IoT-Based Sit-in Restaurant Waiter Alert Systems

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ABSTRACT

To get the attention of the waiter in restaurants, customers typically adopt the traditional method of waving. Due to waiter shortages and rush-hour in some places, this method causes delay in service delivery. Many different alerting methods have been suggested to deal with this issue. In this work, two internet of things (IoT) prototypes have been developed. The first prototype uses an ESP32 microprocessor connected to a computer that serves as the waiter's receiver, and the customer transmitter is a phone with an app called serial Bluetooth terminal (SBT) that is installed on the customer's phone. The second prototype has the customer's transmitter being a small IoT device developed with a display, buttons, a buzzer and an ESP32 microprocessor. These systems have the potential to reduce waiting times, improve efficiency in service delivery where waiters operate, as well as allow future enhancements to the systems as per business needs.

Keywords: Bluetooth, ESP32, IoT, Waiter Alert

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1. INTRODUCTION

Eating out at restaurants has become a popular social phenomenon of people around the world. Many a time, many restaurants get busy with high volume of customers [1-2]. The restaurant industry has been focusing on satisfying customer's needs beyond the means of food. Restaurant managers try to create multi-pleasure experiences by service quality, satisfying the physiological, social, and intellectual needs of their customers [3]. Additionally, this can also be achieved by using technology to enhance service, increase efficiency, create an edge towards positive results and outcomes [4].

Waiters and waitresses are very essential staff in any restaurant or café who deal directly with the customers. Other than food-related tasks, they are also responsible for other aspects of a restaurant's daily operations [5]. With all these duties, it can be quite difficult for some to focus on which task has to be done first. A key component in any successful business operation is coordination. Having a systematic way of designating tasks can prevent customers complaints. Waiters can perform their tasks more efficiently if they are aware of when customers need them as well as the service delivery can be monitored. Technology that is used to call waiters, are called waiter alert systems (WAS) [1]. A restaurant waiter call system (WCS) is a technology used to facilitate communication between customers and waiters in restaurants [1].

In this work, we propose two IoT waiter alert system. The first prototype uses an ESP32 microprocessor connected to a computer for the waiter, and the customer transmitter is a phone with an app called serial Bluetooth terminal (SBT) that is installed on the customer's or restaurant's phones. The customer phones connect to the waiter's device through Bluetooth. The second prototype has the customer's transmitter being a small device with a liquid crystal display (LCD), three buttons, a buzzer and an ESP32 microprocessor. The waiter system in this system is also an ESP32 microprocessor connected to a computer with Bluetooth enabled. A QR code can be provided to enable customer to download the app more conveniently to their phones.

2. LITERATURE REVIEW

In a busy restaurant or café, it is not always easy to ensure that waiters are able to check if every table requires anything. It is often difficult for a customer to get a waiter's attention. Typically, a customer has to attempt to make eye contact with the waiter, hold up his or her hand to get the waiter's attention, or otherwise call out to the waiter as the waiter passes by the customer's table [6]. These methods may not be discreet, and often difficult because the waiter is busy. It would thus, be desirable to provide a diner/customer with a method whereby he/she could easily notify the waiter that the waiter's services [1].

This issue has led to the invention of many systems. A restaurant pager system also known as the waiter call button, or the waiter attention alert system was invented for use in restaurants and other hospitality sectors to allow clients to discreetly call for their waiters [7]. Several

waiter call systems have been developed over the years offering several benefits as shown in table 1. The table shows systems that have used IoT approaches as well as those that have not.

