Design of a waiter robot and automatic cleaning and disinfection table

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Abstract: With the industrialization of communities, restaurants are using new mechanisms from ordering to serving food, which leads to better performance, faster and easier service, less staff, and reduced costs, and other benefits. One of the mechanisms that have recently become very popular is the use of robots as waiters in the restaurant industry. In addition, these robots play an important role in an era when people should not be gathered in one environment due to the spread of the coronavirus. In fact, the purpose of designing such robots is to reduce manpower and minimize human contact to prevent the spread of the Coronavirus. In this project, in addition to designing a waiter robot, an automatic table has been designed that intelligently collects garbage and sprays alcohol on the table to prevent the spread of Coronavirus.

Keywords: Waiter Robot, Machine Vision, Automatic Cleaning Table, Infrared Sensor

1. Introduction

The use of mobile robots in the service industry and in particular in restaurants is on an increasing trend in the industry. The robots are being designed to become a part of ordinary people to live for an increasing extent. To assist human with tedious tasks or difficult, their tasks may range from play or entertainments. The robot will closely interact with a human group in everyday environments, in these kinds of application. This means that it will be essential to create models, intuitive and natural communication between robots and humans [1]. Nowadays, robotic waiter is creating huge attraction in restaurants, hotels and offices. Considering robotic technique based waiter, there are numerous innovative technologies developed by researchers, to make easy ordering services like adopting mobile robot [2], collecting dining decisions [3], wireless call system [4], waiter-robot [5], self-service ordering system for restaurant [6] and automated menu-recommender [7]. Rupali Saple et al. [8] in his research proposed that the customers can take their refreshment by pressing the buttons, where using the black line following technique the robot reaches the customer's table. When customers settled down in their chair of the restaurant they simply press a button to order for their refreshment. On switching the button, a LED at the receiving side will make the robot to move to his destination (customer's table) which also had a LED that glows brightly creating a junction between the robot and the table. The robot headed towards the table following the black line and takes order of the customer. In the same way following the black line the robot comes back to source destination. Neeti Malik, Neetu Rani, Alpana Singh, Pratibha, Srishti Pragya [9] proposed that the customer can gave orders via keypad. In the keypad the list of food items along with the prize has been provided so the customer can order from them easily without calling or waiting for someone. The LCD monitor shows the placed order on the screen. After taking the customer order, the robot will move towards the exact table location by the following black line. After serving the customers refreshment then the robot comes back towards the source position. The development and design of a waiter robot, where the customer gave the order by using electronic menu bar and the bluetooth module transferred data to the kitchen from the customers table at a baud rate of 9600 bps has been shown by M. Asif et al. [10]. The robot waiter by using line following technique reaches the destined table. In the project four IR sensors were used where the two sensors installed on the sides for counting the table, the other two sensors in the center are used for line following where the robot has been always connected to internet. The reception point using the communication network sent order to the kitchen from the table. Then the robot waiter transferred the refreshment to the customer's table from the kitchen. Sakari Pieska, Juhana Jauhiainen, Markus Liuska, Antti Auno [11] recently proposed in their paper that the customers can order through application works on an Android tablet. The database connects to this application and download the realtime in the restaurant's menu. So the customer can easily browse the menu bar and order it. By pressing a button, the customer can call the waiter. The waiter comes, for confirming the order and count the bill. In the kitchen's display this menu can be displayed. When this refreshment item is ready, then the kitchen staff can mark them as done. This refreshment item is visible in the cashier and also in the waiter application so that they can easily deliver them to the customer [12].

In this study, the aim is to design an automatic restaurant with a waiter robot and a self-cleaning table and alcohol sprayer for the period of Corona virus outbreak. Which automatically detects the number of people and the entry and exit of the customer.

Waiter Robot operation method

People are detected by the camera every time a customer enters the restaurant and is tracked to choose the table and sit down. People are identified by the machine vision method using the Tensorflow toolbox (Fig 1). After people sit down, the number of people is determined using an infrared sensor. Since each table's position in the central system is defined, this position is sent along with the number of customers for the robot and the central system via the HMTRP Expert. This information is recorded to provide basic services and the robot moves to the customer to receive the order. The robot moves to the customers (the desired table) and the customers register their order through the LCD on the robot, which has a list of appetizers, foods, desserts, and drinks.

After the order is registered by the customer, the information recorded by the customer is sent wirelessly through the HMTRP Expert embedded in the robot to the central system for food preparation, and the computer issues the order through a printer in the kitchen. The robot then returns to its reference point, which is also where the robot charges. While preparing food or booking several tables simultaneously, the robot provides services in order. After the order is prepared, the order is placed on the robot to be delivered to the customer by the robot. Due to the spread of the coronavirus, along with the order, disinfectants, disposable gloves, and handkerchiefs are provided to the customer.

