JURNAL EMACS
[Engineering, MAthematics and Computer Science] Vol.4 No.2 May 2022: 67-72
e-ISSN: 2686-2573
DOI: 10.21512/emacsjournal.v4i2.8119

The Development of E-Butler Hotel Service Robot

Benedick Clemons[1*], Ignatius Ferdyan[2], Kevin Anderson[3]

[1,2,3] Computer Science Department, School of Computer Science,

Bina Nusantara University,
Jakarta, Indonesia 11530
benedick.clemons@binus.ac.id; ignatius.halim@binus.ac.id;
kevin.anderson001@binus.ac.id

*Correspondence: benedick.clemons@binus.ac.id

Abstract — *A hotel is a place that provides accommodation, food, drink, and services for people traveling far from home. During this pandemic, many hotels started to apply strict health protocols for social distancing by reducing the number of their employees. For this purpose, we developed a service robot for some works in a hotel called E-butler. E -butler robots can provide amenities delivery service for the guest. The butler application for ordering amenities was developed by using MIT App Inventor as a prototype and will be developed further using Flutter. While the hardware of the E-butler robot is developed using the Mecanum wheels platform and Arduino for controlling the movement of the robot. Furthermore, the e-butler robot is equipped with teleconference devices based on Jetson Nano to facilitate communication between hotel employees and guests. Based on our evaluation, the butler robots can carry out the main task of E-butler, which can replace human butlers in hotels.*

Keywords: *E-butler Robot; Social Distancing; Service Robot; Teleconference*

I. INTRODUCTION

Tourism during the COVID-19 pandemic played a role in aggravating the public health crisis, which is why travel restrictions and border shutdowns were introduced in many countries and regions to limit the spread of COVID-19. Presently, tourists and destination residents are required to pay more to reduce the risk of COVID-19, not to mention that job losses occur during the pandemic. These problems cause a drop in tourism demand (Richard T.R Qiu, Jinah Park, ShiNa Li, Haiyan Song, 2020) (Yeh, 2020). One of many solutions to this problem is reducing direct contact between humans.

Many hotels are already offering more futuristic experiences, with robots delivering items ordered through room service to a guest's door. A boutique hotel nestled between Apple's headquarters and other tech companies, called Aloft Cupertino, has a robot butler named "Botlr" that can move between the hotel's various floors to take items such as items as toothbrushes, chargers, and snacks to Guests (Marr, 2019).In terms of technological applications, many industry sectors have adopted different automated systems, such as kiosks in airports that offer express check-in/out, near field communication (NFC), mobile payments in many retail stores, and keyless registration transactions via customers' mobile phones. Notably, the global market for service robots is expected to generate revenues of $34 billion by 2026, with 1.3 million robot installations. The service robot growth rate is seven times faster than the robotic manufacturing market (Business Insider, 2015) (Lee, Yejin; Lee, Seunghwan; Kim, Dae-Young, 2020).

AI robots in the hospitality industry have a promising future because robotic services can demonstrate a high degree of efficiency and accuracy, thereby minimizing costs. For example, front desk robots can reduce check-in and check-out queuing time (Sillers, 2017).

With the rapid development and implementation of robots and artificial intelligence (AI) technology, discussions about how robots will replace human jobs and labor are omnipresent among researchers and practitioners. These automation technologies combine facial recognition technology, robots, wearable technology, and voiceover technology that can be implemented in the manufacture and delivery of products and services (Seongseop (Sam), Jungkeun, Frank, Marilyn, & Youngjoon, 2020) (Ivanov, 2020) (Hirotaka Osawa, Arisa Ema, Hiromitsu Hattori, Naonori Akiya, Nobotsugu Kanzaki, Akinori Kubo,, 2017). The presence of a Robot butler will make it easy for staff to

deliver hotel amenities to guests' rooms and reduce human contacts during pandemics. Therefore, we intended to build our E-butler Hotel service robot to deliver hotel amenities items to guests' rooms. Besides that, our E-butler also offers a real-time face-to-face capture with the operator so the guests can interact with the "robot."

II. METHODS

2.1 Approach

The approach that we use to begin writing this research paper is qualitative methodology. Qualitative methodology is a methodology that is concerned with qualitative phenomena (C.R.Kothari, 2004). In this research, the phenomenon is the COVID-19 pandemic that aggravates the hotel industry in Indonesia, with the objective of finding a solution to lessen the impact of the pandemic.

