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RESEARCH ARTICLE

An Android-Based Smart Ordering System for Restaurant Menu Placement

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ABSTRACT - One of man's necessities is food; thus, it is often a practice to visit places where favorite dishes are served. A restaurant is such a place of attraction for gathering, delivering food, and ordering services. The quality of service rendered is often an issue, especially with traditional methods such as using pen and paper, manual inspection, delivering orders to kitchen and tables, billing, etc. which are often prone to errors due to human failures. To offer a solution to the aforementioned, We designed a smart restaurant system to accelerate the ordering processes using an Android-based application installed on a smartphone to place an order to a kitchen embedded with an Atmega 328P Microcontroller interfaced with an HC-05 Bluetooth module, an LCD screen for display of orders and a buzzer alarm to confirm orders received in the kitchen. This smart approach is fascinating as order data can be sent through a wireless network connecting the kitchen computer with customers' smartphones through Bluetooth wireless technology. This study implemented a practical setup that can be replicated in a small startup restaurant or cafe with an average Bluetooth range of transmission. This technology is expected to reduce the level of error in processing the consumer's order and reduce the burden on the waiters as they can focus on billing and other processes. This upgrade to the traditional method further enhances the quality of services. The system achieved significant success and showed an effective range of transmission of 20m during the performance evaluation. This result shows the reliability and suitability of adopting Bluetooth wireless technology in indoor settings such as a restaurant for placing orders with a limited range of transmission of about 20m.

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1. INTRODUCTION

The rapid advancement and trend in technology cuts across all facets of human endeavors with emerging technologies on the rapid increase in wireless systems deployable to restaurant services [1]. Lots of manual work is required in the traditional ordering systems bringing inconveniences resulting in avoidable human errors in taking and delivering orders, and billing which often leads to dissatisfaction with such systems [2]. A restaurant menu ordering system allows customers to place their orders by the service of a waiter or through wireless means. Digital technologies are replacing the conventional methods which are often prone to avoidable human errors, time-consuming, and require lots of human power. Such traditional methods are largely dependent on manpower to handle customer reservations, order delivery, billing, and others. To improve the efficiency of such a system and enhance customer experience, distinctive technological innovations are plausible interventions [3]. The study proposed a smart ordering with an Android application installed in a customer's smartphone connected to the Bluetooth address of the restaurant to place an order in the kitchen. The system in the kitchen utilizes an Arduino-based microcontroller with a Bluetooth module to receive customers' orders while the waiter delivers the order to customers. This system promotes multitasking of processes, ensures faster delivery, and even eliminates human-prone errors. This restaurant ordering system guarantees customers better and faster service satisfaction with fewer working mistakes.

The works of [4], proposed a food ordering system equipped with a limited-range RF transmitter in a restaurant, with a transmission range of only 4-5 meters. Using the concept of an autonomous self-ordering system, the customer places the order directly to the chefs. Zigbee technology is used to communicate data in real-time order data. The chef may see the order details and the table number on the display screen. The use of a microcontroller unit on the table creates complexity, while the PDA system for the waiter increases installation and maintenance costs. The addition of a LAN system from the server to the chef increases the networking complexity which was improved in [5]. The article is an attempt to create a restaurant ordering system that allows each customer to order his or her food from an e-menu displayed on an embedded touch screen on each customer's table without troubling any staff and send the order directly to the kitchen. This touch screen can also monitor the entire culinary process. The use of Touch screens on the table is costlier during installation, occupies space, and requires lots of maintenance. The growing popularity of Android devices necessitates the developers to focus on Android applications for the menu systems as described in [6]. Each table in the restaurant will be accompanied by an Android tablet or a Smartphone. The device will be loaded with an

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Android-supporting application containing a food menu. A Wi-Fi network was used to establish wireless communication.