Table 1: Electronic Waiter Alert Systems

System	**Description Summary**	**IoT Based**	**Microprocessor**	**Connection mode**	**Ref**
Retekess TD165 Pager System	This system is ideal for restaurants, bars, and cafés. It has a built-in battery.	No	Yes	Radio frequency	[8]
Kitchen Call Waiter System	The system directly receives the pager signals. it cannot work with other pagers. It can make a single/ group call.	No	Yes	Radio frequency	[1]
Restaurant Call Buttons Wireless Pager Call Button	This device uses RF tech (200m coverage). It is worn resistant and durable.	No	Yes	433.92MHz Host Radio frequency	[8]
SINGCALL Wireless Waiter Caller for Customer	Each pager can set different alert music. It is also equipped with a waterproof base.	No	Yes	Radio frequency	[8]
Wireless Call Buttons SOS Alert System Portable Alarm	This system comes with 2 call buttons and 1 pager. It comes with a belt clip.	No	Yes	Radio frequency	[1]
SINGCALL Wireless Kitchen Calling Waiter System for Cafe, Hotel,	This system comes with 20 button bells and 1 watch receiver. It works without any control center. It uses vibration and music as alert modes.		yes	Radio frequency Frequency Range:433MHZ	[8]
Intelligent Restaurant System Smart menu	Applications installed on handheld tablets and computers. Uses Cloud services. Used for ordering. Shows the menu.	Yes	No	Wi-fi	[9]

Smart Restaurant System using QR Code	A system where a QR Code is scanned to the phone. The system allows customers to order and receive bills.	Yes	No	Wi-fi	[10]
An IoT-Based Restaurant Calling System with QR Code	Has an Arduino based server. Users scan a QR Code to install the app to their phones to call the waiters	Yes	Yes	Wi-fi	[11]
IoT Based Menu Ordering System	Uses an Arduino Microcontroller to build a system for customers to order in a restaurant.	Yes	Yes	RFID	[12]

Some of the weaknesses of present waiter alert systems are that they are not custom designed to different restaurant needs and are closed source, such that they cannot be changed to the restaurant needs. Our approaches use Bluetooth unlike most waiter alert systems. The advantage of Bluetooth is that it offers a larger bandwidth range to connect more devices accommodating larger restaurants. Our system uses QR code such as in papers [10-11] also. However, our approach is only on service delivery to improve service delivery. Both prototypes in this work can be reprogrammed and enhanced to restaurant needs with time.

3. METHODOLOGY

The aim of this work is to create a waiter attention alert system that will allow easier communication between the waiter and the customer. We use two approaches in this work. One approach communicates using Bluetooth and an App and the other uses Bluetooth and an end device with buttons. It customer has a choice of the end device he/she wants to use.

The first prototype consists of a waiter's device with an ESP32 microprocessor that connects to the computer. The customer would have to download and install an App called Serial Bluetooth terminal using the provided QR code. The App will allow the customer phone to communicate with waiter system using Bluetooth. Whichever call message they send to the waiter, either to ask for the bill or waiter's help, a message will be displayed on the computer for the waiter to see and attend to. With this application setup in their phone, they will be able to send any message they want to get the waiter's attention. The receivers display has a timestamp function which will allow the waiter to see when the customer called and how long they have been waiting for.

The second prototype uses the same waiter system, except the end customer device is different. The customer end device has three buttons and an LCD display. The three buttons correspond to three commands (call waiter, asking for water and asking for the Bill). When a customer presses a button, a message is sent to the waiter's serial display specifying which table is calling and what they need. The transmitter unit will vibrate using a buzzer to notify the customer that

a request has been made and display it. These prototypes offer a two-way communication as the waiter can reply to customer as to how long the waiter will take (waiting time). The system can also specify what the bill amount is before they arrive to pick it up. The LCD screen on the device will display any message sent from the waiter's computer. The receivers display has a timestamp function which will allow the waiter to see when the customer called and how long they have been waiting (response time).

3.1 Equipment

The components and hardware used to build these prototypes were the ESP32 DOIT Devkit V1 microprocessor, LCD screen (16*2 without 12C), mini pushbuttons, buzzer, data transmission cable, serial display (on pc laptop) and SBT app for the phones. Table 2 summarises the equipment needed for the two prototypes.

