Smart Online Shopping Cart

S.M. Tahmeed Reza
Department of Electrical & Electronic Engineering
Bangladesh University of Engineering & Technology
Dhaka, Bangladesh
1906149@eee.buet.ac.bd

Manjur Muntasir
Department of Electrical & Electronic Engineering
Bangladesh University of Engineering & Technology
Dhaka, Bangladesh
1906150@eee.buet.ac.bd

Samia Akter
Department of Electrical & Electronic Engineering
Bangladesh University of Engineering & Technology
Dhaka, Bangladesh
1906151@eee.buet.ac.bd

Md. Aktarujjaman Swan
Department of Electrical & Electronic Engineering
Bangladesh University of Engineering & Technology
Dhaka, Bangladesh
1906152@eee.buet.ac.bd

Md. Asif Kabir
Department of Electrical & Electronic Engineering
Bangladesh University of Engineering & Technology
Dhaka, Bangladesh
1906153@eee.buet.ac.bd

Tamim Hasan Bhuiyan
Department of Electrical & Electronic Engineering
Bangladesh University of Engineering & Technology
Dhaka, Bangladesh
1906154@eee.buet.ac.bd

***Abstract*— This paper presents the design of a smart shopping cart that can be accessed by customers through e-commerce site of a retail store. The design completely automates the shopping experience with live footage of products being picked up after the order is placed. A prototype is built where the cart is carried by a line follower. Equipped with a mechanical arm and a camera that can live stream the robot's activity to the customer, this design could be an extremely important leap forward in automation in retail stores during pandemics and to empower differently abled customers check the quality of the products they buy without being physically present at the store. Overall, this system will ensure that the customers will have the best shopping experience.**

Keywords*— *Shopping Cart, automated, user friendly, feasible

I. INTRODUCTION

With profits from e-commerce surging in a global pandemic, the lesson for retail stores is that automation and product integrity is key in thriving in the business. Moreover, these stores have an untapped market of differently abled people who don't have the option of choosing to go to a physical store to ensure the quality of the product that they are buying. Worldwide online shopping has taken prevalence over physically going to stores to choose items when available. With this work, we look to bridge the gap in between the shopping experience from online and grocery shopping and get the best of both worlds to improve the shopping experience.

With our prototype, the customer can place their order from an e-commerce site where the products available in the physical store are displayed. The order is received by the cart in the store, and it moves through the shop following lines along the aisles. As it reaches a particular product that was ordered, it live streams the product with a camera to the site that the customer is on. If the customer is happy with the quality of the product, then the robot picks it up with the help of a mechanical arm with five degrees of freedom and moves on to the next product.

II. DESIGN DESCRIPTION

A. Website for customer

First, we designed a website with the product available to the shopping mart. In the website interface, customers can choose the product with desired quantity. The customer will be able to access the site of the shopping cart using any LAN connected mobile or computer devices. On this website, there will be ways for the user to find items they are looking for. Then he can confirm the purchase and thus the order of product will be completed. Another feature of the website is that it can take the video of the product by live streaming. So users can easily visualize the product before cancelling or purchasing it.

B. Line follower robot

The line follower robot can detect and follow the line drawn on the floor. Generally, the path is predefined and can be either visible like a black line on a white surface with a high contrasted color or it can be invisible like a magnetic field. The robot should sense the line with its infrared ray (IR) sensors installed under it. After that, the data is transmitted to the processor by specific transition buses. Hence, the processor is going to decide the proper commands and then it sends them to the driver and thus the path will be followed by the line follower robot. As the location of each product is fixed in a retail store, line following is a good strategy for efficient movement of the cart.

C. Robotic Arm

Robotic arms are programmed to execute a specific task or job quickly, efficiently, and extremely accurately. Generally motor-driven, they're most often used for the rapid, consistent performance of heavy and/or highly repetitive procedures over extended periods of time. They closely resemble a human arm, having a wrist, forearm, elbow, and shoulder. The different

joints allow them the required degrees of freedom of movement. In the project we design such a robot that can pick a weight up to 400 g and put it in the cart.

III. Methodology of the Project

A. User interface

The website is an extremely important part of our design idea. The website links all the other features together and allows the customers to use them. Because of how important the website is, we need it to be as user friendly as possible so the clients will have an easy time navigating the website to utilize our other features in helping them shop more efficiently.

To design our website, we used HTML,CSS and JavaScript. For communication between the robot and the website we used the WebSocket protocol.

HTML was used to provide the site structure, CSS was used to stylize the site. The interactive features of the website was designed using JavaScript.

Our website provides the customer with a list of products along with their images in the homepage. The customer can choose their favorite groceries and place them in the cart. They can then increase the quantity of the products in the cart and remove any item. They are then redirected to the confirmation page where they can send the order to the shop and see the live stream of the robot.

Another key feature of the website is the customer feedback to the robot. We offer the customer a chance to cancel or remain with their order after they have had a good look at a particular product from the live stream. With this feature we have empowered the online shopper to judge the quality of any product in real time.

The website hosting and site to robot communication is done using the ESP32 (ESP WROOM 32) WiFi & Bluetooth Dual-Core MCU Module.

