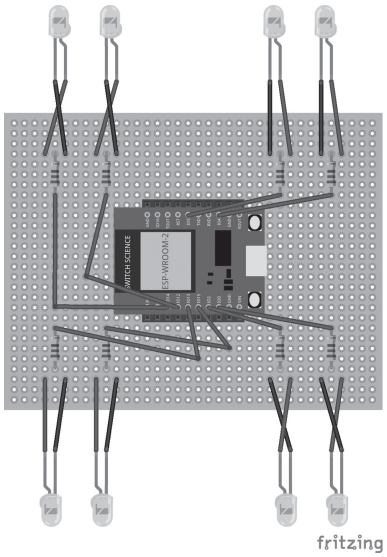

Figure 5: Hardware circuit of pointing guide

3.3 Server and Kinect sensor communication

All the information about the currently pointed jacket and the other jackets are stored in a server with a database, and the hardware is always communicating with the server with a wireless connection using REST, by sending HTTP methods get and post.

3.4 Indicated area prediction system

For the PMC, we reached to an indicated area prediction system shown below in Figure 6.

The indicated area prediction system is constructed from "That?" guess system with pointing guide hardware, web application, and database. The ESPr Developers number 1 to 3 have 8 LEDs and the number 4 has only 6 LEDs, in total 30 LEDs. The Guess System identifies the record the user is aiming at that moment, and then sends the record ID to the RESTful Node.js server via HTTP post and saves in session.

When the server receives the selected record, Socket.io triggers an event; the web page changes in real-time with the record information from the database. Every second, each ESPr Developer sends an HTTP get to the Node.js server to receive the information about the selected record to light up the correct LED.

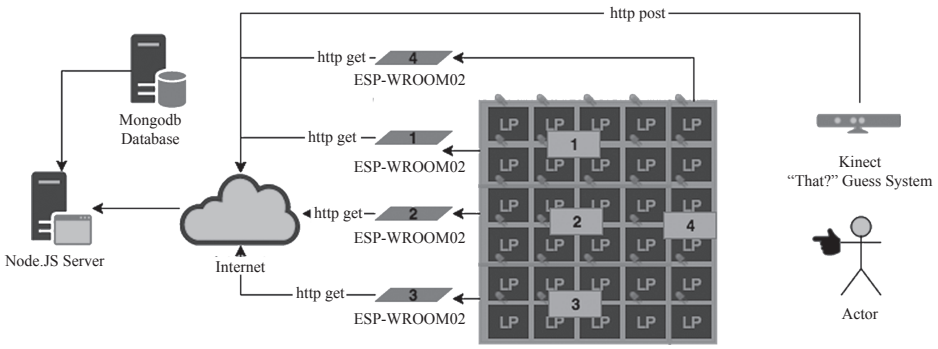

Figure 6: Indicated area prediction system

4. Experiment and results

4.1 Implementation at PMC

As shown in Figure 7, we used the left side of the display of record jackets available at the entrance of PMC and the information about the selected record jacket was at the right side, see Figure 8.

The hardware was located in strategic places, see Figure 9, so that each LED correctly fit in the top of each record jacket, shown in Figure 10.

As shown in Figure 11, a computer with the software connected to the Kinect sensor was behind the jackets display. In addition, two batteries connected to the ESPr Developers were behind the jackets display.

