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Design and Development of an Automated Food Cart for Small-Scale Restaurant: An Experimental Prototyping

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Abstract:

The automated food cart is capable of following a line and detecting an object and designed based on Arduino Mega microcontroller unit with an ultrasonic distance sensor for sensing objects, IR sensors as its primitive reactive sense to follow a line. The automated cart used a Motolite battery as its main power source that is responsible for the movement of the output. There are two fixed wheels that are directly connected to the DC Motor and this is paired by a caster wheel. This automated food cart used Arduino 1.6.9 programming software which is compatible with the Arduino Mega microcontroller that is programmable in C Language. The prototype is low cost compared to the existing product with the same output in terms of performance. This research lessen the human intervention giving the owner high profit less the cost on staff in the long run. On the other hand, this automated food cart can only carry a reasonable amount of food .It has also a limited speed to transfer food from one point to another. Lastly is, it can only perform its' task in a flat horizontal surface.

Keywords — **Automated Food Cart, Food cart, Microcontroller-based food cart**

I. INTRODUCTION

The term robot comes from the Czech word robota, which means forced labor or subservient labor. In Czech, a robotnik is a peasant or serf (Gibilisco, 1994). In popular culture, the term robot connotes some anthropomorphic (human-like) appearance. The word robot came into popular consciousness on January 25, 1921, in Prague with the first performance of Karel Capek's play, R.U.R (Rossum's Universal Robots) (Concise International Encyclopedia of Robotics, 1990).

Just like humans, robots would not function without a brain which is the program. Without it, the whole system will be useless. A program is a series of specific set of instructions for a computer to perform. There are a lots of application software that could be used to program a certain device, like a computer or a robot.

One of the most popular businesses today is food related business, restaurants for example. The conventional way in serving food in a restaurant is through our waiter and waitresses. These people are paid to render services to the costumers.

The premise of the study includes the design, development, and evaluation of an Arduino-based automated restaurant food cart. To the academe, it could be used as an instructional material, it would also promote our course in pursue of continuous excellence in the field of Robotics. Lastly, to the entrepreneur it would entice them to invest on something that will attract the costumers.

The coverage in this study includes the capability of the cart to follow a straight and curve line. The obstacle sensor, which is placed in front of the cart, can detect object and stops 70 cm away from it. It can only operate on a flat horizontal surface. The IR Infrared sensor can detect a white line on a black surface and communicates via light. This study is limited to the speed of the cart to move from one point to another. Another limitation of this study is

that the cart can only carry reasonable amount of food.

II. METHOD

A. Robot Design

Several factors shall be considered in designing the robot. The design must be suited for the allocated budget of the researchers. Moreover, the design must connect the objectives of the study.

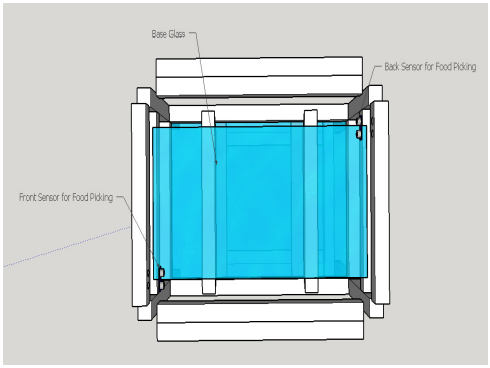


Fig. 1 Top View

Fig.1 shows the top view components, two ultrasonic sensors are placed parallel to each other which are located at the cart's handle. When these sensors detect the hand of a person, the cart will stop and if the sensors can no longer sense an object within 10 seconds which is the delayed time, the cart will continue to move forward. The center part of the cart in the uppermost level is made up of a clear glass. This is where food is placed. The researchers decided to make this prototype rectangular in shape considering its stability.