2.2 Analysis Methods

The analysis method that we use in this research is called the descriptive analysis method. It is based on the result of Forum Group Discussion with the topic of Acceptance of Smart Technologies Theory (Han, D., Hou, H. (Cynthia), Wu, H., & Lai, J. H. K., 2021). According to Cresswell (2018) (Ernesto Ersada Barus, Suprapto, Admaja Dwi Herlambang, 2018), descriptive research is research that classifies a phenomenon by using a number of variables that have a connection with the problem that is being researched. The steps that are used in this research starts from identifying the problem, theoretical study, collecting data, analysis and data processing, and conclusion and suggestion.

2.3 Data Collection

Literature Review is the method that we use to obtain the information needed to achieve the research objectives. Data collection is also a basis for starting research or discovery.

III. RESULT & DISCUSSION

3.1 E-Butler System

E-Butler is a robot that is made to bring hotel amenities to customers' rooms. There are two main aspects that are involved in how the E-Butler robot is going to work. The first aspect is the relationship between customer and admin that will be done in the amenities order application that we made (will be explained in the Ordering Application Design), and the robot that is programmed using Arduino (McRoberts, 2011) (Smith, 2011).

The E-Butler robot is constructed with a mecanum wheel robot, a scaffold on top of the robot, and a monitor at the top. The idea of such construct is so that it acts like a human body, with the mecanum wheel robot being the driving force of the construct, scaffold as the body of the butler, which is going to be used as a holder of a pair of speakers for communication and a box that acts as a container for the amenities that the customer ordered, and monitor as the head of the butler which is going to be used as a way of customer communicating with the operator. The component of the mecanum wheel robot consists of a battery, two motor driver controllers, four mecanum wheels, four motor DC that are connected to each mecanum wheel, and Arduino Mega type 2560. The reason for the use of mecanum wheels instead of other kinds of wheels is so that the robot can be more agile and have more adjustability to the direction on where it wants to go because mecanum wheels can move omnidirectionally (O. Diegel, A. Badve, G. Bright et al., 2002). Below is a picture of an E-Butler robot. (Figure 1).

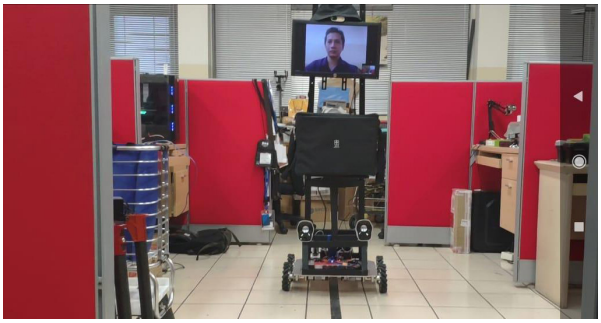
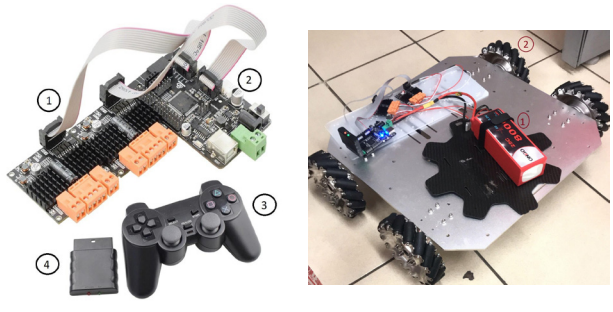


Figure1. E-Butler

This robot is constructed by using the same principle as a smart trolley, which has the same function to carry items and move via remote control in this case (Alexander A S Gunawan, Valdi Stevanus, Albertus Farley, Heri Ngarianto, Widodo Budiharto, Herman Tolle, Muhammad Attamimi, 2019). The E-Butler robot is going to be controlled using a joystick controller, which will be connected via the joystick controller's receiver that will be plugged into the Arduino Mega type 2560.

3.2 Hardware Design

The E-Butler robot that is shown in Figure 1 is constructed as explained briefly in the previous section. This section will show each important part of the mecanum wheel robot, as well as show and briefly explain the flow of E-Butler.