The ultrasonic sensors embedded in the robot prevent the robot from colliding with obstacles and humans while moving, and it is also received by the robot's engine encoder to validate the robot's movement in the right direction.

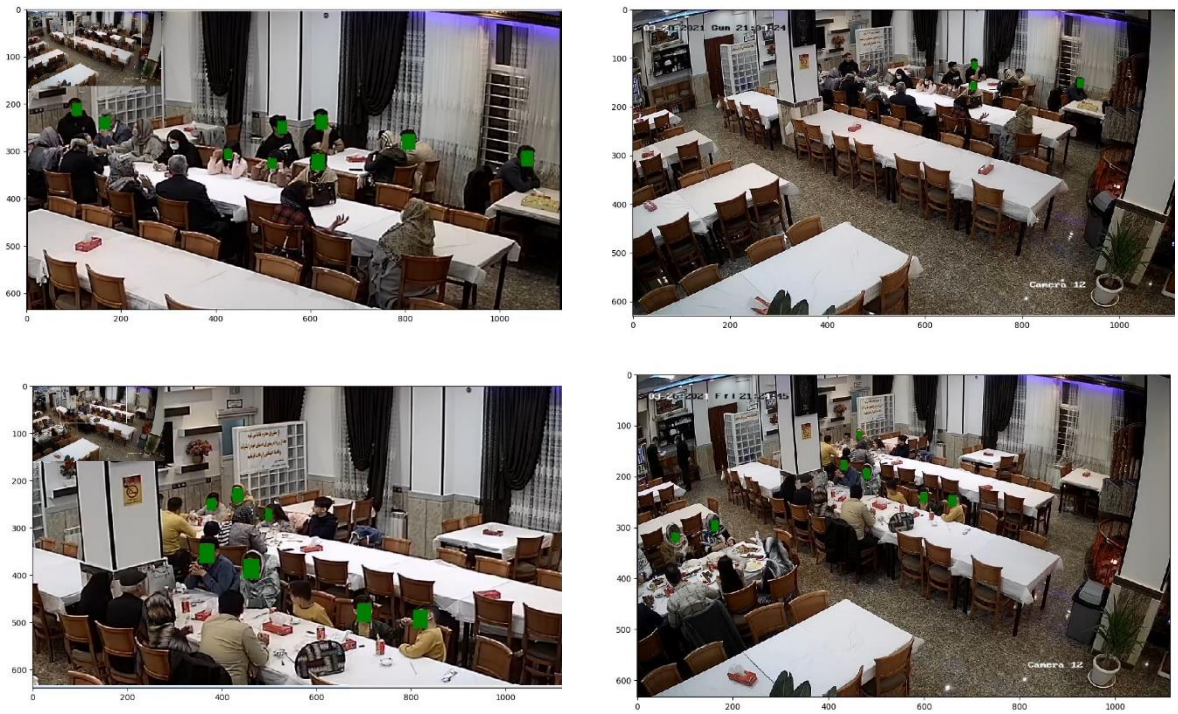


Fig 1: The result of recognizing people from the machine vision method

During robot routing, the LED color embedded in the bottom of the robot indicates trouble-free routing in the robot. The LED will be red and the robot will stop if the robot is less than 20 cm away from the obstacle. And if the distance is 30 cm, the LED turns green, and if the distance is between 20 to 30 cm, the LED turns yellow.

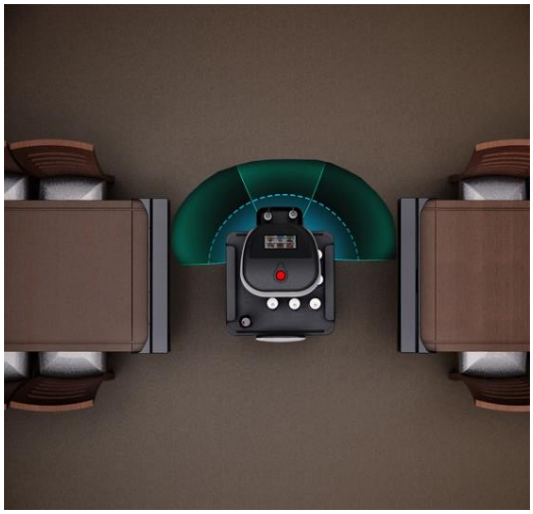


Fig 2: Robot routing and obstacle detection

The flowchart of how the automatic restaurant system behaves is shown Fig.3:

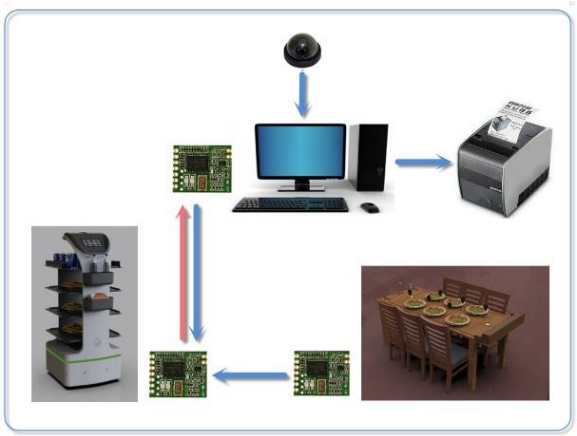


Fig 3: Robot working flowchart

Automatic Table operation method

After customers leave the table and confirm that the table is empty using infrared sensor feedback, the table is automatically cleared by a moving box attached to the table, by first opening the trash can lid, then the garbage and food waste are then transported to the trash by the moving part of the table. When the moving box returns to its original location, the trash can lid closes and the moving box begins to spray alcohol to disinfect the table and prepare it for the next customer. After returning the moving part to the starting point, the table is ready to receive new customers.

At the end of business hours, the restaurant owner can find out the actual number of people who have eaten in the restaurant during the day by using the feedback of infrared sensors in front of each seat, and through recorded statistics to strive for the prosperity of their business.

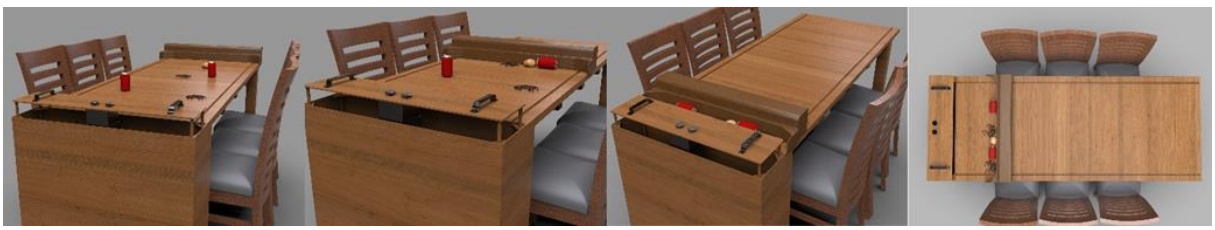


Fig 4: Self-cleaning table method

Routing a Waiter Robot

For customer service and easier access to the robot, three paths are provided, which you can see in the figure below. The first route is displayed in red for the three tables to the right of the restaurant. The second path, shown in green, is for the two middle tables, and the third path, shown in blue, is for the three tables on the left. The routing of the robot is selected according to the position of the table and the robot moves towards the table.

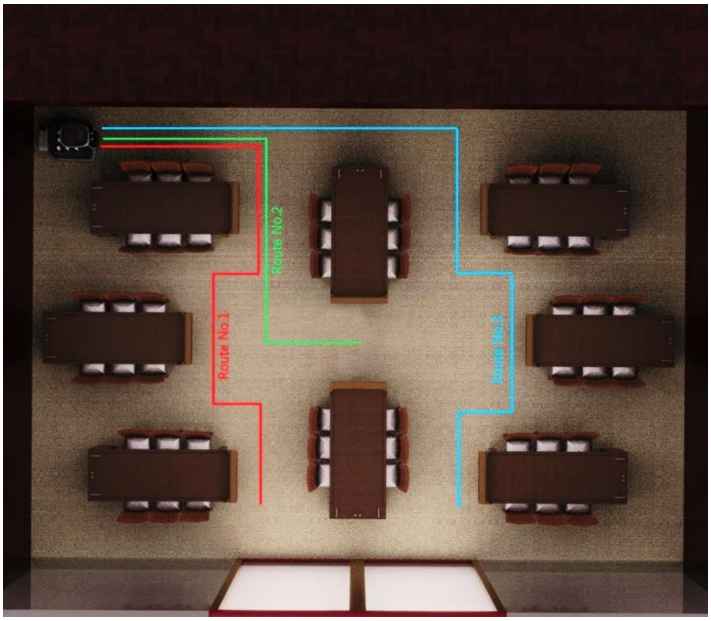
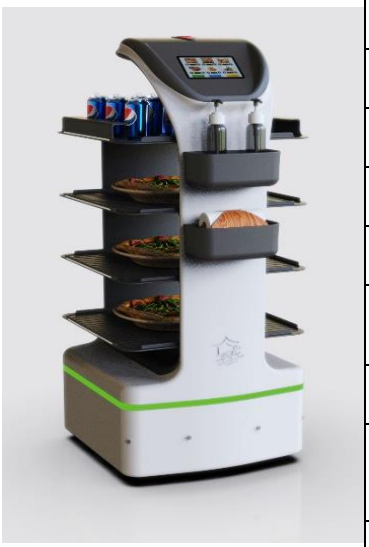