Abdussalam et al., (2023) [7] developed an Arduino-based restaurant menu-ordering system by presenting a hybrid approach in a soft and hardware perspective. A web-based app was developed and enables order requests from anywhere. The hardware implementation was done using two Arduino-a transmitter and a receiver. The customer can seamlessly monitor the turnaround time for the delivery of their orders. The authors of [8] developed a smart food ordering system for restaurants as a new digital solution to clients' ordering services. The project's goals are to address these faults and provide clients with efficient and accurate services by creating bespoke menus depending on their preferences. On the user's device, a menu will appear. The customer will not need to wait for the waiter to take their order. With wireless communication, the chef's display will receive the placed order immediately. This method boosts service efficacy and efficiency. It has various benefits, including good usability, time savings, portability, less human error, customization, and consumer feedback, among others. A food purchasing assistance system that targets the cafeteria and all other food purchase operations has been implemented with the use of QR codes [9]. The efforts resulted in the development of a cinema complex-oriented food purchasing assistance system that allows users to place online orders and scan QR codes. The technology created uses a QR code to pose every feature of a food service facility. This technique was working well for all places, even if it may lessen the workload of servers but quite cumbersome in a food service establishment.

In the web-based application for ordering [10], the goal is to offer a platform with an intuitive interface so that patrons can communicate and place food orders. Customers can use this web-based program to customize their online meal orders by adding extra ingredients, adjusting the amount of spiciness, adding extra toppings, and more. Customers are also given the option of a tailored menu based on their past orders, which increases user satisfaction and gives them a productive dining experience. The author also discusses how a good user interface contributes to user pleasure. The value and relevance of including extra features like order and transaction tracking, secure payment methods, and status updates The author in [11] designed a food and drink order system with an Android-based app. The authors also gave an option for manual ordering and by observation measured the result of effectiveness from customers' feedback to compare the manual approach with the app, the result indicated many customers prefer the use of the app to manual ordering. The customers listed the benefits derived from the app such as comfort, convenience to restaurant owners, and safe time and cost. The authors in [12] introduced a web-based application that customers can open on their smartphones to place their orders. The system is authorized by an attendant in the kitchen to manage the menu from each table and keep track of each order. The authors presented a framework for smart restaurant management and ordering to reduce order mix-ups. Liyanage et al. [13]. The authors proposed a futuristic strategy that integrates machine learning, data mining, artificial intelligence, business intelligence, and predictive analysis. Combining technologies resulted in a unique dining experience for clients with customizable options. If implemented, the system will feature a smartphone app that allows users to examine menus in 3D images. However, no record of deployments was mentioned in the works but rather suggested.

2. METHODS AND MATERIAL

2.1 Design of the System

2.1.1 Electronic circuitry design

The electronic circuitry of the receiver was implemented using the Arduino Uno ATmega 328P microcontroller as the main control unit, an HC-05 Bluetooth module, a 1602 LCD module, a buzzer, a potentiometer, a control board and wires, and a pair of 3.7V Lipo battery rated 7800mAh. The suitability of the ATmega 328P microcontroller forms the basis of electronic components. The customer places his/their order through a developed Android app preinstalled on his/her smartphone and connected to the Bluetooth address of the kitchen. The Bluetooth module decodes this and sends it as the microcontroller receives a signal to give the output of the menu order via a 1602 LCD and buzzer alarm. The system uses a developed Android application installed on a smartphone to make orders. In the first place, the customer connects to the Bluetooth address of the arena and chooses their menu as the display via the app. The ATmega328P decrypts the code and transmits data via Bluetooth transmitter. Data is also received via the Bluetooth receiver module. The process is sent to the kitchen via Bluetooth to receive orders. Fig 1 shows the block diagram of the communication interface of the system.