- **ESP32 DOIT Devkit V1 Microprocessor:** The ESP32 is a dual-core microprocessor with built-in Wi-Fi and Bluetooth connectivity [13]. It is used to retrieve and transfer data in accordance with the program written.
- **LCD Screen:** This is a liquid crystal display with a 16x2 screen size. There are 2 rows and 16 columns in a liquid crystal display. Many commercial applications employ this display module, and practically all programming languages include a library to support it [14]. For our case, users can view information like waiting times, service status and service requested.
- **Mini push Buttons:** A push-button is a switch that uses a mechanism to regulate a machine or a process operation [15]. It is usually constructed of metal or plastic, the surface is often flat or contoured to fit a human finger or hand, making it simple to push or depress [16]. Customers can push these buttons to call the waiter. The ESP32 microprocessor uses digital input pins to read the button input states and displays the result.
- **Serial Bluetooth Terminal (SBT) Application:** For microcontrollers, Arduinos, and other devices with a serial interface connected by Bluetooth, there is an app called Serial Bluetooth Terminal that functions as a terminal or console [17]. SBT enables wireless data transfer between Bluetooth-enabled devices. Bluetooth modules are used by the waiter attention alert device to create a communication path between the customer's smartphone and the waiter's display. The waiter's serial display will immediately and without delay show whatever message the customer demands.
- **PC Serial Display:** The waiter attention alert device incorporates a PC serial display that can be accessed through the Arduino ide software connected to a computer or a tablet used by the waiter [18]. Information such as the table number or customer identifier allows the waiter to recognize and respond to client demands.

Table 2: Equipment needed for the two prototypes.

	Waiter Device	**Customer Device**
Protoype 1: Waiter Attention System with Phones as the Customer Device	ESP32 microprocessor connected to a computer	Mobile phones with an app installed
Prototype 2: Waiter Attention System with IoT End devices for the Customers	ESP32 microprocessor connected to a computer	Customer End Devices Built: • ESP32 microprocessor • LCD Screen • Buzzer • Pushbuttons • Resistors • Potentiometer • Power supply (battery)

3.2 System Design

Figure 1 shows the block diagram of waiter attention system for prototype 1, that uses phones as the end devices. Blue tooth is used for connecting the devices. Figure 2 shows the block diagram of waiter attention system for prototype 2, that uses IoT End devices as the end devices. Blue tooth is used for connecting the devices also in this system. Figure 3 shows the end device block diagram of the end devices for Prototype 2 and figure 4 shows the end device schematic diagram of the end devices for Prototype 2. In the end deviced an ESP microprocessor is used to transmit messages of button selected to the waiter's computer. It also receives and displays data (e.g., waiting time and bill amount to be paid) from waiters' computer on to the LCD screen. A buzzer is used to make a sound whenever a new order is placed. The buzzer makes a sound when each individual button is selected to alert the waiter if they are nearby or just as an alert to the customer that the message has been sent.