(a) (b)

Figure 2. (a) mecanum wheel robot components and joystick controller (b) left rear view of the mecanum wheel robot

In Figure 2. (a), four main components are used to operate the mecanum wheel robot as labeled:

- Dual motor driver 9-24V
- Arduino Mega type 2560
- PS2 controller
- PS2 receiver

In Figure 2. (b), The labeled components are as follows:

- Battery
- Mecanum wheel

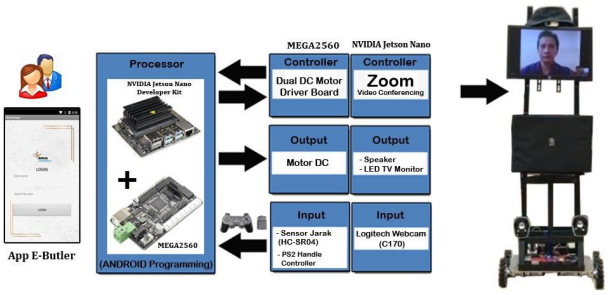


Figure 3. E-Butler flow

As shown in Figure 3, which is the brief flow of E-butler as a whole, includes the relation between customer and admin in the amenities order application called App E-Butler in the picture, and the processors which are the brain for both the robot and the monitor.

Each processor has its own role. The NVIDIA Jetson Nano Developer Kit is used to operate the ZOOM Video Conference, which is going to be used as media for both the user and the operator of the robot. On the other hand, Arduino Mega Type 2560 is used to operate the mecanum wheel robot.

Each processor will receive and send data from and to its respective input and output. NVIDIA Jetson Nano Developer Kit will receive input from Logitech Webcam (C170) then send the data it received to the speaker and monitor as outputs, while the Arduino Mega Type 2560 will receive input from Distance Sensor (Zhmud V, Kondratiev N, Kuznetsov K, Trubin V, Dimitrov L, 2018), which will make the robot avoid obstacles automatically along with the way and PS2 Controller then send the data to the motor DC to move the robot as an output.

3.3 Ordering Application Design

Our ordering applications, called BINUS Hotel, are divided into two different parts for two different roles, the first one is customer, and the second is admin. But even though there are two applications, both are still connected to one database.

3.3.1 *Customer*

For the Customer's Application, the customer can see information about the BINUS Hotel (such as lunch, breakfast, dinner, the spa, the gym, etc.). In addition to providing information, customers can also order facilities provided by BINUS Hotel (such as towels, shampoos, etc.).

3.3.2 Admin

For the Admin's Application, the admin can receive all orders from the customers. Besides that, the admin also can add new Users.

3.4 Application Flow

3.4.1 *Application Flow Chart*

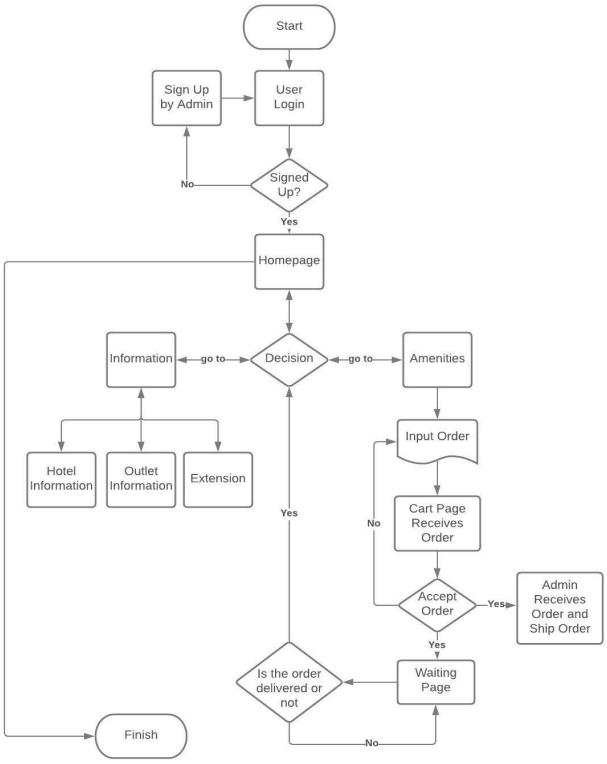


Figure4. Flow Chart

When the application is first opened, the display that will appear is the login page. As shown in Figure 5. below, there is a username and room number. To be able to successfully log in, these two indicators (username and room number) must match those in the database.

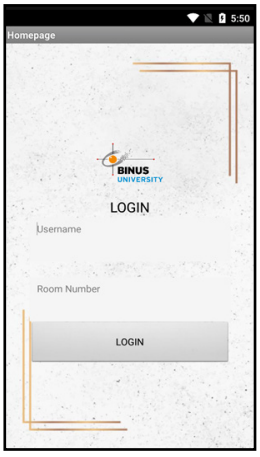


Figure 5. Login Page

After successfully logging in, the user will be directed to the Homepage, as shown in Figure 6 below. On the Homepage, there will be two menus that can be selected by the user: Amenities and Information.

