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PROJECT CHARTER

Autonomous Delivery Vehicle

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Table of Contents

Document Change History

Release version	Date	Description of changes
1	3/29/23	First set of revisions of design requirements and CONOP's

1.0 Introduction

1.1 Project Description / Customer Needs & Requirements

BioComp LL.C is in the need for a small autonomous vehicle for their company's clean room. They have tasked our design team to develop a prototype and supporting documentation for such vehicle that can meet their specified requirements. They laid out that they need this vehicle to pick up and place objects of different size and weight, move these objects up varying steepness of ramps all while avoiding obstacles. This product will improve BioComp LL.C efficiency and allows automation to increase their work flow.

The Pickup & Place task requires the robot to detect a small or large, red or blue box from a platform based on the customer's discretion, pick it up, then based on the color of the box find and follow a colored path to a set of four placement platforms, two for each color. It will then decide based on size and color of the box which one to place it on. An important note for this task is that the boxes are fragile and must not be damaged in the process of carrying or placing them.

For the Carry/Push/Pull functionality, starting from the bottom of a ramp, the robot must carry and push or pull, an object to the top. Successful completion of this task is dependent on both the robot and object making it to the top without falling off or being damaged. The performance will be measured through the speed at which the task can be done and by how much weight the robot can transport. Should the task not be completed the distance which the object was transported will be measured and recorded.

During the Move with Obstacle Avoidance task the vehicle will initialize in one of three. fixed starting positions where it will then navigate through a black field of black walls in order to cross a green finish line. Success of this task requires that the robot stays within the white field boundaries and avoid the obstacles present. The performance of this test is assessed on how fast the robot can complete the task and cross the finish line. Should a wall in the field be hit, a time penalty will be incurred where the clock is paused and the robot and field are reset to the starting position. The clock will then be resumed and the robot will restart the test.

Customer Requirements

- Autonomous Vehicle
- Be able to pick up specific color and size object and transporting to a specified location
- Transport objects by carrying and pushing/pulling
- Vehicle must be able to transport objects up varying levels of incline ramps
- Vehicle must also avoid obstacles while performing duties
- Vehicle Size Constraints
    - Max Length : 530 mm
    - Max Width : 280 mm
- Vehicle must be built will the provided requirements

BioComp LL.C has provided some resources to help the design team reach thor envision goal for this project and can be seen in the figures below