Fig 5: Waiter robot movement paths

Technical Specifications robot



Machine Dimensions :	590*550*1300 mm
Robot Weight :	51 Kg
Machine material :	ABS
Charge Time :	3.5 H
Battery Life :	12-24 H (Replaceable Battery)
Safety :	0.4- 1m/s (Adjustable)| Climbing Angle <=5‘
Load Capacity :	35 Kg
Tray:	Edged: 1 No edge: 3
Boxes Health:	2

This robot has four trays, one of which is designed with an edge, which is for carrying drinks to prevent them from falling and spilling along the way, health boxes are included to prevent the spread of the corona virus, which includes disinfectants, gloves and masks. You can see the complete specifications in Table.1:

Table 1 Technical Specifications robot

Mechanical design

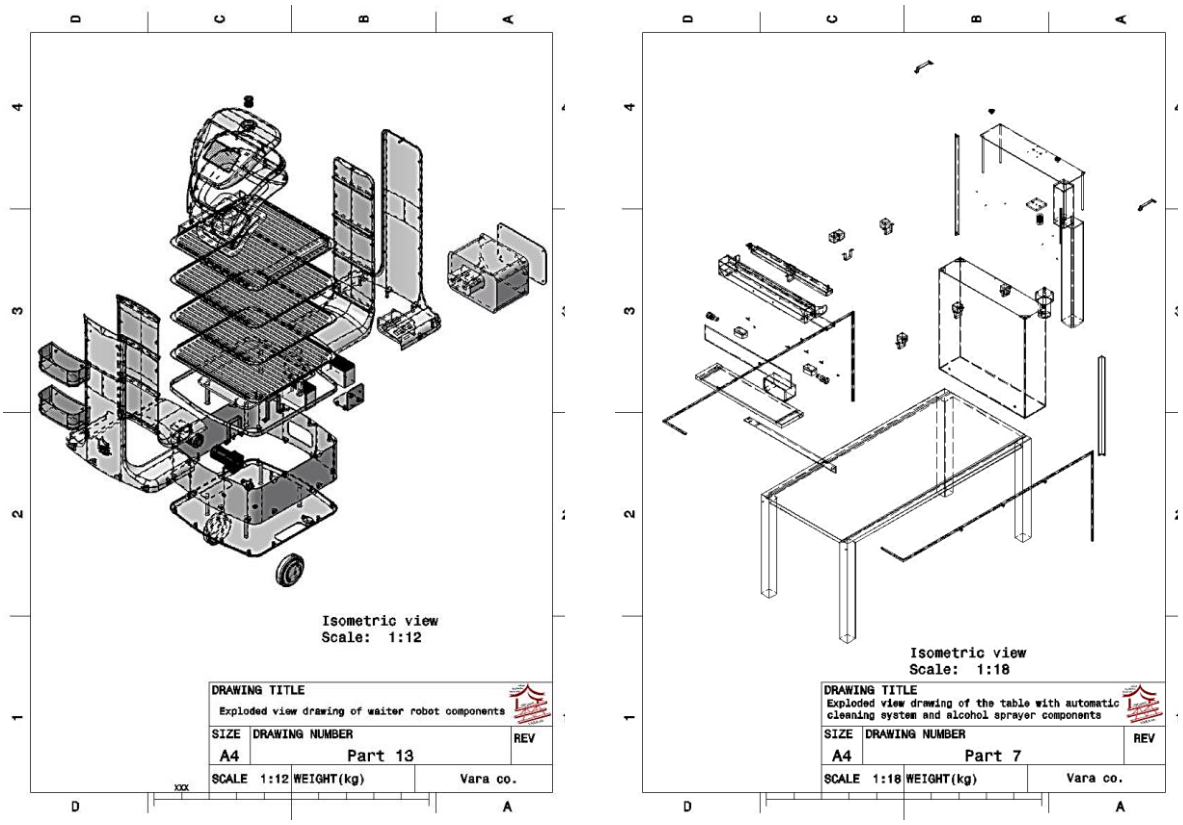


Fig 6: Explosive drawings of a waiter robot and a self-cleaning table

Conclusion

In this study, customer entry to the restaurant was recorded using machine vision and image processing knowledge, and the number of customers was detected using an infrared sensor and sent to the central system, and the robot moved to receive the order. The self-cleaning table was also designed to be sprayed with alcohol to automatically clean the table to prevent the spread of coronavirus.

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