CONTACTLESS DELIVERY ROBOT

SYSC 4907 ENGINEERING PROJECT PROPOSAL

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ABSTRACT & INTRODUCTION

Because of the prolonged epidemic, the government carried out lock-down policies to reduce exposure at different stages. Many stores lay off staff or significantly reduce the number of employees, making it very hard to keep the original and steady customer load. Also, during this period, people are more and more used to a shopping mode called “curbside pickup” where we order the product online and wait in the parking spot outside the store for pickup. All of these stimulate the thinking about the application of robots in maintaining service inside and outside the store for delivery. In this project, we mainly propose a “contactless delivery robot” used for curbside delivery.

During the cold and long winter in Canada, the use of robots for curbside delivery can ease the situation where a single staff needs to handle both indoor and outdoor service, as well as balance the labor demand both inside and outside of the store. It can also reduce the waiting time for pickups and the risk of infection due to personal contact during delivery. In summary, the proposed approach has some potential for commercial applications.

REQUIREMENTS & DELIVERABLES

Based on what we discussed in the introduction, the robot is designed as a head of a short-length train. It starts with moving to a specific area waiting for loading. Usually, the waiting-for-loading area is something that can be “defined” and “told the robot” by the store. Once the products have been loaded into the cabin, the robot will have to pair the cabin number with the product code for precision delivery. After it is fully loaded, it can be waiting around the curbside pickup area. When the customer arrives at a pickup spot, they will send a confirmation message with the spot number to the store server, which is then sent as the delivery instruction to the robot. The robot will follow the delivery instruction and direct itself to the specific parking spot. To process the delivery and make sure the customer pickups his and only his products, the robot will ask the customer to input his product code, then find the matched box for pickup. Upon finish, the robot needs to send an identification message to the store server indicating which product has been delivered/ which cabin is empty. Then, if no new delivery instruction is received, the robot can move back to the loading area for new product loading in the empty cabin. Otherwise, head for the next delivery. Attached below, is the designed workflow for the contactless delivery robot.

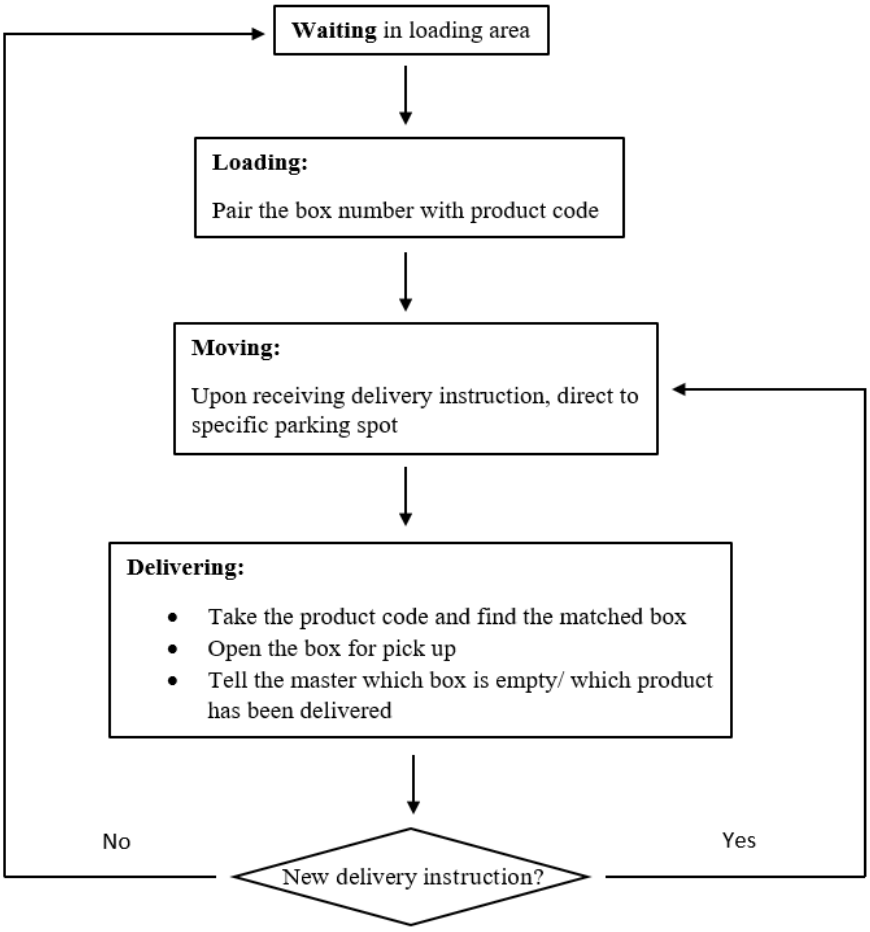

Figure 1. workflow chart

DESIGN PLAN

To achieve our goals, we decided to start the design from the most fundamental function of our robot: mobility by users' instructions in a particular condition. We don't go straight to design our robot but create a relatively small, simple, and extensible prototype. The prototype only needs to move under our manual control, such as RF and Bluetooth wireless remote, in a limited room condition like indoor places with less interference from temperature, humidity, and weather change. Arduino motherboard, extension board, motors, and some plugs about remote control will be used in this stage. After completing the prototype, we then design some routines and store them into its memory to move automatically along with multiple lines and directions. In this case, we only need to set a destination, and the "car" can drive there without any more instruction code. In this stage, ambient is also relatively ideal with less interference. After the

