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Wireless Waiter Robot

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Abstract

A robotic waiter with integrated technology is an ideal solution for restaurants. This paper considers facilitating the services in restaurants. Many problems can be observed in this case such as overcrowding of customers and lacking for waiters. These problems can be addressed by using the robotic techniques. In this study, A waiter robot and a smart restaurant are designed to provide better services for customers. The robot can response to a lighting signal from any table in order to provide the restaurant services for that location. In addition, the customer can use an Electronic-Menu (E-Menu) which is embedded within the robot to select his/her order. The order will be sent to the kitchen and the food will be prepared. Consequently, it can be delivered to the determined table by the waiter robot. A credit card service within the same robot is suggested for paymentpurposes.

Keywords: *Waiter Robot, Smart Restaurant, E-Menu, Arduino*

1. Introduction:

Robotics are currently considered as one of the most attractive humans' accomplishments. In recent years, manufactured robots are increasingly being available for public[1]. Robotsare an intelligent machines or devices that automatically operate to provide specific services. Usually, people prefer to use such equipments [2]. Robots are complex yet useful systems that have been employed in industry since several decades. The capability and utility of robots have dramatically been increased [3]. They have been exploited in many technology fields such as mechanical engineering, electrical engineering, computer sciences, electronics, sensors, actuators and artificial intelligence [4][5]. Robots are required to have much higher mobility and dexterity than traditional machine tools.

It is known that being a waiter in a restaurant is not an easy job. This inspires the idea of establishing a waiter robot. A smart restaurant can significantly decrease the efforts of individual waiters, reduce restaurant parts or sectors, simplify food orders, support restaurant services, manage payments, and increase customer reliability [6]. Robotic waiters in smart restaurants can perform better services than that are provided by individual waiters in normal restaurants.

In the literature, several studies focused on exploiting robots in restaurants.In 2015, Omair *et al.*presented a Waiter-Bot as an exceptional autonomous robot which has the ability to follow a designated path with the help of IR sensor arrays [7]. In the same year,Saple *et al.* proposed an autonomous prototype robotic waiter. The robot could follow a black line track and serve customers [8]. Also in 2015,Asif *et al.*developed

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new robotic models in the case of human-robot interaction. The new models have interested communication protocols and their architectures can provide real-time path planning, guidance and control [9]. In 2016, Malik *et al.* demonstrated a prototype of Autonomous Serving Robot (ASR). It was proposed for taking food orders and serving customers. The ASR was designed by using available resources to reduce the cost [10].In the same year,,Cheong*et al*, design as restaurants have the most diverse designs and layouts, developing an autonomous system can be more efficient when done in the Robot Operating System (ROS) framework and using a modular robot design[11].Alsoin 2016,Shah *et al.* concentrated on providing facilitated restaurant environment, where a robot can smoothly deal with customers. The designed robot waiter in this study used an accurate control mechanism by suggesting a coordinate mapping method in order to precisely access a certain customer table [12]. In 2018,Jin *et al.* invented a robot which was able to get instructions from a central microcontroller, which was located in the kitchen. It could navigate its way to specific destinations[13].

The aim of this study is proposing a waiter robot with a smart restaurant. The robot is assigned for collecting the customer orders. Furthermore, it is determined for delivering the service(s). Designing such robots can provides useful interactions between humans and machines.

The rest of this paper is structured as follows: Section 2 presents the theoretical design of the robot waiter and smart restaurant, Section 3 discusses the results and Section 4 clarifies the conclusion.

2. Methodology:

Robotic technology can reduce human efforts in restaurants or café systems. A waiter robot is suggested in this paper. It can move through a tracking line and provide different restaurant services. Fig. 1 shows a designed waiter robotthat implemented in the Technical Engineering College / Northern Technical University/Iraq and Fig. 2 demonstrates suitable restaurant environments.