Fig. 2 shows the middle part or the second layer of the cart. Basically, the middle part of the cart is just an additional space where food can be placed if ever the uppermost level lacks for a space. However, for the convenience of both parties, this part could also be used as a space where utensils like fork and spoon can be placed. This layer is also made up of a clear glass

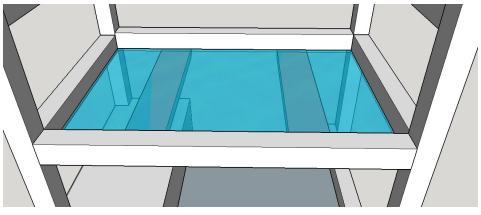


Fig. 2 Second Layer

Fig. 3 shows the switching components of the cart. Start button will be used for switching on and off of the cart, while the indicator will be used to show the status of the battery and the amount of voltage present in the system. Both components are directly connected to a 12 volts battery

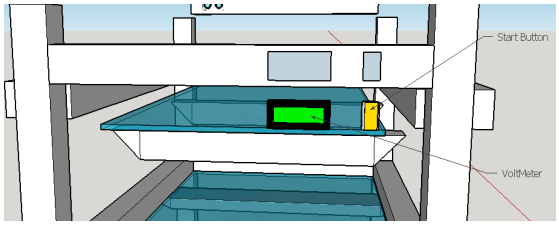


Fig. 3 Switching Components

Fig. 4 show that the automated restaurant food cart used ultrasonic sensors as its reactive sense for obstacle avoidance. A microcontroller is used to achieve the desired operation. There are two ultrasonic sensors attached in front of the robot.

When the robot is going on the desired path, the ultrasonic sensor transmits the ultrasonic waves continuously from its sensor head. If an obstacle blocks the way of the cart, the ultrasonic waves are reflected back from an object and that information is passed on to the microcontroller. The microcontroller is tasked to stop the cart when an obstacle is detected and to continue moving if there's none.

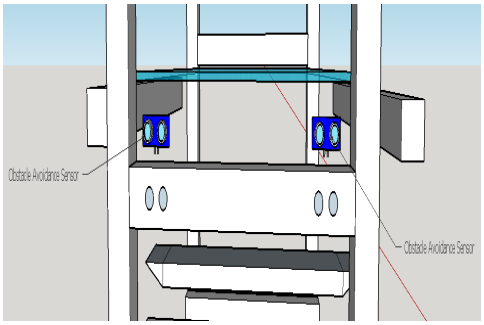


Fig. 4 Obstacle Avoidance Components

As seen in Fig. 5, the cart is composed of four (4) wheels. Two of them are directly attached to the DC motors and installed in front of the cart and the

two other wheels are the caster wheels which are installed at the back part of the cart. The movement of this free wheel depends on the direction of the fixed wheel. These fixed wheels can either go left or right. When it is moving towards left, the left wheel will stop while the right wheel continues to move and vice versa

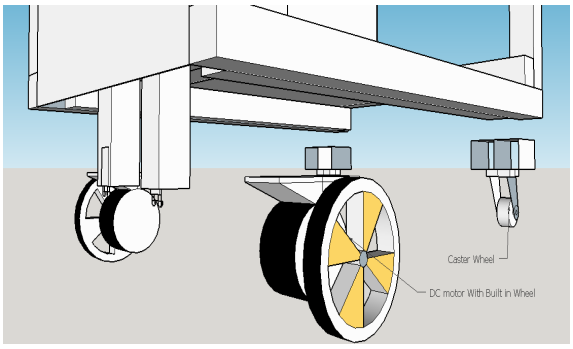


Fig. 5 Steering Wheel

Fig. 6 shows the line following components; there are two IR sensor modules, one for each side. The IR Infrared sensor can detect white line on a black surface and communicates via light. When both left and right sensor senses white line then robot moves forward. If in case either of the two IR sensors detected black line, it will move either way to look for a white line to follow. If both sensors pass on a black line, the cartwill stop.