plans mentioned above are finished, we can now move our robot outside by adding sensors like temperature, line tracking, ultrasonic sensor (to detect distances), etc., on the Arduino motherboard or extension board. Now the robot can analyze and adapt to the outdoor environment using sensors. We will still design a shield for the robot and choose environmentally friendly material. More than three alternatives for the material will be considered to optimize cost and endurances. The hardware part is almost completed except some calibration on the routines and sensors. Then, we need to design a software user interface that collects customers' park positions number and order numbers. An interface used by stores will also be designed so that store workers can enter park position numbers after load delivery on it.

METHODOLOGY

To properly finish this project, we decided to assign different work to every group member and cooperate. Since all four of our group members are in the Electrical Engineering program, it will not be very hard for us to communicate and understand each other's ideas. We decided to work in two different aspects: the software and the hardware. The two members of the software group will be working on developing functions of instruction receiving and sending, product box matching, pathfinding, and customer identifying. The hardware group will focus on making the delivery robot's hardware part which includes the processing and command unit (Arduino), the antennas, the delivery platform (motors, batteries, wheels, steering system). These essential functions of our automatic delivery robot are based on Arduino, which we have already used in the 3rd year's project. We would also use all the coding skills, all the hardware assembling, and developing techniques we have learned in the past few years. Our group is skillful enough to develop with Arduino and combine it with other hardware.

ABOUT US / TEAM

ZHUOXIN MA

As a fourth-year Electrical Engineering student, the robot is designed to use Arduino as the motherboard which I have been exposed to in the course ELEC 3907. The GPS navigation system and the sensor system used for detecting potential collisions are also something that I have learnt in the third-year engineering project. Applying this knowledge to this project, the

robot can have a better navigation functionality. As I have been a team leader for several engineering projects, I am also confident in giving a good organization and integration among all members in this group. Furthermore, the skill of independent research developed during various engineering courses will help with facing many potential obstacles and problems during the implementation of the project.

YUCHEN MIAO

As an Electrical Engineering student, with all the knowledge and skills that I have learned in the past several years, I can make my own contribution to this project and my group. I have learned a lot of useful knowledge about how to combine hardware and software together. Verilog is the language I learned and practiced when I was taking the ELEC 3501 course, it not only taught me how to use Verilog to control FPGA chips, but also gave me experience on coding for hardware, which is what we are doing in this project, we will use coded chips to control our delivery robot; and in the ELEC3907 project, I learned how to use Arduino, and Arduino is what we chose for our delivery robot as the processing center. I will use my experience and coding skills on developing the remote-control function of our robot.

LANG SUN

Lang Sun, majored in undergraduate Electrical Engineering Program, is planned as a hardware designer in this project. The integrated circuit and digital circuit development ability, related to previous course ELEC 2607, ELEC 2507, SYSC 3006, ELEC 4601, ELEC 3500, should be demonstrated. C-based Coding skill, related to course ECOR 2606 and SYSC 2400, should be implemented in this project. The project management skill, teamwork, and engineering design ability from ELEC 3907 should be illustrated. Therefore, if all stated aspects are satisfied, the capability as a hardware designer is proven.

YICHEN XIAO

As a fourth-year student of Electrical Engineering at Carleton University, I have acquired the knowledge and skills that are applicable to this project. I learned a lot about hardware implementation, designing circuits, software programming, system control and computer communication. From my understanding of this project, this project involves creating a delivery robot for customers who drive cars to supermarkets or stores. Customers can order items to pick up in the park outside the store. The store can send items to a customer's parking spot by the

robot. The project needs hardware combination, app interface designing, and system control by programming, and I can utilize my acquired knowledge on this project. Also, the robot applies Arduino as the main motherboard, and I have experience using it in my ELEC 3907 course in the 2020/2021 winter term. Furthermore, I can enhance my team communication skills, engineering report writing, problem-solving, data analysis, and oral presentation in this project. More importantly, I can also gain new experience outside of lectures, such as learning different electronic elements like sensors, new program languages, and exploring application integrations.