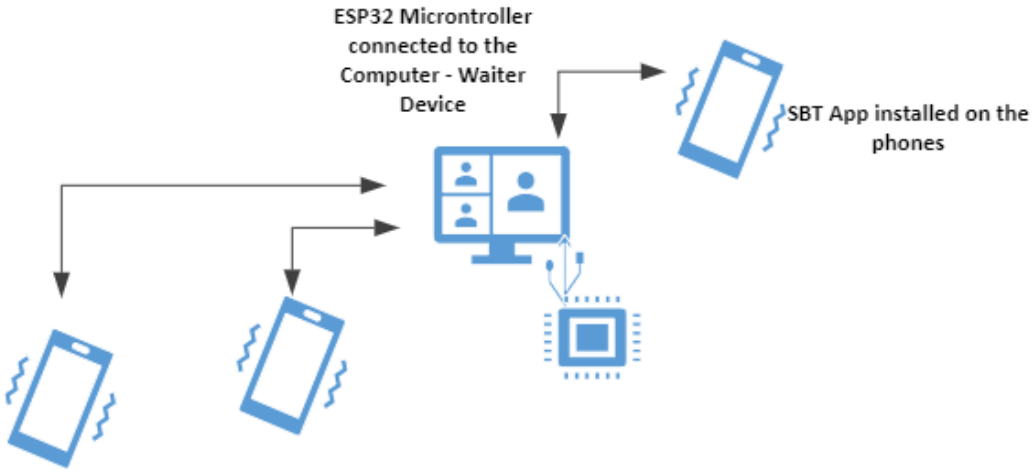

Figure 1: Prototype 1 with phones running the SBT App

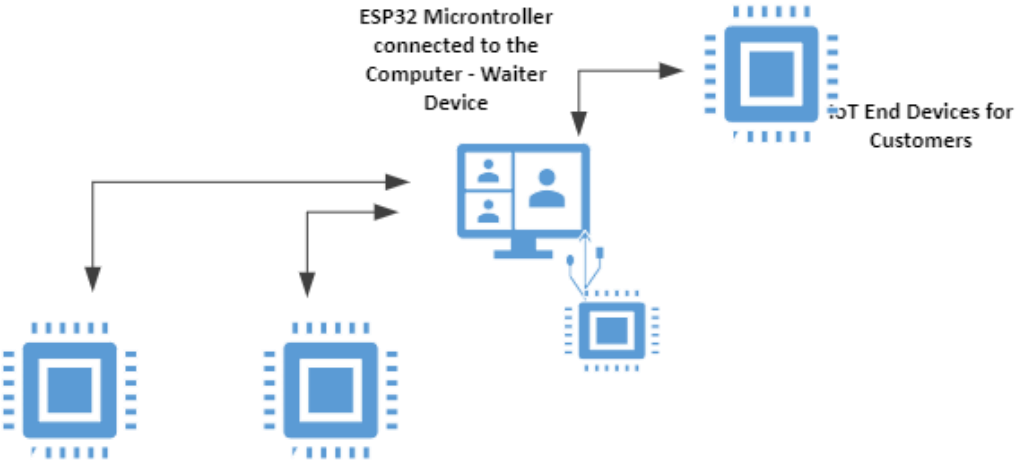

Figure 2: Prototype 2 with IoT end devices

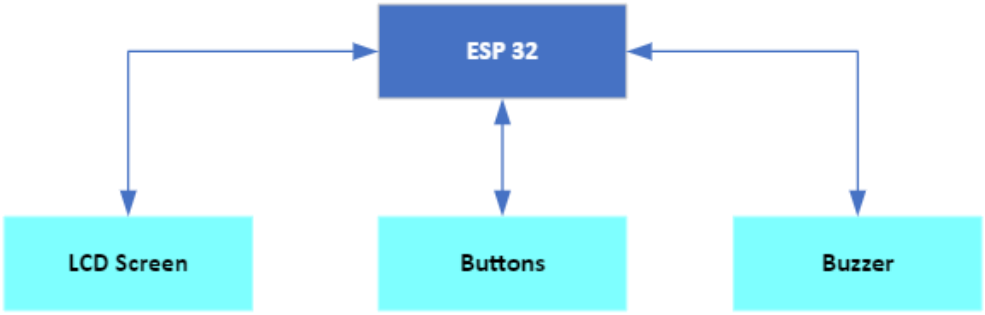

Figure 3: Block diagram of the end devices for prototype 2

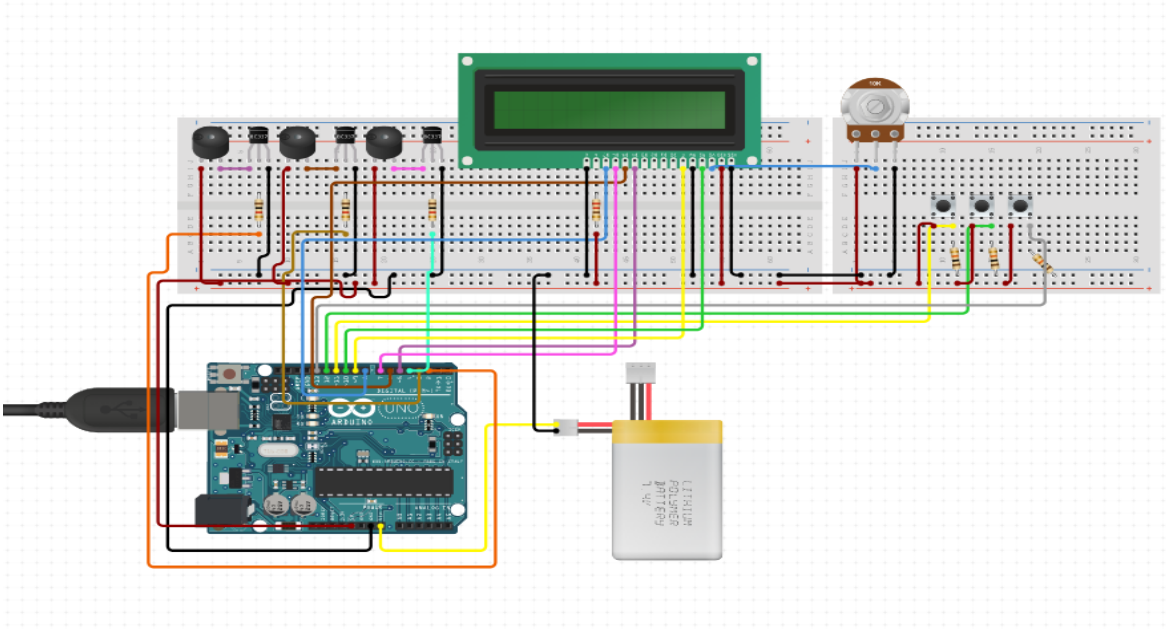

Figure 4: A circuit for the button transmitter device

Figure 5 shows how a Bluetooth connection with the waiter system is established with the phones for prototype 1. Figure 6 shows how a Bluetooth connection with the waiter system is established with the end devices for prototype 2.

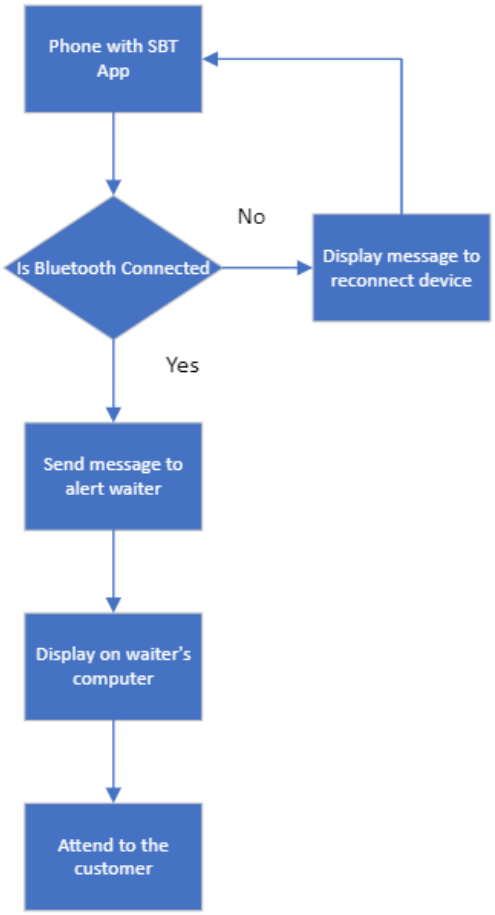