Figure 1:The designed waiter robot. It implemented in Technical Engineering College / Northern Technical University

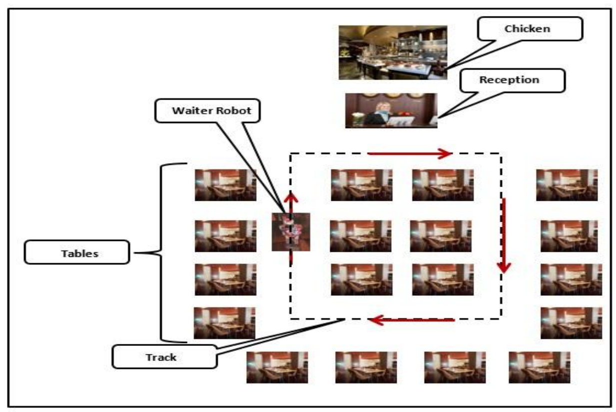

Figure 2: The proposed smart restaurant environments. It consists of chicken, reception, waiter robot and arranged tables

Fig.2 demonstrates four required parts or sectors in theproposed smart restaurant namely: the designed robot, chicken, ordered tables and reception. A wireless network is utilized to set the communications up between the waiter robot and different restaurant sectors, where the required service(s).

2.1 Waiter robot parts:

The proposed waiter robot contains the following parts: E-Menu, keypad, LCDdisplay, Bluetooth wireless and Arduino. These parts are detailed in the following subsections:

2.1.1 E-Menu:

One of the most interactive parts in the waiter robot is the E-Menu. It is suggested to provide important interfacing between the customer and waiter robot, where any customer can set his/her order by this tool. It consists of the Liquid Crystal Display (LCD), keypad, Arduino and Bluetooth. The LCD is used to display the E-Menu options. Whereas, the keypad is used to select the order. The LCD and keypad are both connected together by the Arduino technology. Then, the order is sent to the kitchen and reception by the Bluetooth. The essential parts of the E-Menu are given in Fig. 3.

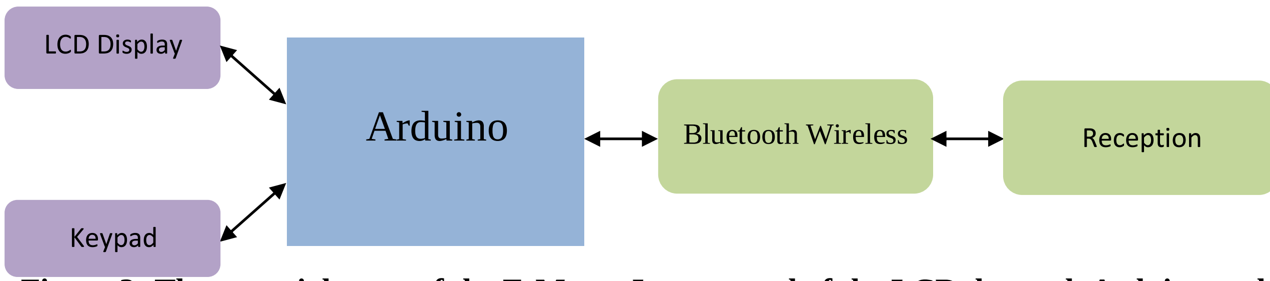

Figure 3: The essential parts of the E-Menu. It composed of the LCD, keypad, Arduino and Bluetooth

In Fig. 3, it can be observed that the Arduino receives the commands from a customer by the keypad. Subsequently, the determined order will be displayed by the LCD. The Arduino will also send the order to the reception by utilizing the Bluetooth wireless technique.

2.1.2 Keypad:

The keypad is used for selecting the restaurant order(s). It is a simple 4x4 keypad. When any key is turned “ON”, its voltage level will be changed. So, the Arduino can specify the selected option in real-time. The determined order will immediately be sent to the reception and its confirmation will directly be sent to the LCD.

2.1.3 LCD display:

Obviously, the LCD is proposed to display the options of the E-Menu. It is interfaced to the keypad so that any customer can see and select an E-Menu option. The display is also connected to the Arduino. So that it can show the confirmed option, which is sent as an order to the reception.

2.1.4 Bluetooth wireless:

A Bluetooth wireless module is suggested to be utilized as a communication device. The Bluetooth is a wireless communication that is covering a range of 10 meters. It can provide communications between reception and E-Menu. The customer selects the order by the E-Menu. Consequently, the order is sent wirelessly via the Bluetooth to the reception. The reception sequentially arranges the orders in a queue. The reception also sends the orders one after one to the kitchen according to the First Come First Serve (FCFS) rule.

2.1.5 Arduino:

Arduino is a single-board controller designed to make the process of using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open-source board with 8-bits Atmel AVRmicrocontroller. The software utilizes a standard programming language and a boot loader that facilitates the microcontroller's instructions. The Arduino is used to develop stand-alone interactive objects.It can be connected to a computer, a network or even the Internet to retrieve and send data according to the provided instructions[14].