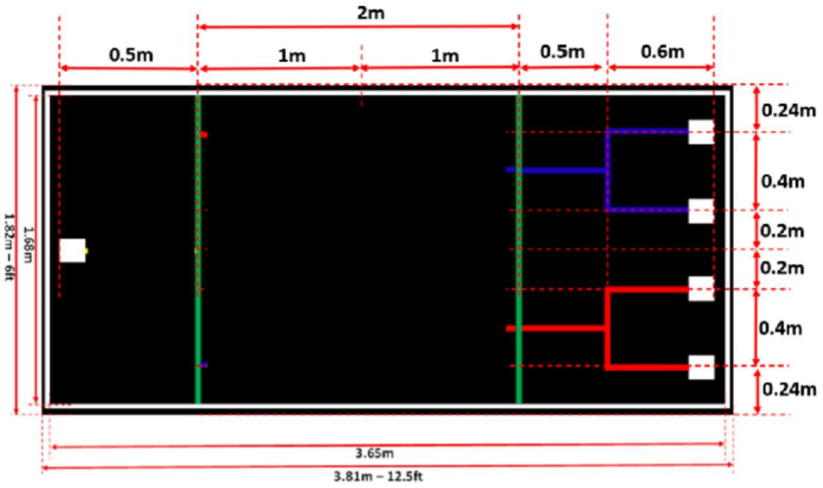

Figure 1 - BioComp LL.C Clean Room Layout

Hardware Components		
Component	**Qty**	**Link for more information**
Grid Plate 17 x 29 Hole	2	https://www.servocity.com/1116-series-grid-plate-17-x-29-hole-136-x-232mm/
U-Channel 1 Hole	6	https://www.servocity.com/1120-series-u-channel-1-hole-48mm-length/
2-Post Clamping Mount	4	https://www.servocity.com/1401-series-2-side-2-post-clamping-mount-43mm-width-22mm-bore/
Lightweight Set Screw Hub 4mm	4	https://www.servocity.com/1308-series-lightweight-set-screw-hub-4mm-bore/
Lightweight Set Screw Hub 6mm	2	https://www.servocity.com/1308-series-lightweight-set-screw-hub-6mm-bore/
Omni Wheel	4	https://www.servocity.com/3604-series-omni-wheel-14mm-bore-96mm-diameter/
Disc Wheel	4	https://www.servocity.com/3607-series-disc-wheel-14mm-bore-96mm-diameter-black-2-pack/
ServoBlock	2	https://www.servocity.com/servoblock-standard-size-25-tooth-spline-hub-shaft/
Round-End Pattern Plate 7 Hole	1	https://www.servocity.com/1105-series-round-end-pattern-plate-7-hole-176mm-length/
Round-End Pattern Plate 5 Hole	1	https://www.servocity.com/1105-series-round-end-pattern-plate-5-hole-128mm-length/
L-Channel 1 Hole	2	https://www.servocity.com/1113-series-l-channel-1-hole-48mm-length/
Parallel Gripper Kit A	1	https://www.servocity.com/parallel-gripper-kit-a/
Flanged Ball Bearing	4	https://www.servocity.com/1611-series-flanged-ball-bearing-6mm-id-x-14mm-od-5mm-thickness-2-pack/
Stainless Steel D-Shaft	1	https://www.servocity.com/2101-series-stainless-steel-d-shaft-6mm-diameter-300mm-length/
26 or 116 RPM DC brushed Motors	4	https://www.servocity.com/26-rpm-premium-planetary-gear-motor/ https://www.servocity.com/116-rpm-premium-planetary-gear-motor/
High-torque servo motors	2	https://www.servocity.com/2000-series-dual-mode-servo-25-2/
High-speed servo motors	2	https://www.servocity.com/2000-series-dual-mode-servo-25-3-speed/

Electronic Components		
Component	**Qty**	**Link for more information**
Teesny 4.1	2	https://www.pjrc.com/store/teensy41.html
USB cable type A and type B male	2	https://www.amazon.com/MaGeek-Samsung-Motorola-Android-Smartphones/dp/B00WMARA04/ref
Ultrasonic Module HC-SR04 Sensor	2	https://www.amazon.com/Dorhea-Ultrasonic-Distance-Duemilanove-Raspberry/dp/B07L68X65N/ref
IR Obstacle Avoidance Sensor	2	https://www.amazon.com/HiLetgo-Infrared-Avoidance-Reflective-Photoelectric/dp/B07W97H2WS/ref
RGB Color Recognition Sensor	3	https://www.amazon.com/DEVMO-TCS3200-Recognition-Detector-Compatible/dp/B07Y88WRNQ/ref
Thin Film Pressure Sensor	2	https://www.amazon.com/Pressure-Precise-Force-Sensitive-Resistor-Resistance-type/dp/B07T1CHY58/ref
Rotary Angle Sensor	2	https://www.amazon.com/ACEIRMC-CJMCU-103-SV01A103AEA01R00-Trimmer-Potentiometer/dp/B094XT5WMS/ref
L298 7A motor controllers	2	https://www.amazon.com/Controller-Regulator-Industrial-Optocoupler-Isolation/dp/B0B8RL7PXM/ref
Buck Converter 12v to 5-7v	2	https://www.amazon.com/AITRIP-Mini360-Converter-Airplane-Step-Down/dp/B09MVK48KY/ref
12V DC Power Connector	1m 1f	https://www.amazon.com/Power-Connector-Female-Adapter-Camera/dp/B07C61434H/ref
TalentCell Rechargeable 12V	1	https://www.amazon.com/TalentCell-Rechargeable-12000mAh-Multi-led-indicator/dp/B00ME3ZH7C/ref
Wire Stripper, 20-30 AWG	1	https://www.amazon.com/Eclipse-CP-301G-ProsKit-Precision-Stripper/dp/B005JVJDIA/ref
Breadboard	4	https://www.amazon.com/Breadboard-Solderless-Prototype-Male-Female-Female-Female/dp/B073X7GZ1P/ref
PCB Solder-able Breadboard	1	https://www.amazon.com/EPLZON-Solder-able-Breadboard-Electronics-Compatible/dp/B0B27XB69M/ref
Push button	2	
Thumb Joystick Module	2	https://www.amazon.com/Wishiot-Joystick-Controller-Breakout-Arduino/dp/B089VXPHDH/ref
Organizer box	2	https://www.amazon.com/DEVMO-TCS3200-Recognition-Detector-Compatible/dp/B07Y88WRNQ/ref

