# ENGG 160 Project Proposal :
# PuppyPi Backpack

## Revisions

| Revision | Author | Changes | Date |
|---|---|---|---|
| 001 | Pierre Mertiny | Initial Release | 2024-01-05 |

# ENGG 160 - Intro. To Engineering Design

## Project Proposal : PuppyPi Backpack

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# 1 Project Definition

Design a backpack for the transportation of ping pong balls by a PuppyPi quadruped robot.

# 2 Objectives

The main objective is to design and prototype a backpack for a PuppyPi quadruped robot. The robot is shown in Figure 1. The purpose of the backpack is to accept six ping pong balls that are dropped individually in short succession from a given height by a suitable device. The backpack must further contain the ping pong balls while the robot performs various motions. The performance requirements (see next section) of the backpack must be demonstrated during a design evaluation event at the end of the winter term 2024.

(a) (b)

*Figure 1. (a) PuppyPi Quadruped Robot [1] and (b) robot forward and backward kneeling positions.*

# 3 High-level Functional and Performance Requirements

High-level functional and performance requirements are provided in Tables 1 and 2, respectively. Functional requirements describe the capabilities of the product (i.e., what the product must do). Performance requirements describe how well the product must perform a function. There may be other requirements that are found during the conceptual design of the product that can be added to the list. Do not add more than a few.

A requirement is verified either by design and/or by testing. If by design, there should be an analysis, if by test, there should be a description of the test and results. If both are indicated (by a 'Yes') in Tables 1 and 2, then one or both may be included.

*Table 1. High-level Functional Requirements (FRs)*

| # | Name | Description | Met by Design | Met by Testing |
|---|---|---|---|---|
| **FR-1** | Physical system | Must be aesthetic and rapidly attachable to, and removable from, the robot's back plate (i.e., permanent attachment via adhesives or similar is not permissible). | Optional | Yes |
| **FR-2** | Acceptance of payload | Must accept a payload of six standard-size ping pong balls (diameter ~4cm). The ping pong balls are dropped individually in short succession from a height of 75cm when the robot is stationary with level back plate. | Optional | Yes |
| **FR-3** | Containment of payload | Must contain the payload during subsequent motions performed by the robot. | Optional | Yes |

*Table 2. Performance Requirements (PRs) referenced to applicable FR*

| # | Name | Description | FR# | Met by Design | Met by Testing |
|---|---|---|---|---|---|
| **PR-1** | Rapid attachment and removal | It must be possible to attach and remove the backpack each within 10 seconds. | FR-1 | No | Yes |
| **PR-2** | Mass | The backpack mass shall be 100g or less. | FR-1 | Optional | Yes |
| **PR-3** | Size | The packpack shall not extend (i) beyond the robot's back plate in any direction by more than 20mm (measure in the plane of the back plate), and (ii) perpendicularly above the back plate by more than 120mm. | FR-1 | Optional | Yes |
| **PR-4** | Materials | The design must be made of three distinctly different primary types of materials. Each type shall be used in a functional capacity (i.e., not purely decorative). | FR-1 | Yes | Yes |
| **PR-5** | Payload acceptance | The entire payload shall be accepted and then contained inside the backback. | FR-2 | Optional | Yes |
| **PR-6** | Payload transportation | No portion of the payload shall be dropped from the backpack while the robot performs the following motions:<br>M1. forward kneeling position<br>M2. backward kneeling position<br>M3. 3m walk along a straight line | FR-3 | Optional | Yes |

# 4 Constraints

## 4.1 Allowed Costs

All reasonable material costs will be covered by ENGG 160.

## 4.2 Materials

The three distinctly different primary types of materials are: plastic, wood, and paper/cardboard.

3D printing is allowed using PLA and PETG plastics.

Fasteners and non-toxic adhesives are permissible for the assembly of the backpack.

Only materials as provided by the Elko Garage and/or the teaching team are allowed.

## 4.3 Robot

For measurements, inspection and testing, the design team can use a robot only during designated lab hours under the supervision by a member of the teaching team.

# 5 Resources

The following resources are explicitly allowed:

1. Facilities in the Elko Garage may be used for some construction as limited by ENGG 160 policy.
2. ENGG 160 materials provided via the Elko Garage.
3. Various computer-aided design tools can be used for 3D printable design development. For example, OpenSCAD is a “Solid 3D CAD Modeller” [2] that is easy to use and has good tutorial support.

# 6 References and Links

[1] Hiwonder PuppyPi Quadruped Robot with AI Vision Powered by Raspberry Pi ROS Open Source Robot Dog - Advanced Kit, https://ca.robotshop.com/products/hiwonder-puppypi-quadruped-robot-with-ai-vision-powered-by-raspberry-pi-ros-open-source-robot-dog-advanced-kit (accessed Jan 5, 2024)

[2] OpenSCAD, Solid 3D CAD Modeller, https://openscad.org (accessed Jan 5, 2024)

# 7 Intellectual Property Restrictions

This project must be open source. The project should be hosted on Github or Gitlab.

# 8 Sponsor

The ENGG 160 Instructional Team is the primary sponsor of the project.