2.2 Smart restaurant:

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This section concentrates on the suggested smart restaurant parts or sectors. First of all, a special design of a smart restaurant is proposed. Fig. 4 demonstrates the distribution of tables around the robot track movements. As shown in this figure,a squared track for waiter robot movements is designed. 18tables arearrangedaround both sides of the track.

This design can provide the appropriaterobot movementsbetween the tables.Consequently, smooth serviceswould be presented to the customers. The reception part can also be found in this figure, it receives the service request(s) and prepares the required order(s).

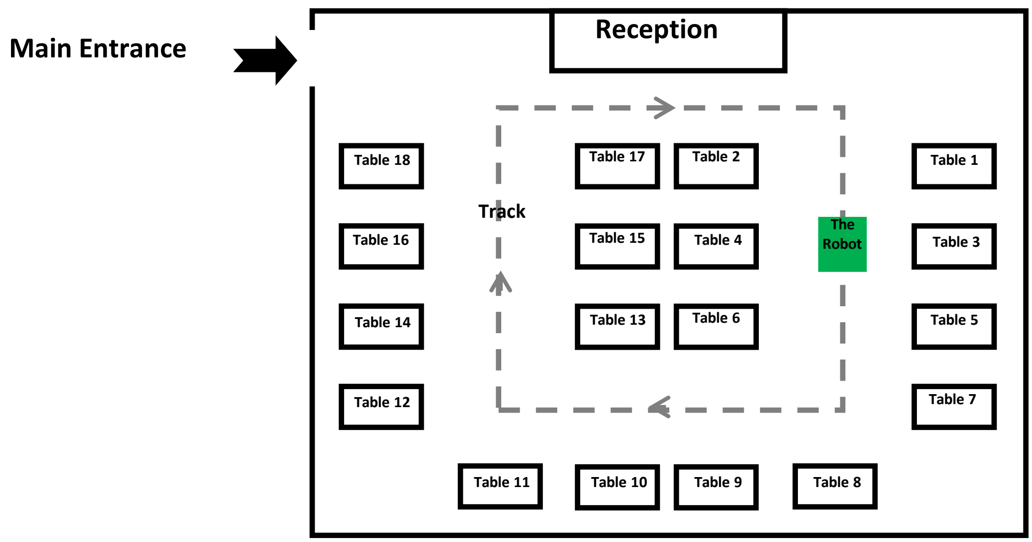

Figure 4: The proposed smart restaurant design. It consists of reception, tables, waiter robot and appropriate track position

The robot waiter will follow the service line (or track). Four InfraRed (IR) sensors are required: two center sensors and two side sensors. The two center sensors are for tracking the service line. The two side sensors are utilized for table counting. That is, if the robot counts one this means that it has been stopped near the first table and if the robot counts two this means that it has been stopped near the second table, and so on. These are parts of signal processing as [15]. Requesting service command at a specific table number is wirelessly transmitted to the robot by using the Wireless Local Area Network (WLAN). The reason of exploiting the WLAN is that it covers wider area of communications than the Bluetooth.

3. Results:

Results are organized according to the hardware parts that are required for providing smooth restaurant services. So, the following sections are almost based on the previous theoretical sections.

3.1 Electronic Menu:

Acomprehensive design of the E-Menu is suggested. It consists of four main options: table number, menu, payment and send order.Each option is for establishing an interface with a specific part. The first one is for selectinga table number. The secondone is for the food or drink menu.The third option is for order payment.The last option is for sendingthe order to reception.