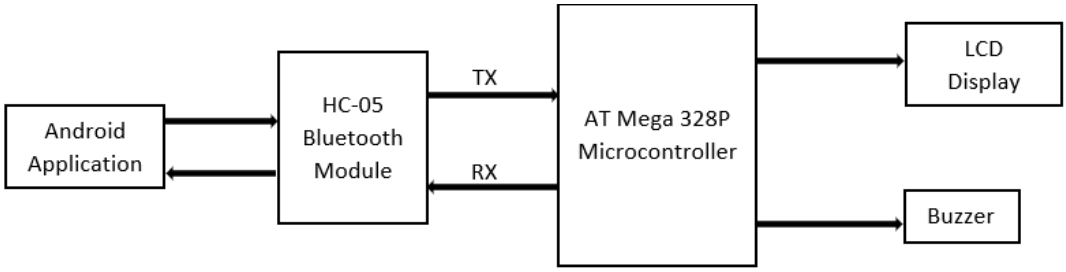

Figure 1. Block diagram of the system

2.1.2 Firmware design

This comprises the codes written on the Arduino 1.8.5 Integrated Development Environment (IDE) and embedded in the ATmega 328P of the Arduino microcontroller to receive commands and give outputs to the Android app, Bluetooth module, LCD screen, and buzzer. The code was written in the C/C++ programming language in the Arduino IDE environment and uploaded to the Arduino Uno ATmega 328P microcontroller. The code deployed to the ATmega 328 P microcontroller to decrypt the instructions as programmed for the interfaces.

2.2 Android Application Development

An MIT inventor app was used to develop the graphical user interface (GUI) for placing orders when installed on a smartphone. The MIT app inventor is an intuitive visual programming environment developed by Google but now managed by the Massachusetts Institute of Technology (MIT). The platform allows everyone to develop functional apps compatible with smartphones. The application was developed through building blocks picked and dropped on the plan screen to frame tabs that execute instructions when coded for a function as it is pressed. The app interacts with the microcontroller through the RX and Tx communication protocol of the HC-05 Bluetooth module. Fig 2 shows the Android app development processes.

(a) (b)

Figure 2. (a) Application building blocks and (b) Application plan screen setup

Upon the completion of the Android application development process on the MIT app inventor environment, the file was downloaded and installed on a Bluetooth-enabled smartphone. The connection to the kitchen Bluetooth address was established with the HC-05 Bluetooth module at the kitchen receiver's setup. Figure 3 shows the installed Android App on a smart phone while Figure 5 shows the kitchen's receiver's setup.