B. Line follower robot to reach the desination

In the Arduino based line follower robot**,** we have used IR transmitters and IR receivers also called photodiodes. They are used for sending and receiving light. IR transmits infrared lights. When infrared rays fall on the white surface, it's reflected and caught by photodiodes which generate some voltage changes. When IR light falls on a black surface, light is absorbed by the black surface and no rays are reflected, thus the photodiode does not receive any light or rays. Here in this Arduino line follower robot when the sensor senses white surface then Arduino gets 1 as input and when senses black line Arduino gets 0 as input.

1) Sensor Section: This section contains IR diodes, potentiometer, Comparator (Op-Amp) and LED's. The potentiometer is used for setting reference voltage at comparator's one terminal and IR sensors are used to sense the line and provide a change in voltage at the comparator's second terminal. Then the comparator compares both voltages and generates a digital signal at the output. Here in this **line follower circuit,** we have used two comparators for two sensors. LM 358 is used as a comparator. LM358 has inbuilt two low noise Op-amps.

2) Control Section: Arduino Pro Mini is used for controlling the whole process of the line follower robot. The outputs of comparators are connected to digital pin numbers 2 and 3 of Arduino. Arduino read these signals and send commands to driver circuit to drive line follower.

3) Driver Section: The driver section consists of two motor drivers and four DC motors. The motor driver is used for driving motors because Arduino does not supply enough voltage and current to the motor. So we add a motor driver circuit to get enough voltage and current for the motor. Arduino sends commands to this motor driver and then it drives motors.

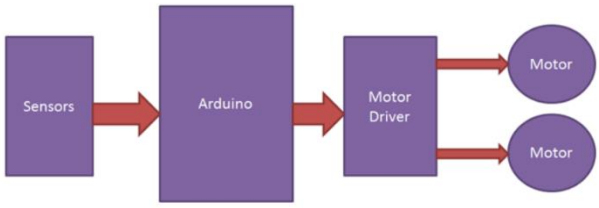


Fig. 1. Flow diagram of Line follower robot's mechanism

C. Product visualization

ESP32 CAM Wi-Fi Module Bluetooth with OV2640 Camera Module 2MP for product visualization has an extremely competitive small camera module that can be operated independently as a minimal system. It provides a deep sleep current of up to 6mA and is widely used in various IoT applications.

Suitable for smart home devices, industrial wireless control, industrial wireless control, wireless monitoring and other applications. ESP integrates Wi-Fi, traditional Bluetooth and BLE beacons with two powerful 32 bit LX6 CPUs and 7 stage pipeline architecture. It has a main frequency adjustment range of 80MHz to 240MHz, on chip sensor, Hall sensors, temperature sensor and more. As we are powering the ESP32-CAM using the 5V power pin the FTDI adapter must be set to a 5V VCC output. 5V setup is recommended as it increases the range without the end of an external antenna. While programming the EPS32-CAM, we need to note that GPIO 0 is connected to ground.

D. Pick up the product to cart

The basic principle of most of these designs is on similar lines. These robots are typically mounted on a stable stand, and have a long arm that can reach their entire area of operation. The end of arm attachment is specialized to the type of objects the robot intends to move.

These robots can transfer items from a stationary surface to a stationary surface, stationary to a moving surface, moving to a stationary surface, and moving to a moving surface (such as between two conveyor belts).

A pick and place robot has several dedicated parts, such as:

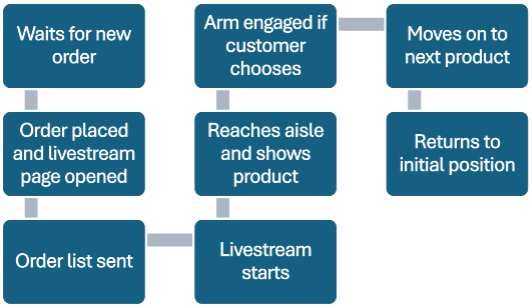
1) Robot Arm tool: A robotic arm, also known as a manipulator, is the extension of the robot by using cylindrical or spherical parts. links, and joints.

2) End Effector: The end effector is the accessory at the end of the robotic arm that does the required job such as gripping objects. The end effectors can be designed to perform different functionalities based on requirements.

3) Actuators: Actuators create the motion in the robotic arm and end effectors. The linear actuators are basically any type of motor, such as servo motor, stepper motor, or hydraulic cylinder.

4) Sensors: You can think of sensors as the eyes of robots. The sensors do the tasks like identifying the position of the objects.

5) Controllers: Controllers synchronize and control the movement of different actuators of a robot, thereby being the brain behind the smooth robotic operation.



IV. Implementation of the Design

Smart Online Shopping Cart Project is conducted to prevail automation and make people's life easier. This cart is designed to carry up to 1 Kg items in it with the average speed of 1 meter per second. A robotic arm is designed for this cart to pick up objects and put them in the cart's basket up to 400 grams. Choosing the correct motors and location of them is a crucial task as the cart does not have a symmetric shape.