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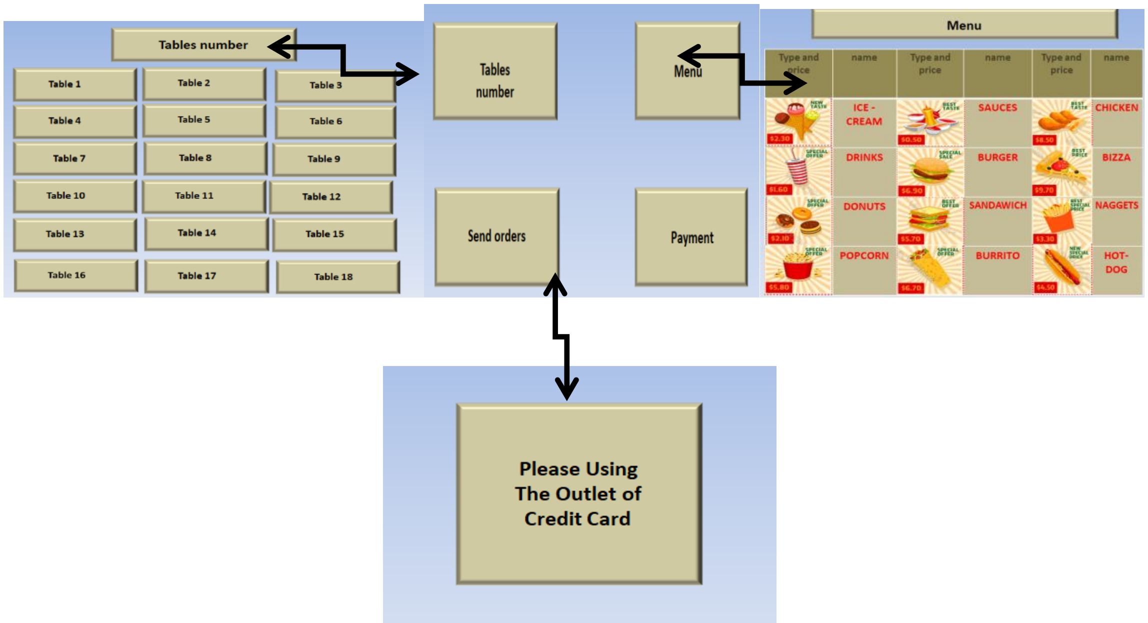
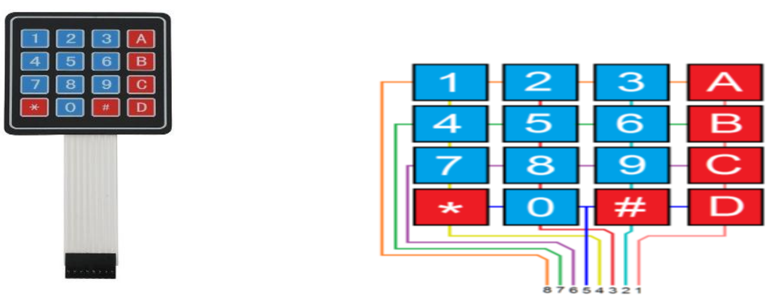


Figure 5: Designed E-Menu options

3.2 Keypad:

An exploited 16-button keypad can provide a useful human interface with the Arduino. It represents a simple way to deal with variety options. A combination of four rows and four columns in the keypad matrix can be helpful for the microcontroller to manage the button states. That is, underneath each key is a push-button with one end connected to a row and another end connected to a column. Fig.6 shows the external and internal keypad maps. In order for the Arduino to determine the pressed button or key, it observes the internal connectors of the four columns and four rows. Depending on the electrical status of the columns and rows, the Arduino can tell which button is used.



(a) (b)

Figure 6:The external and internal keypad maps: (a) the external map buttons and (b) the internal map connections

3.3 LCD display:

The LCD display consists of 16 characters, two alphanumeric lines and a single 9-way of D-type connector. It can clearly display the E-Menu options. The LCD is interfaced with the keypad so that it can show the customer order too. Fig.7 demonstrates internal LCD parts.

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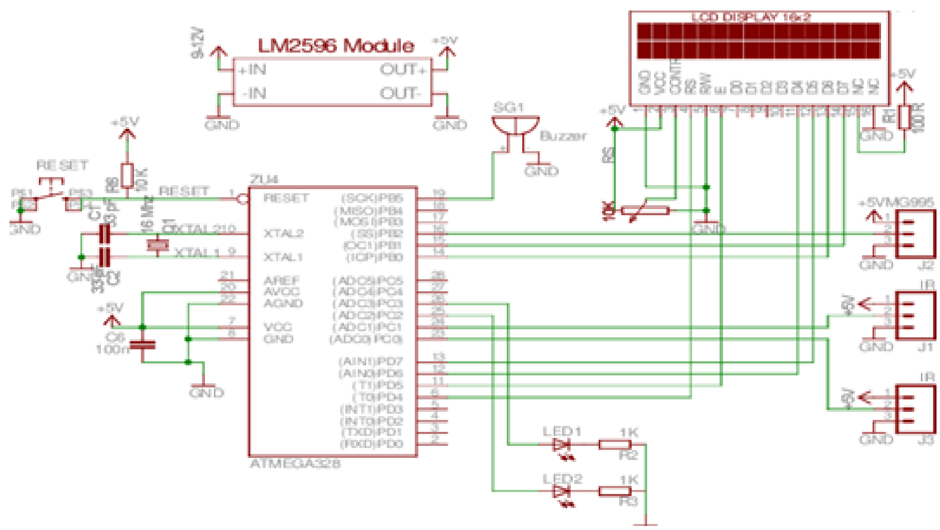