Figure 3. Installed android application

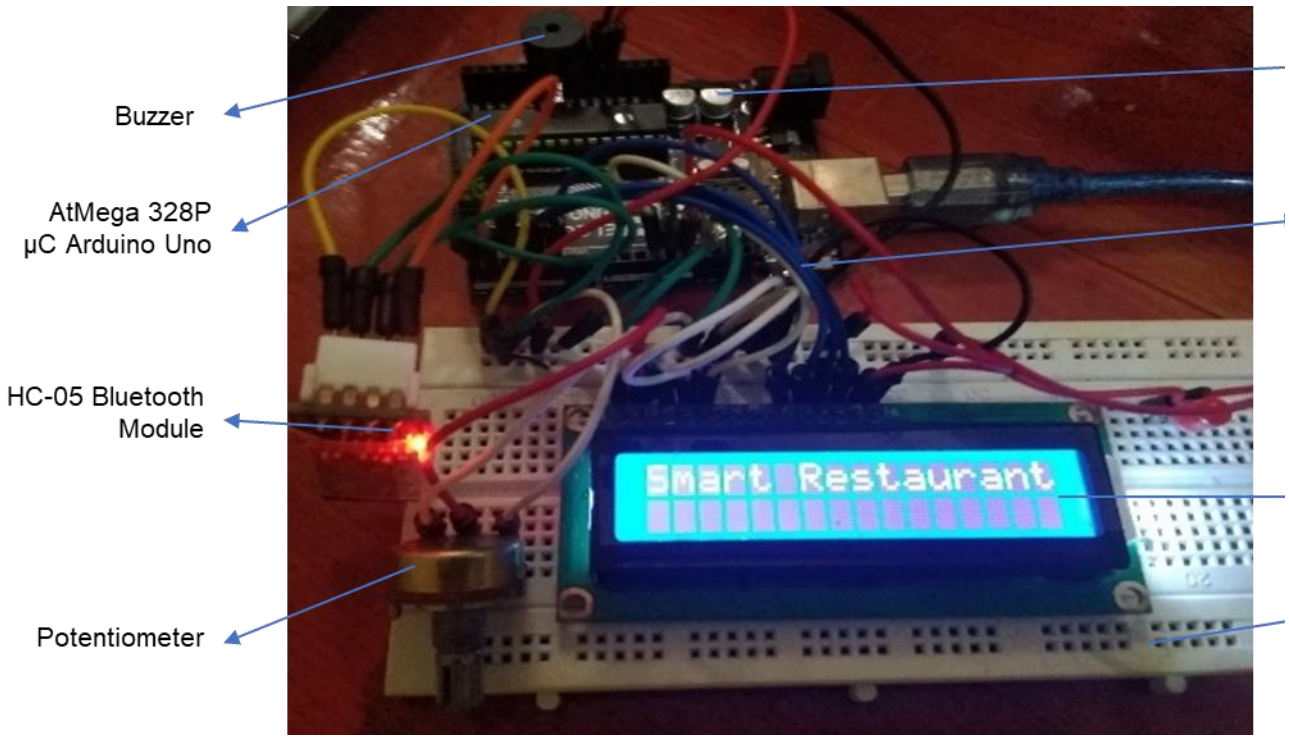

Figure 4. Kitchen reciever's setup with HC-05 bluetooth module

2.3 Working Principle

The experimental setup is demonstrated as shown in Figure 3 and Figure 5. The developed app was installed on an Android 8.0 smartphone, connected to the HC-05 Bluetooth module of the arena. The customer selects their menu following tab buttons via the app as the request is received through the Bluetooth module in the kitchen arena. The ATmega 328P decrypts the code to display the ordered item via LCD accompanied by a buzzer alarm in the kitchen. Figure 4 shows the operational flowchart of the process. The system can only take an order per time with a 1Mbps speed fast to deliver an order to the kitchen without noticeable lag.

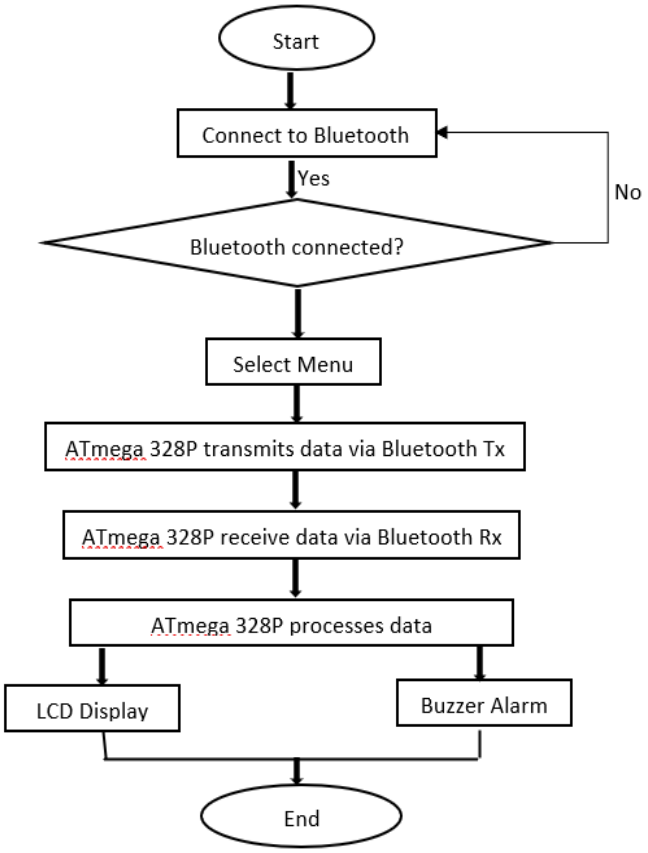

Figure 5. Operational flowchart of the System

3. RESULTS AND DISCUSSION

3.1 Bluetooth Module Range Test

This test was carried out to ascertain the maximum range to which the commands on the Android application can be sent successfully to the kitchen receiver without failure. The Received Signal Strenght Indication (RSSI) of Bluetooth helps to estimate the distance between two smart devices. This test ascertains the Bluetooth connectivity with the developed Android application. This is very crucial as it ascertains a waiter's ability to receive the customer's order in a restaurant setting. When the commands encoded for each button on the app are pressed, data is sent and received by the Rx pin of the HC-05 Bluetooth module using a 5m successive distance. To achieve this, it was ensured that no obstacles or electromagnetic emitting devices between the Bluetooth and Android App (Mobile) devices could cause interference. After a successful signal reception indicated by the display on the LCD and buzzer alarm, a further movement of 5m was done to check if the signal was received. Table 1 shows the records of variation of distances of placing a command via the app and the Bluetooth connectivity status and signal results.