Figure 5: Operations Flow chart of Prototype 1 using phones with the SBT App

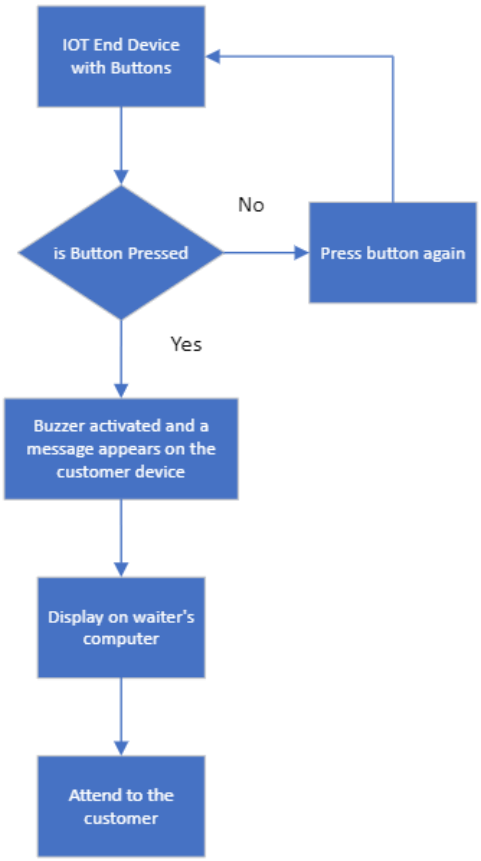

Figure 6: Operations Flow chart of Prototype 2 using IoT end devices

4. RESULTS

These systems allow two-way communication between the waiter and customer. A resistor was added to the buzzer and button to reduce current flow. The waiter can reply to the customers' messages, and they will be displayed on the customers LCD screen. The waiter can send waiting/response timer as well as messages specifying the amount of bill to be paid if customer requests it as shown in figure 7 for the end device for the customer.