Figure 7:LCD display circuit and how to connect with the Arduino

4.4 Bluetooth wireless:

A Bluetooth module of (HC-06) is suggested to be utilized. It contains of 4 pins namely: power (Vcc), ground (GND), receiver (Rx) and transmitting (Tx). In Fig.8,the connections of these pins between the Arduino and Bluetooth wireless model are demonstrated.

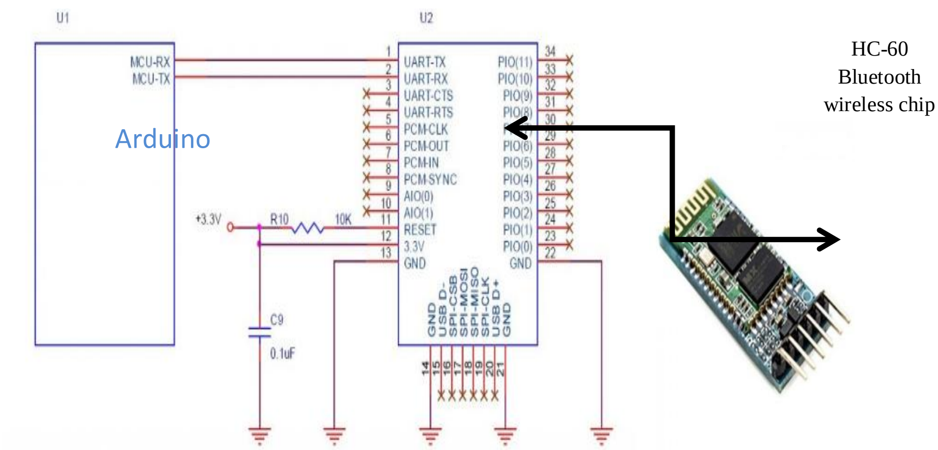

Figure 8: A circuit diagram of connected Arduino with the HC-6 Bluetooth wireless

3.5 Arduino:

Arduino can manage all the required processes of waiter robot. Principally, when the robot receives a service requested command by the RF receiver, it passes that to the microcontroller of type (ATMEGA 328). Subsequently, the ATMEGA 328 will drive the waiter robot toward the determined table. See Fig. 9.

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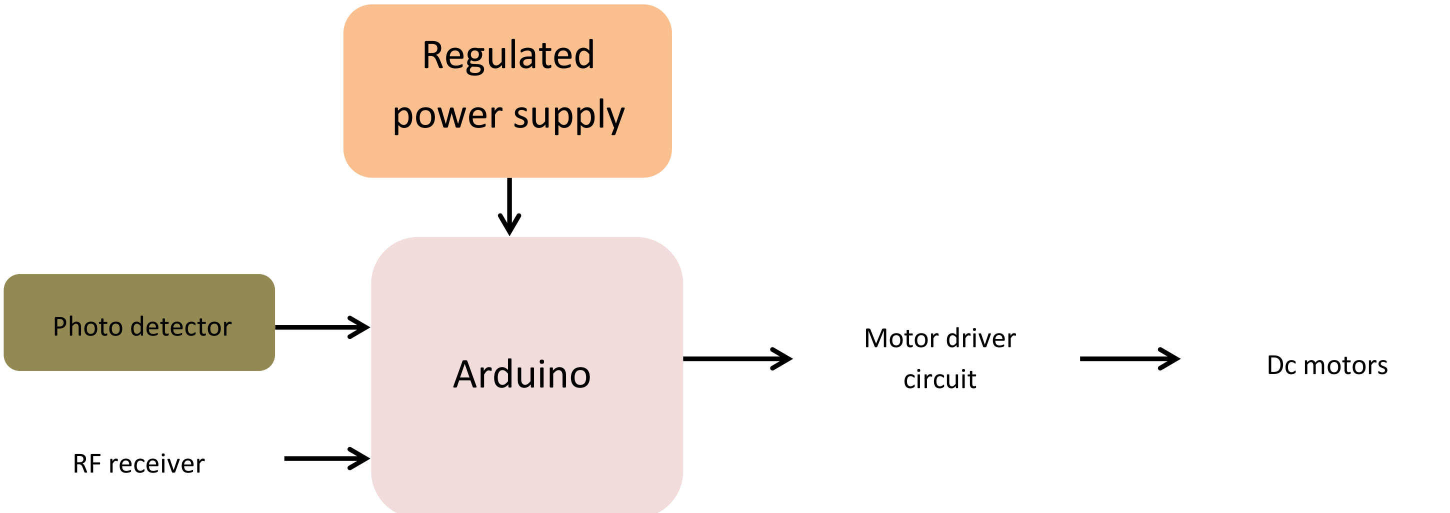