The Bluetooth test within a 20m range shows the system can be adopted in an indoor arena within the specific range. Table 1. Shows the test at various distances with the results

Table 1. Bluetooth range test

Command	Bluetooth distance test Bluetooth Connection Status (m)					Result
	(5)	(10)	(15)	(20)	(25)	
Call	S	S	S	S	F	Alarm, LED on to signal the attendant
Water	S	S	S	S	F	Display "Request! Water" on LCD
Juice	S	S	S	S	F	Display "Request! Juice" on LCD
CANCEL	S	S	S	S	F	Clear screen to Cancel Order
OK	S	S	S	S	F	Display "Waiting please " on LCD
TABLE 1	S	S	S	S	F	Display "Table 1" on LCD
TABLE 2	S	S	S	S	F	Display "Table 2" on LCD

KEY: S = Success, F = Failure

From the result obtained, the HC-05 Bluetooth module successfully received a command from the Android app with a range of 20m distance. This result is in tandem with a work on Bluetooth range carried out on wireless communication with Bluetooth module (HC-05) interfaced with Arduino microcontroller by Cotta et al., (2016) [15]. In addition, this result shows the suitability of the HC-05 Bluetooth module as a wireless communication module for data transmission and signal reception that can be adopted in a small restaurant setting of a 20m arena. Figure 5 illustrare the general The line graph illustrates the Bluetooth communication success rate (%) across increasing distances ranging from 5 meters to 25 meters. The success rate remains at 100% from 5m to 20m, indicating reliable communication within this range. However, there is a sudden and complete drop to 0% at 25 meters, demonstrating a critical threshold for Bluetooth connectivity under the tested conditions.

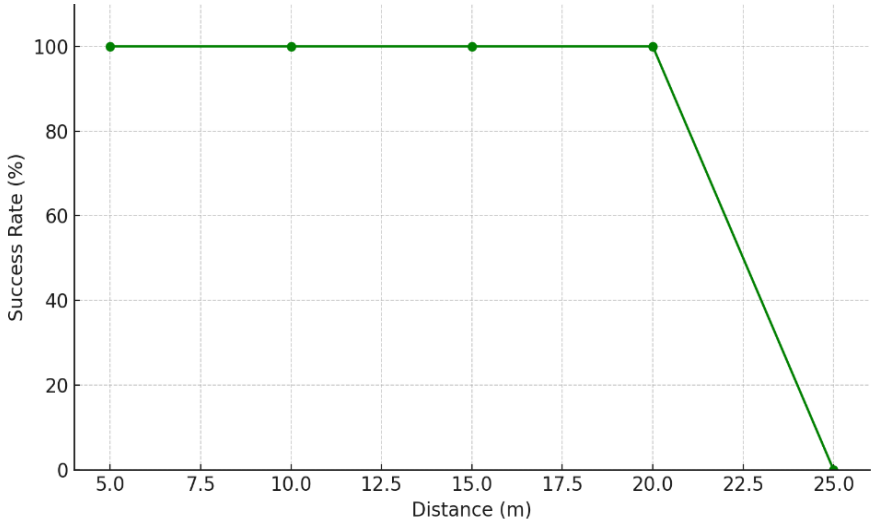

Figure 5. Bluetooth command success rate over distances

4. CONCLUSIONS

In this study, a smart menu ordering system for restaurant service was implemented with a pre-installed Android app connected to the kitchen's Bluetooth address. The system in the kitchen is an Arduino microcontroller for sending and receiving signals from the Bluetooth module. With the result of this work, the challenges of customers in getting ordered food items, especially during peak hours in the restaurant. The Arduino microcontroller-based implementation with the transmitter and receiver of a Bluetooth module minimizes manpower thus reducing human errors and maximizing turnaround for economic advantage. The result and implementation of this work will contribute significantly to tackling the challenges of the conventional process of ordering food in a restaurant. The results presented were fascinating showing possibilities of adopting this approach in an ideal setting. The system works best in a line-of-sight and an effective distance of 20m between the app and the receiver, thus, a longer range and better connectivity wireless technology is proposed for further research. A more advanced Android application development is proposed to enhance a more friendly user interaction.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest of any form in this study.

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