TIMELINE & MILESTONES

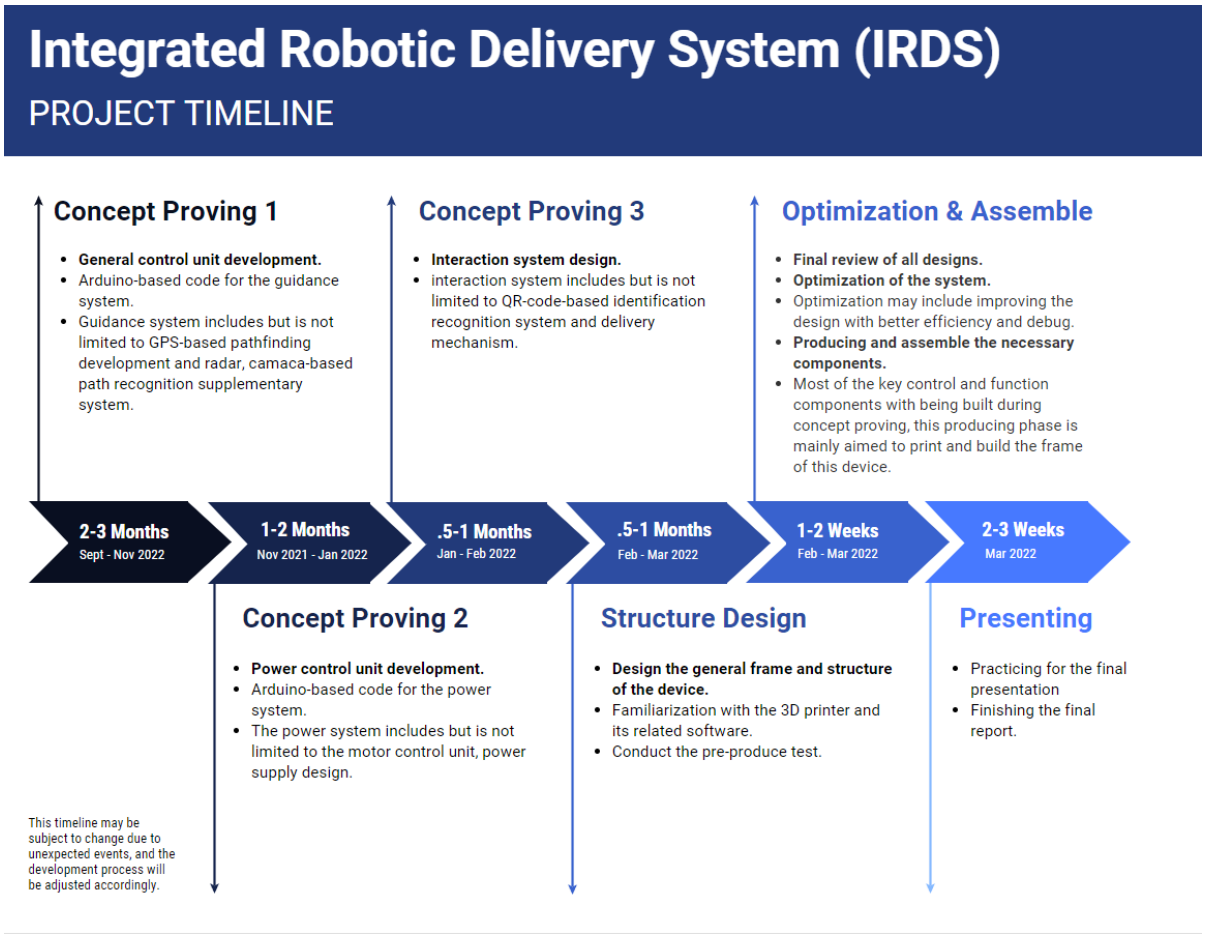

Figure 2. Timeline & Milestones

RISKS

While working on this project, there could be risks happening at any time if our team members are not careful enough, especially we are working on the project at home instead of the professional university laboratory. To avoid potential risks, we need to consider them in advance and do our best to prevent them from happening.

It could be dangerous and harmful when team members are using electrical hardware with carelessness: soldering iron could scald unprotected skin or even lead to a fire; bare wires may cause electric shock; falsely connected batteries could be short-circuited and cause an explosion, etc. These potential risks are considered in advance, and before working on the actual project, our team members will start with the theoretical design first, after calculations and designs are confirmed to be correct, we start using electrical equipment with extreme care. When we stop, all our electrical components will be disconnected from the power source to ensure there will be no risk happening when we are not around.

There could also be risks in time management. Because of the pandemic, we must do our project at home instead of doing it on campus, which significantly lowered working efficiency in the group. To avoid wasting too much time and causing a failure of our project, we made a timetable of how our progress should be and decided to have online meetings at least once a week, every week we check our work, compare with our timetable, and assign new works for next week. Frequent meetings and continuous communication will keep us at a proper pace.

SPECIAL COMPONENTS & FACILITIES

- Control system
- Micro-controllers (currently assuming Arduino) may be upgraded with other board or custom PCB later for optimization.
- Guidance system
- Arduino-compatible GPS unit, camara unit, and radar unit.
- Power system
- Proper size motor with Power supply currently TBD, which depend on the final power requirement of the design. Battery and power control and failsafe unit is needed.

- Interactive System
- QR code display screen, locking mechanism.
- Structure system
- The components of the general frame of this device will be printed via 3D printer.
- Therefore, a 3D printer with suitable size and functionality is required.