A. Website and product's video streaming

We built a Wi-Fi remote controlled car robot with the ESP32-CAM. We'll be able to control the robot using a web server that displays a video streaming of what the robot "sees". We can control our robot remotely even if it's out of our sight. The ESP32-CAM will be programmed using Arduino IDE.

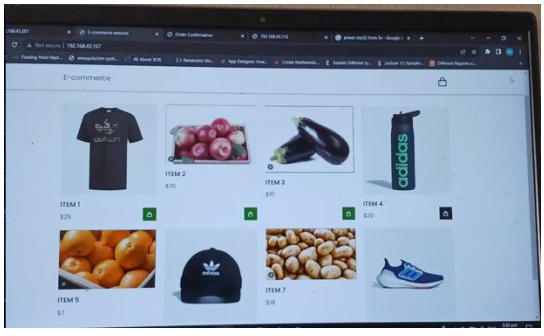


Fig. 2. Website design

Fig. 3. Video streaming

B. Line follower configuration

In this line follower robot, we use IR transmitters and receivers (photodiodes). They are used to send and receive the lights. When IR rays fall on a white surface, it is reflected towards the IR receiver, generating some voltage changes.

When IR rays fall on a black surface, it is absorbed by the black surface, and no rays are reflected; thus, the IR receiver doesn't receive any rays.

In this project, when the IR sensor senses a white surface, an Arduino gets 1 (HIGH) as input, and when it senses a black line, an Arduino gets 0 (LOW) as input. Based on these inputs, an Arduino Uno provides the proper output to control the bot.

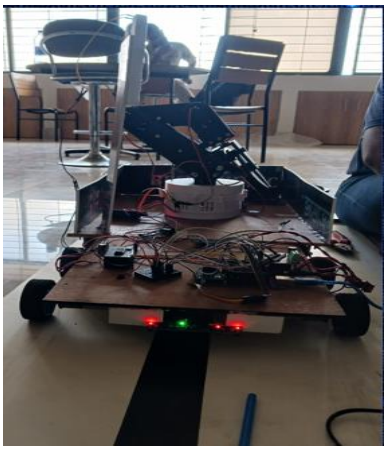


Fig. 4. Line follower robot

C. The robotic arm

The hardware used to control the movement of the robotic arm consists of a Robotic Arm, Remote control, IR receiver, Arduino Uno board and Shield board. Also, Arduino IDE or Integrated Development Environment is used as a software platform to upload the robotic arm program.

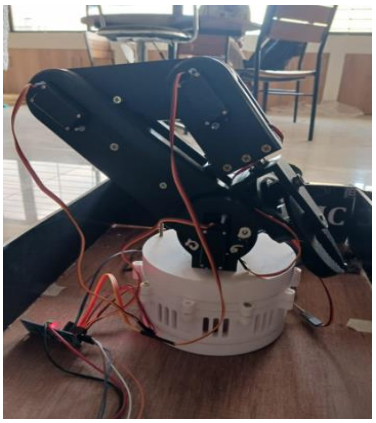


Fig. 5. Robotic arm

Conclusion

The presented prototype is a novel solution to the problems faced by retail stores both small and large. It has a simple design and can be adapted to operate in any architectural design of the shop. It is designed to carry any reasonable amount of products on the cart. Integration with delivery services will lead to complete automation of the shopping experience while ensuring product quality. The implementation of the prototype can decrease the required manpower to operate the shop.

References

[1] Y. Nagumo and A. Ohya, "Human following behavior of an autonomous mobile robot using light-emitting device," in Robot and Human Interactive Communication, 2001. Proceedings. 10th IEEE International Workshop on, 2001, pp.225-230.

[2] T. Yoshimi, M. Nishiyama, T. Sonoura, H. Nakamoto, S. Tokura, H. Sato, et al., "Development of a Person Following Robot with Vision Based Target Detection," in Intelligent Robots and Systems, 2006 IEEE/RSJ International Conference on, 2006, pp. 5286-5291.

[3] T. Kohtsuka, T. Onozato, H. Tamura, S. Katayama, and Y. Kambayashi, "Design of a Control System for Robot Shopping Carts," in Knowledge- Based and Intelligent Information and Engineering Systems. vol. 6881, A. König, A. Dengel, K. Hinkelmann, K. Kise, R. Howlett, and L. Jain, Eds., ed: Springer Berlin Heidelberg, 2011, pp. 280-288.

[4] D. Schulz, W. Burgard, D. Fox, and A. B. Cremers, "Tracking multiple moving objects with a mobile robot," in Computer Vision and Pattern Recognition, 2001. CVPR 2001. Proceedings of the 2001 IEEE Computer Society Conference on, 2001, pp. I-371-I-377 vol.1.

[5] F. Hoshino and K. Morioka, "Human following robot based on control of particle distribution with integrated range sensors," in System Integration (SII), 2011 IEEE/SICE International Symposium on, 2011, pp. 212-217.

[6] M. Bigos, J. Doiron-LaRue, R. Mui, E. Wu. (2011). Final Project Report: Cart-A-Long. [Online]. Available: http://www.ecs.umass.edu/ece/sdp/sdp11/pishro-nik/FPR.pdf