Figure 9:Receiving the requested service order and providing suitable robot movements by the Arduino

3.6Moving inside smart restaurant:

As mentioned, the smart restaurant can be arranged in a way that the waiter robot smoothly moves between the customer tables. Therefore, a squared track is suggested as shown in Figs. 2 and 4. This track is determined to cover all the restaurant area, especially between the customer tables. The reception sector can be considered as the starting and ending point at the same time. Firstly, the waiter robot should start from the reception. Secondly, it moves on through the tables to collect the orders. Thirdly, it comes back to the reception to hold the available order. Fourthly, it moves again between tables to deliver the order. Fifthly, it returns back again to the reception. Then, all of these processes are repeated.

The central two sensors are utilized for line-tracking (to keep the robot waiter in line). The other two side-sensors are utilized to recognize tables. Fig. 10 shows an electronic circuit of how a line tracking sensor circuit can be connected to the Arduino.

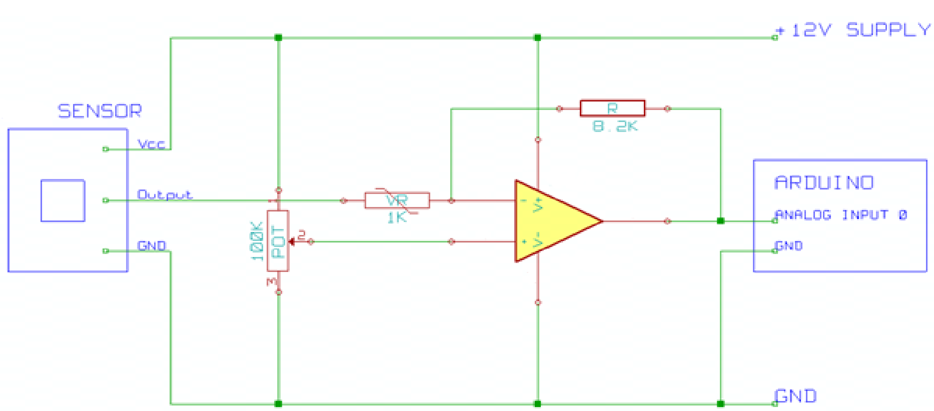

Figure10: An electronic circuit of how a tracking sensor circuitcan be connected to the Arduino

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It is worth mentioning that any one of the central two censors could not detect its sending signal, the waiter robot should immediately stop. Because it expects that a customer or someone is crossing the track. The waiter robot continues to move when its following track is clear.

3.7 Payments:

In this work, a credit card device is proposed to be included within the robot body. This would allow the customer to pay his/her meal price. The device is of type (VX 520). This type has a powerful processor, expandable memory and integrated Near Field Communication(NFC) capabilities. The NFC is facilitated to support alternative payments and also to provide value-added applications such as loyalty or gift cards. A uniquely designed base area underneath the device keeps the device stable and smart all the time. See Fig. 11[16].

Figure11: Credit card device of type (VX 52ex0) [16]

4 Conclusion:

In this study, we designedtwo models. The first one is for a waiter robot. The Second one is for asmart restaurant.Both are suggested to provide smooth restaurant services for customers. The proposed waiter robot is facilitated by essential hardware parts. These are the E-Menu, Keypad, LCD display, Bluetooth, Arduino and credit card device. On the other hand, the proposed smart restaurant is facilitated by main four sectors. These are the reception, tables, waiter robot and appropriate track position.

The waiter robot can follow the determined track to collect the customer orders. These orders can directly be sent to the reception. When the waiter robot reaches the reception it can pick the orders up. Then, these orders can be delivered to the specified customers (the customers who requested the orders). Any customer can make the payment by using a credit card device which is proposed to be within the robot body. This may reduce the customer efforts to make his/her payment in the reception or in any restaurant payment center.

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