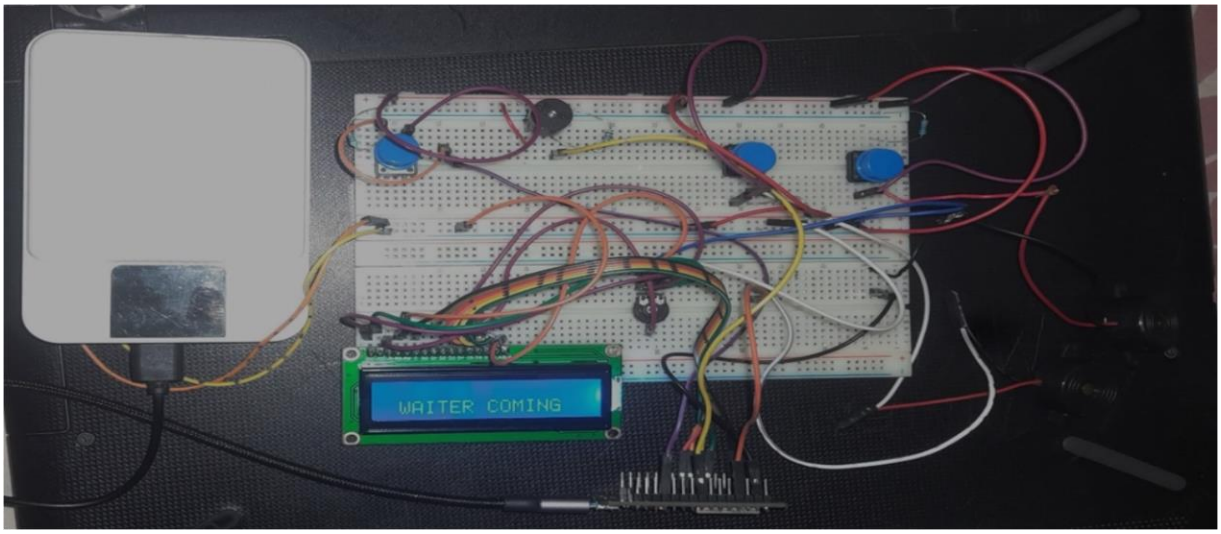

Figure 7: Message after button has been pressed.

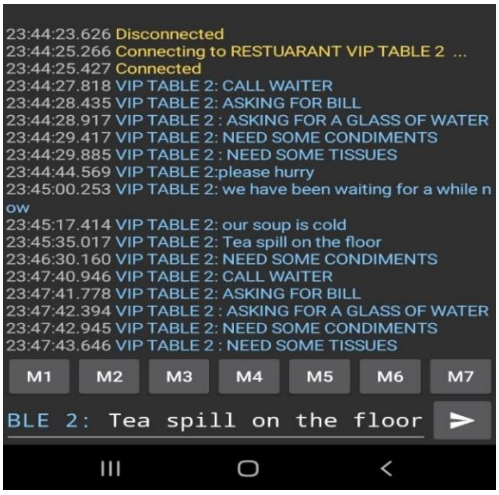

Figure 8: Serial Bluetooth terminal app display on a customer's phone

Figure 8 shows messages that a customer has sent to the waiter's display. The M1-M7 options are where automatic messages can be set up and used continuously e.g., Call waiter. In the panel below the M1-M7 buttons is where the customer can enter and send any message to alert the waiter of their needs. E.g., there is tea spill on the floor. The display also show time when the message has been sent which can be used as waiting time or to calculate response time.