Figure 7: Testing the pointing and the projection information

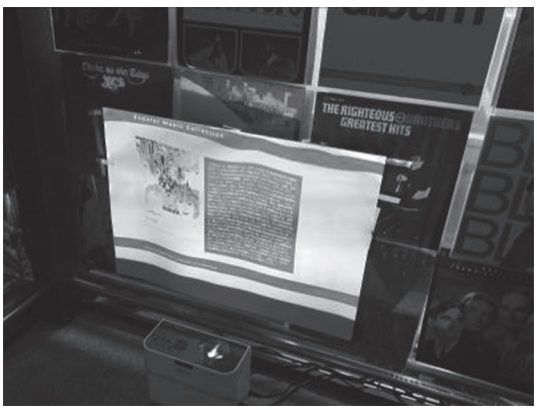

Figure 8: The display showing the LP's information

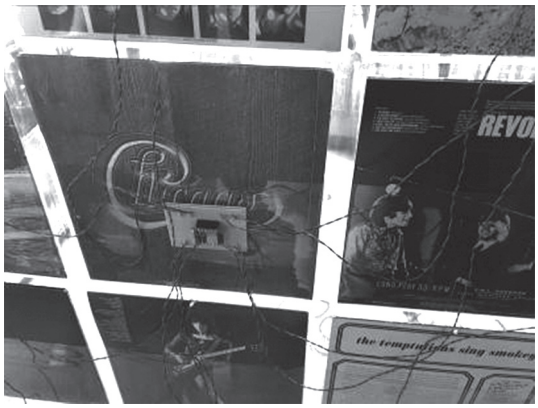

Figure 9: The board in a strategic place

Figure 10: The jacket and LED turned on

Figure 11: PC with the Kinect sensor running the "That?" Guess System

4.2 Results of PMC

From the implementation at PMC we have received many compliments and positive feedbacks. About six users, including university and PMC staff tested the system, and the desired

information was successfully shown, surprising them. The LEDs became useful to know exactly where the user is aiming at that moment.

The PMC Manager was also present in the implementation and proposed to use the system in a record jacket exhibition during the 2017 edition of KIT Festival—the university's school festival, to increase the user experience.

4.3 Implementation at KIT Festival

We exhibited the system at KIT Festival 2017. Figure 12 shows the exhibits panorama. In Figure 13, the selected record information is displayed on the floor. Kinect sensor was on top of the exhibit as shown in Figure 14.

In conjunction with the project created last time at the PMC, we implemented a system that plays the record jacket music and announces the artist information by pointing with a finger using speech synthesis, in order to improve the user experience. When users continue to point at a specific record jacket for about 3 seconds, sound data compressed to mp3 will play. About 3 seconds later, the system announces the artist information.

Figure 12: KIT Festival panorama

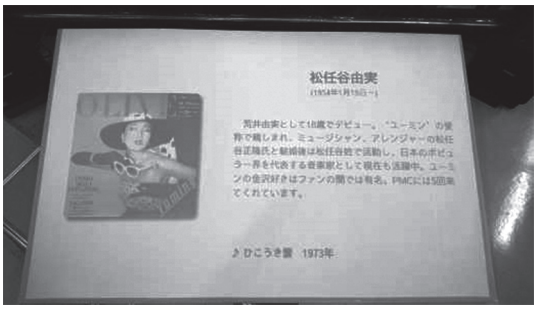

Figure 13: Display with artist information

Figure 14: Kinect sensor position

We used MMDAgent to announce artist information. MMDAgent is an open source software developed mainly at Nagoya Institute of Technology to use voice dialogue contents [MMDAgent SHARE]. It is possible to make a smooth announcement by using this software. MMDAgent makes the output of the artist's biography and hit songs.

In addition, we expanded to collect the number of users who experienced this system, and to be able to collect the average number of times of music playback per person, maximum number of times, and minimum number of times. Furthermore, we expanded so that we can collect the number of selections per record jacket. With all this information, the exhibition staff can analyze the usage situation of popular artists and users as statistical information, and it is possible to provide feedback information for improvement in the next exhibition.

4.4 Results of KIT Festival

49 visitors answered surveys. First, the result on whether or not the user could point intuitively to the record jacket the user wants to hear is shown in Figure 15. About 71 % said that they could do it, 29 % said that they could not do it. In the negative answered users, there were many people who tended to misjudge another record jacket by shaking the fingertips while pointing.

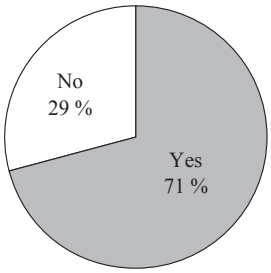

Figure 15: Intuitive pointing

The results of feeling of the time intervals (3 seconds) from pointing at the record to the beginning of music are shown in Figure 16. About 18 % users felt too long, 80 % felt just fine, and 2 % felt short. Many users who felt too long could not select at once because they selected another jacket. To increase positive answers, time intervals must be fine-tuned to applicable time.

Figure 17 shows that users could receive satisfaction from information of the artist on the display. About 93 % users were satisfied, but 7 % users were not satisfied. The users who were not satisfied, wanted information that is not normally known.