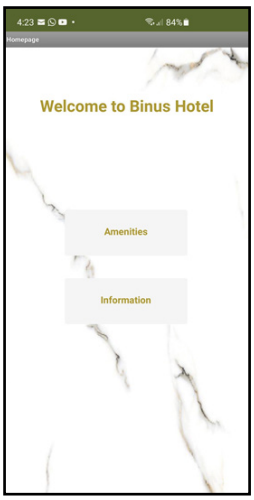


Figure 6. Homepage (Customer)

If The User Chooses "Amenities," the user will be directed to Order Page, as shown in Figure 7. in this page, users can choose amenities items and quantities. After ordering, the user can click the "Add to cart" button. Then the cart icon on the top right will be filled with the total quantities from all the items that are ordered. After the user has finished filling items into the cart, the user can click the cart icon on the top right from the picture below.

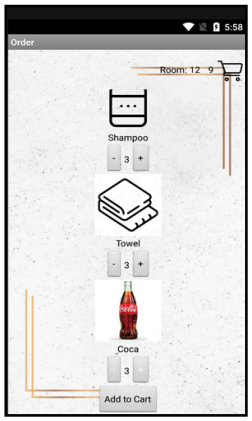


Figure 7. Order Page

After clicking the cart icon, the user will be brought to the Cart page, which is shown like in the picture in Figure 8. This page shows the product and quantity as the user has ordered. Once the user is done checking whether the order is correct or certain, the user can then click on the "Finish Order" button for confirmation.

Figure 8. Cart Page

After clicking the "Finish Order" button, the user will be brought to the Waiting Page, which is shown in Figure 9.1. On this page, the user can confirm the order by clicking the "Confirm Delivery" once the order has arrived in their room, and the user will not be able to access the "Go Back" button or go to another page before doing so (as shown in Figure 9.1), once the user has confirmed the delivery, user can go back to Order Page by clicking on "Go back" button (as shown in Figure 9.2).

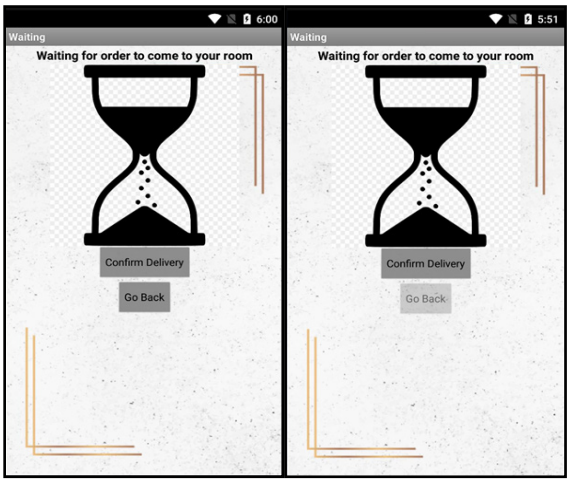


Figure 9.1. Waiting Page Figure 9.2. Waiting Page

Back to the Homepage, if the user chooses the Information menu, then the user will be directed to the information page as shown in Figure 10. in the Information page, there are three menus.

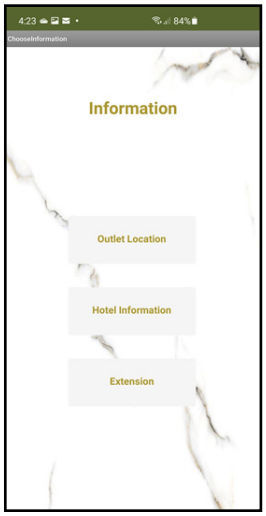


Figure 10. Information Page

Users can access vital information about the hotel's activities. This page was established so that users may quickly determine the best time to eat and the opening and closing times for swimming pools, spas, and gyms, among other things. In addition, the customer will be aware of all possible hotel extension numbers that the customer can reach.

Figure 11. Homepage (Admin)

Figure 11 shows the application for the admin to see what the customers have ordered. The "Refresh" button is used to refresh the page and update on what is shown on the screen and see if there are any new orders or if the user has finished their order which will remove their order from the page. The "Add User" button is used for the admin to add new users.

3.5 Discussion

There are still improvements that can be made for this E-butler project. First, a more advanced algorithm for the admin ordering application so that the admin can set the maximum quantity that the user can order for free. If the user wants to order more than the maximum quantity, then the user must pay for additional items. Second, more validation for the items on the order page so that the system can disable the items if the items are out of stock.