5. DISCUSSION

With the waiter attention alert device implemented using Bluetooth technology, the customer can download the SBT app and send messages to the waiter using it. The waiter will then see the message and attend to the customer it. The implementation of a waiter attention alert device that utilizes a SBT app offers benefits like of ease of use, flexibility, and affordability. This system implemented using Bluetooth offers several advantages in terms of communication reliability, power efficiency, and ease of use. Bluetooth normally has a range of up to 100 meters, making it acceptable for most restaurant settings. The coverage provided by Bluetooth ensures that customers can send alerts and notifications even when they are in different sections of the restaurant or moving between different floors.

The use of a SBT app provides a cost-effective option by utilizing existing smartphones or tablets. It eliminates the need to buy specific gadgets for each consumer. While Bluetooth technology offers numerous benefits, there are certain limitations to be considered. The range of Bluetooth may be affected by physical barriers, such as walls or large objects, within the restaurant environment. Additionally, Bluetooth may experience occasional interference from other electronic devices operating on the same frequency.

The other limitation to this prototype is that most customers would feel it is inconvenient to install the Bluetooth terminal app especially if they don't have enough space in their phone. This of course can be mitigated by offering this service to regular customer who will frequent the store or providing devices with the app installed to private room/ VIP tables only.

With waiter attention alert device implemented using buttons, we were able to simulate several entries a customer can make. The way it works is that a customer would select any of the 3 buttons (call waiter, asking for bill, asking for water). Immediately when a button is pressed the message Waiter is Coming will be automatically displayed on the customers' LCD screen to make them aware that their call has been received. The LCD display is utilized to present the estimated waiting time to customers, ensuring transparency and managing their expectations.

The waiter can also send a waiting time or response time to the customer so that they know how long they would have to wait or how long the waiter will take to respond. This system offers several advantages in terms of ease of use and communication reliability. In ease of use, any device that uses buttons is direct and very easy to use. The design is not complicated, and the buttons are labelled to make it easier for the customer. This device also offers back-to-back communication with the waiter which allows them to send the waiting time and response time to the customer, making for a unique dining experience. It offers very reliable communication that can't easily be interrupted by other communication modules. The device is directly connected to the waiter's receiver using cable. Another great benefit to this module is that there is no interruption when multiple such devices are used all at once. Using a USB adapter will allow the restaurant to expand on the number of devices for the customers they have without worry.

While this prototype offers numerous benefits, there are certain limitations to be considered. One of which is that the device is not wireless. It must be connected using cable to the waiter's computer. This hence limits its range to the length of the cable. Another limitation can also be that it depends on external power supply that needs to be replaced each time they stop working.

6. CONCLUSION

The systems developed in this work can improve the eating experience for patrons and staff of restaurants through the usage of waiter alert systems. Three areas of interest in particular were highlighted, interaction, effectiveness and shorter wait times. The interactivity requirement will be satisfied by the direct interaction the waiter will have with the customers via the devices on the tables. Waiters will be able to respond to their tables more effectively when the customer calls the waiter. Therefore, improved efficiency will be achieved. Customers are given a more independent and comfortable way to call waiters whenever they are ready. This will be achieved through the two approaches, one being a readily available table device that use buttons and the other being using their phones to call the waiter. When the customer is ready to order they will have options to choose from and send it to the waiter. The options will be the call option to call the waiter to your table, the bill option to request the waiter to come prepared with the bill, the drink option to call the waiter with the beverages if they are using the button device. The same messages and more can also be sent using the phone app.

Customers can easily select any order they need and have the immediate attention of their attendant waiter, leading to improved efficiency in the restaurant. Similarly, the preceding improvements affect the expenses and reputation of the restaurant owners. This constitutes the third goal, which we attempted to achieve in this project. Owners do not need to hire as many staff as before and are able to invest their financial capital elsewhere. This is because customers are attended to faster freeing up manpower. Most restaurants these days already have a computer they use to process customers' orders; the same computer can also be used to receive customers' messages, which saves a lot of money for the restaurant.

The prototypes of the waiter attention systems have only been developed in this work. The final products are still to be developed. The systems can also be improved by using Wi-Fi connectivity and a phone app developed. The systems and apps can be developed as per restaurant needs.

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