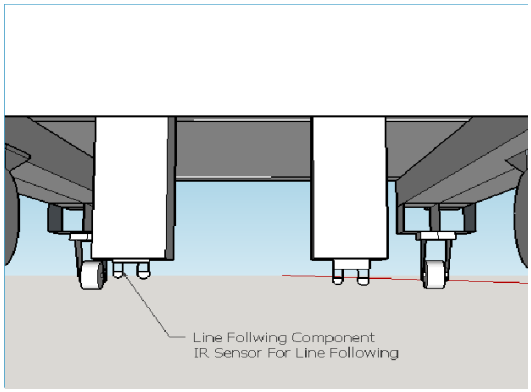


Fig. 6 Line Following Components

B. Robot Development

The isometric view of the project as shown in Fig. 7 is made up of 2x2" aluminum square, 41 inches in height and 32 inches in width and it has three levels. The height of the first level to the second level is 12 inches and the second level to the last level is 10.2 inches high. Each level is covered with different materials. The first and second level is covered by a clear glass and the last one is covered by a steel plate; each plate has a dimension of 36 x 48 inches. ADC motor which has a high torque is paired by caster wheel. An ultrasonic sensor is placed at the second level in front of the cart to detect or sense an object along its way. The component of the external part is placed at the third level covered by a steel plate. Fig. 7 shows the exploded view of the design. Each material is exploded in each of its design component to give emphasis both in internal and external components of the prototype. Exploded view clearly shows where the internal and external components of the cart are placed.

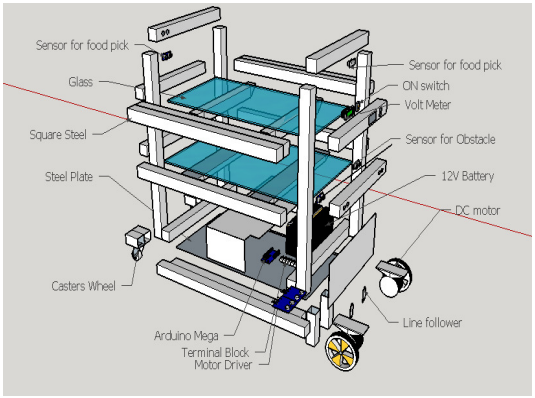


Fig. 7 Isometric View

C. Program Flow

The program is carried out by the robot which is based on the overall operation described by the design. With the operational flow, the program will be developed accordingly. Errors in the program will debug to achieve the robot's functionality.

The program flow of the project as shown in Fig. 8 describes how the robot moves through its corresponding conditions. From the start, the cart will move when the two (2) sensors for the line following detects the color white that will make the two (2) motors on. As the cart moves freely through the line, the cart will stop when the sensor placed at the front of the cart detects an object and moves immediately as the sensor undetected the object. And as the sensor placed at the sides of the cart detects an object, the cart will stop and moves

immediately if the sensor undetected the object. But if the costumer will pick for food, the sensors placed above the cart will detect the object or the hand of the costumer and it will stop the within 10 seconds if no objects are detected.

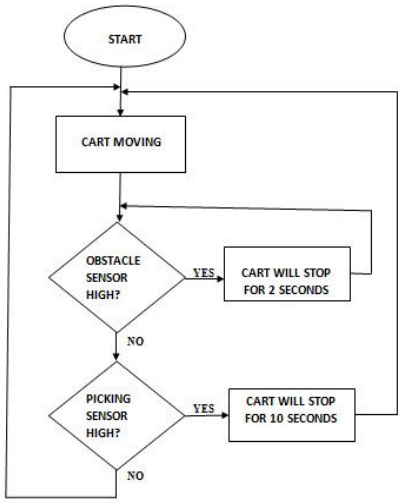


Fig. 8 Process Flow of the Automated Food Cart

III. RESULTS AND DISCUSSION

A. Design and Development

These figures illustrate the researcher's design of the finished prototype or the actual appearance of the automated food cart that follows line with obstacle avoidance.