Figure 2 - All available components that can be used by the design team and provided by BioComp LL.C

1.2 Concept of Operations (CONOPs)

The following Concept of Operations presents a descriptive shared vision between the stakeholders and design team regarding how this system will operate from the end user's perspective.

To use this vehicular robot, the user will need to select the sort of task it is to accomplish prior to initializing the system. The robot will then be started by the user pressing a button. The vehicle will normally find itself in the environment and then accomplish the given task within some reasonable margin of error. In extreme cases, such as electrical or hardware failure, the robot may damage products or itself by falling or applying too much pressure using its method of carrying. Standard maintenance of the machine should not require more than occasional cleaning, lubrication, and tightening, but it is recommended to contact a certified individual or group to do such. If the system detects an error, it will enter a resting state where it stops all functions such that the user may reset or shut the machine down. In case of failure, the vehicle should be placed into a state of shutdown through the disconnection of the battery and by placing it into a state where it cannot move. At the end of the system's life, please find an appropriate way or place to recycle or repurpose the vehicle and all parts.

2.0 Project Scope and Deliverables

2.1 Scope and Dependencies

Team 6 is responsible for manufacturing the physical vehicle and creating software for the autonomous vehicle systems. Team 6 is also responsible for providing relevant documentation for operations and maintenance, as well as for the limitation of the system. BioComp, LL.C. is responsible for providing the hardware components necessary for manufacturing and a comprehensive list of criteria the design team must meet.

2.2 Deliverables

BioComp, LL.C. will receive a prototype of the autonomous closed-loop control system and the supporting documents to maintain and operate the vehicle.

3.0 Design Inputs/Requirements

The following requirements specify the criteria that the system must satisfy to assure suitability for its intended purpose.

3.1 Functionality

- 3.1.1 The system shall carry a mass of 1 kilogram up an 18.5-degree ramp
- 3.1.2 The system should carry a mass of 5 kilograms up an 18.5-degree ramp
- 3.1.3 The system shall push or pull 1 kilogram of mass up an 18.5-degree ramp
- 3.1.4 The system should push or pull 5 kilograms of mass up an 18.5-degree ramp
- 3.1.5 The system shall the color of paths and objects
- 3.1.6 The system shall follow colored paths using closed-loop control

3.1.7 The system shall identify, grab, and place colored objects in the correct zones
3.1.8 The system shall not drop objects while moving them
3.1.9 The system should not damage the objects
3.1.10 The system shall identify obstacles in the field
3.1.11 The system shall avoid and redirect the vehicle around any obstacles
3.1.12 The system should complete the obstacle course in a timely manner

3.2 Operation

3.2.1 The system shall be autonomous (closed-loop control)
3.2.2 The system shall complete objectives by moving the vehicle forwards and backwards, rotating the vehicle clockwise and counterclockwise, and stopping the vehicle