IV. CONCLUSION

This research's main objective is to construct a robot that can bring hotel amenities to customers' rooms that will be controlled via a joystick by the operator. By utilizing this robot and the ordering application, customers and the staff will not have to make direct contact with each other, creating a sense of security and safety for the customers and staff during this corona pandemic (Kumar D, Malviya R, Kumar Sharma P, 2020).

There is still room for improvements in this research. For example, using a joystick as a controller for the robot's travel does not align optimally with our research's main objective because of the controller's short connectivity range, which requires the staff to be in the robot's vicinity. With that in mind, we plan on making the robot use a line follower for travel (RoboCircuits, 2018).

REFERENCES

Alexander A S Gunawan, Valdi Stevanus, Albertus Farley, Heri Ngarianto, Widodo Budiharto, Herman Tolle, Muhammad Attamimi. (2019). Development of Smart Trolley System Based on Android Smartphone Sensors. *Procedia Computer Science, 157*, 629-637.

C.R.Kothari. (2004). *Research Methodology Methods and Techniques (second revised edition).* Jaipur(India): New Age International Publishers.

Ernesto Ersada Barus, Suprapto, Admaja Dwi Herlambang. (2018). Analisis Kualitas WebsiteTribunnews.com Menggunakan Metode Webqual dan Importance Performance Analysis. *Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer, Vol.2,No.4*, hlm. 1483-1491.

Han, D., Hou, H. (Cynthia), Wu, H., & Lai, J. H. K. (2021). Modelling Tourists' Acceptance of Hotel Experience-Enhancement Smart Technologies. *Sustainability, 4462*, 13(8).

Hirotaka Osawa, Arisa Ema, Hiromitsu Hattori, Naonori Akiya, Nobotsugu Kanzaki, Akinori Kubo,. (2017). Analysis of Robot Hotel: Reconstruction of Works with Robots. *2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 219-223.

Ivanov, S. (2020). The impact of automation on tourism and hospitality jobs. *Inf Technol Tourism, 22*, 205-215.

Kumar D, Malviya R, Kumar Sharma P. (2020). Corona Virus: A Review of COVID-19. *Eurasian Journal of Medicine and Oncology*, 8-25.

Lee, Yejin; Lee, Seunghwan; Kim, Dae-Young. (2020). Exploring hotel guests' perceptions of using robot assistants. *Tourism Management Perspectives , 37*, 12. Retrieved 07 26, 2021, from https://sci-hub.ee/10.1016/j.tmp.2020.100781

Marr, B. (2019, August 05). *Robots as a service: A technology trend every business must consider*. (forbes) Retrieved 08 02, 2021, from https://www.forbes.com/sites/bernardmarr/2019/08/05/robots-as-a-service-a-technology-trend-every-business-must-consider/#182d90f924ea/

McRoberts, M. (2011). *Beginning Arduino.* Apress. Retrieved 8 2, 2021

O. Diegel, A. Badve, G. Bright et al. (2002). Improved mecanum wheel design for omni-directional robots. *Shinji Kamiuchi and Shoichi Maeyama, "A Novel Human Interface of an Omni-directional Wheelchair", Int. Workshop on Robot and Human Interactive Communication, 2004, pp. 101-106. (2002) (November) 27-29*, 117-121.

Richard T.R Qiu, Jinah Park, ShiNa Li, Haiyan Song. (2020). Social costs of tourism during the COVID-19 pandemic. *Annals of Tourism Research, 84*(102994).

RoboCircuits. (2018, June 5). *Line Follower Robot Arduino*. Retrieved from Project Hub: https://create.arduino.cc/projecthub/robocircuits/line-follower-robot-arduino-299bae

Seongseop (Sam), K., Jungkeun, K., Frank, B.-B., Marilyn, G., & Youngjoon, C. (2020). Preference for robot service or human service in hotels? Impacts of the COVID-19 pandemic. *International Journal of Hospitality Management*, 1.

Sillers, P. (2017, 09 24). *Robots, chatbots and augmented reality: the future of travel and the*. (INDEPENDENT) Retrieved 11 15, 2021, from https://www.independent.co.uk/travel/news-and-advice/future-travel-airport-technology-hi-tech-chatbots-robots-augmented-reality-ai-a7961171.html

Smith, A. G. (2011). *Introduction to Arduino.* Alan G. Smith.

Yeh, S.-S. (2020). Tourism recovery strategy against COVID-19 pandemic. *Torusim Recreation Research*, 1-7.

Zhmud V, Kondratiev N, Kuznetsov K, Trubin V, Dimitrov L. (2018). Application of ultrasonic sensor for measuring distances in robotics. *Institute of Physics Publlishing.*