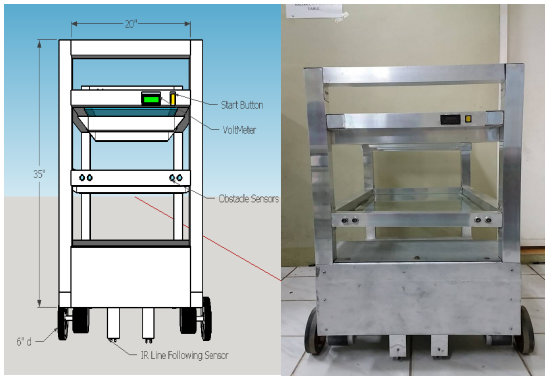
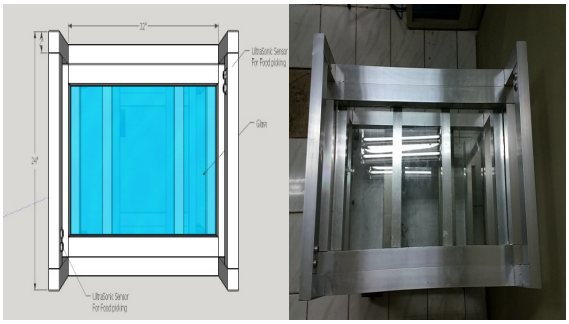


Fig.9 Front view of the Design

The front view of the cart as shown in Fig. 9 has the following dimensions: 41 inches in height and 32 inches wide. The cart has three levels; the distance from the third level to the second level is 17.20 inches. An ultrasonic sensor is placed in front to detect an obstacle, and if the sensor will detect an object, the cart will automatically stop. The two (2) IR sensors located below the cart are used as line following sensors. The wheels used in front are a DC motor because of its ability to carry heavy weight and it is where the internal components are placed

Fig. 10shows the top view of the cart. It is made up of aluminum square with a dimension of 32x20.4 inches. There are two (2) ultrasonic sensors located at the top of the cart. Both sides have one sensor each. These sensors are used when someone is picking a food. Whenever it can detect something, the cart will stop. After 10 seconds when it can no longer sense an object it will then continue to move forward.

Fig. 10 Actual Top View



The right-side view of the cart as shown in Fig. 11 has a dimension of 41 inches by 32 inches. It has three levels, 12 inches high from the third level to the second level and 10.2 inches high from second level to the last. The cart used two (2) DC motor in front paired by a caster wheel at the back

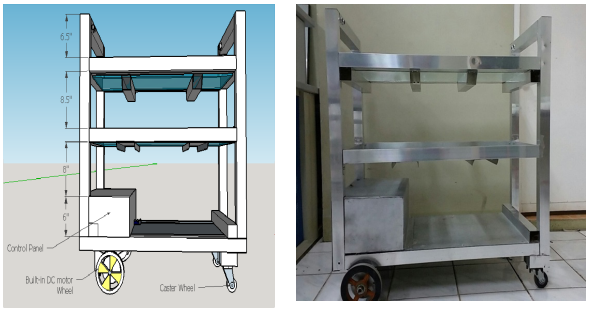


Fig. 11 Actual Side View

IV. CONCLUSIONS AND RECOMMENDATIONS

The automated cart functionality proved to be very reliable. The cart cost was kept to a minimum, despite the use of costly line sensors for providing crucial information regarding the location, the object sensor in which to detect the object inside the line track, and wheels into life and the last one is Arduino microcontroller that seeks to provide the brain of the automated cart functionality.

The overall study of this project was suitable in the assumption, in which theautomated cart was accomplished the equitable task made.

In the completion of this study presented the design and development of a line follower with obstacle avoidance mobile robot established several recommendations in automated cart parts, materials and overall process of the design.

The material suggestions and recommendations were based upon the evaluation conducted. Here are the proposal and request for improvement:

1. Definite design of the automated food cart body to make sure that the foods are covered up ensuring that foods are free from dirt.

2. To make sure that the cart will follow a curve line, instead of using a caster wheel, paired the fix wheel in front with a pololu ball caster.

In the overall process the study recommends further study for the improvement of the design and its main parts for more secure and functional automated food cart that follows line with obstacle avoidance.

The study conjointly seeks to cultivate the next batch of researchers to a higher learning in the prototyping projects of the students of University of Science and Technology in Southern Philippines.

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