3.3 Environments

3.3.1 The system shall have high structural integrity
3.3.2 The system shall withstand impact collisions without becoming compromised
3.3.3 The system shall have a load carrying capacity of 1 kilogram
3.3.4 The system should have a load carrying capacity of 5 kilogram

3.4 Fabrication

3.4.1 The system and physical vehicle shall be fabricated using the kits provided by BioComp, LL.C.

3.5 Physical Requirements

3.5.1 The vehicle shall not exceed a length of 530 millimeters
3.5.2 The vehicle shall not exceed a width of 280 millimeters

4.0 Preliminary Verification Plans (NOT *APPLICAPBLE AT THIS TIME)*

5.0 References (NOT *APPLICAPBLE AT THIS TIME)*

6.0 Appendices

6.1 Appendix A: Project Definitions

DESIGN & DEVELOPMENT DEFINITIONS:

- **Project Charter:** outlines the planned project and problem seeking to tackle. It should outline the perceived size and scope of the project and problem to be addressed along with the investigational efforts that will be undertaken.
- **Customer requirements/user needs**: collection of information gathered from the customer detailing the problems they are facing and their needs and requirements for a satisfactory solution. These form the user needs and intended uses of the device.

- **Design inputs/requirements: a device's physical and performance requirements used as a basis for device design.** This involves the translation of the customer requirements, intended uses, plus standards, regulations and practical factors into technical requirements defining what the solution must do to be successful.
- **Design outputs/specifications**: the results of a design effort. These are the created solutions and specifications which are anticipated to satisfy the needs and requirements of the design inputs. This may be in the form of drawings and/or other types of specifications defining the product to be manufactured. Design outputs/specifications are recorded in the Fabrication Plan (see Project Control Documentation).
- **Design verification**: the information that confirms that the design outputs meet the criteria set by the design inputs and may be in the form of equivalence rationales, calculations, testing and acceptance trials.
- **Design transfer:** the process and procedures that translates the device design correctly into production specifications
- **Design validation**: establishing by objective evidence that device specifications conform with user needs and intended uses. This information confirms a product specifically meets the customer requirements and ensures the product is what we want and is usable. Note that medical devices carry the onus to ensure that the product continues to perform as desired into the future.
- **Process validation**: objective evidence that characterizes the production process and ensures the product will be produced consistently meeting its specifications.
- **Process verification:** confirmation by examination (inspection methods) and provision of objective evidence that a product is meeting specifications.

PROJECT CONTROL DOCUMENTATION:

- **Project Charter:** document which outlines the planned project and problem seeking to tackle. This document is updated and refined as the project progresses. It should outline the perceived size and scope of the project and problem to be addressed along with the investigational efforts that will be undertaken. This document also incorporates the written elements of the design input requirements of your design control plan.
- **Design control plan:** A spreadsheet which captures and tracks the creation and connection from customer requirements to design inputs to design outputs to verifications to validations confirming no loose ends remain.
- **Project Plan:** A list of tasks and activities with assigned responsibilities for each and sequenced to accomplish the project in a timely manner.
- **Project and Design Risk registers:** Documents the potential failure modes of the proposed product and its components as well as other associated risks to the successful completion of the project. Each failure mode/identified risk must be tracked in the register with its associated mitigation plan and resolution.
- **Fabrication Plan:** The (proposed) collection of all documentation containing the design outputs/specifications, i.e., the procedures and specifications necessary to define and build the final product (see Design & Development definitions). This includes drawings, material specifications, process specification, quality inspection criteria and methods, supply agreements and any other required information.

- **Design Review:** A documented, comprehensive, systematic examination of a design/project to evaluate the adequacy of the design requirements, to evaluate the capability of the design to meet these requirements and to identify problems. This is to be done by appropriately identified people at specific points in the process.