Figure 18 shows the result of experiencing and having a good impression. About 73 % of the visitors said that they enjoyed very much, 20 % responded that they enjoyed it, and 7%

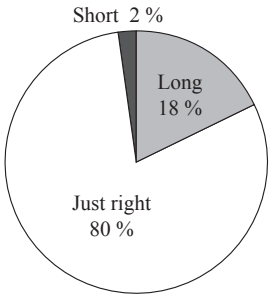

Figure 16: Interval time length

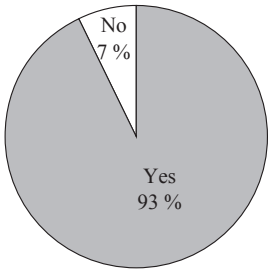

Figure 17: Information satisfaction

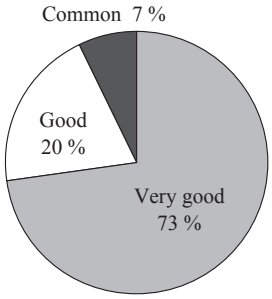

Figure 18: Visitor experience

responded that the experience was ordinary. In addition, there were many impressions such as "fun like magic", "surprised", and "innovative". From these results, this system provided a high visitor experience.

As a reason why positive evaluation of customer experience exceeded 90 %, about 70 % of the visitors could point intuitively to the record jacket and feeling of the time intervals from pointing at the record jacket to the beginning of music was generally appropriate, and visitors were satisfied with artist information.

To further enhance visitor experience, it is necessity to enhance the accuracy of the pointing systems and to provide rare information for an avid fan.

5. Conclusion

The project presented in this paper has been used in 2017 KIT Festival collaborated with Popular Music Collection and Kawanami Laboratory. The accuracy of the Guess System is high and the communication from the hardware to the sensor and server was good, over 50 visitors have tested the system. The visitor's feedback was positive; the system is intuitive and easy to use, achieving a high level of satisfaction and entertainment. According to the visitor's experiences, the goals have been met. The system was able to provide an improved experience to the visitors and providing information.

The system can replace the boards with information about the exhibits that sometimes we can barely read, specifically the exhibits that are close to each other that need space to show their information and in other languages, by adding only one display that can show all the exhibits information by only pointing, catching the visitors attention. Furthermore, not only for museums or for exhibitions, the system can be used in many other areas, such as tourism and shopping, etc.

To reduce cost and miniaturize the prediction system, further studies are needed, such as using AI (artificial intelligence) and a web camera instead of the Kinect sensor system.

Acknowledgments

The authors would like to thank Y. Kobayashi for useful discussions. Funding from Kanazawa Engineering Systems Inc. is gratefully acknowledged. We also thank H. Uehara and H. Takakuwa for developing the first prototype model of "That?" Guess System. Also, the present research was supported by the Nikkei Trainee Program from JICA—Japan International Cooperation Agency, providing technical training to the author who is from a developing country, assisting economic and social growth.

References

Gimeno, J., Olanda, R., Martinez, B., and Sanchez, F. (2011). Multiuser augmented reality system for indoor exhibitions. *Interact, Part IV, LNCS 6949*, 576-579.

Krejtz I., Szarkowska A., Krejtz K., Walczak A., and Duchowski A. (2012). Audio description as an aural guide of children's visual attention: Evidence from an eye-tracking study. *Proceedings of the Symposium on Eye Tracking Research and Applications*, 99-106.

Stock, O., Zancanaro M., Kuflik T., Kahanov Y. 'acov, Kashtan N., Katz S., Rocchi C., and Graziola I. (2006). Preparing personalized multimedia presentation for a mobile museum visitors' guide: A methodological approach. *Proceedings of Museums and the Web*, 22-25.

Kim T., Jang J., Park J., and Park J. (2013), The journey of a white rhinoceros: Sculpture augmentation for gallery exhibition. *IEEE International Symposium on Mixed and Augmented Reality 2013 Arts, Media, & Humanities Proceedings*.

Telegraph UK (2011). Tesco builds virtual shops for Korean commuters. http://www.telegraph.co.uk/technology/mobile-phones/8601147/Tesco-builds-virtual-shops-for-Korean-commuters.html. (accessed 2017/10/01)

Ohya, S., Takano, K., and Kawanami T. (2017). Analysis of error on indicated area prediction system. *Joint Conference of*

Hokuriku Chapters of Electrical Societies, F2-28.
MMDAgent SHARE. http://share.udialogue.org/meissen/login.htm. (accessed 2018/03/16)

(Received March 30, 2018; accepted May 7, 2018)