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Team 6

Submitted to:

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ECED 3901

Subsystem Design and Verification Report

Humidex Dispenser

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1 Introduction

The Humidex Dispenser is a subsystem requirement for the 2023 Peter Gregson Design Challenge robot. The intent of the Humidex Dispenser is to dispense an identifying puck once the systems alert the robot to a humidity leak. This system will drop a puck off the robot when a serial signal is given to the humidex subsystem. This system will be integrated with the humidity sensor and the light sensor. The Dispenser will sit on the back of the robot and drop two pucks throughout the trial. The Puck has a high success rate of dropping the pucks, with little error.

This document will provide a detailed description of the Humidex Dispenser subsystem to the stakeholders involved with the project. It shows how the system works, and dives into the accuracy and dependability of the product. It does not dive deep into the details of the electronics as this is geared towards stakeholders and other engineers to validate the reliability and feasibility of the subsystem.

2 Design

2.1 Subsystem Requirements

A summary of the humidex system design requirements are listed below:

1. Dispense a puck within 5 seconds, on the command of a serial input.
2. Dispense a second puck within an additional 5 seconds of serial input.
3. Reset from the current position state, whether the linear actuator be, none, partially, or fully retracted on a serial input command.
4. System stays immobile compared to the robot's body.

2.2 Proposed Design

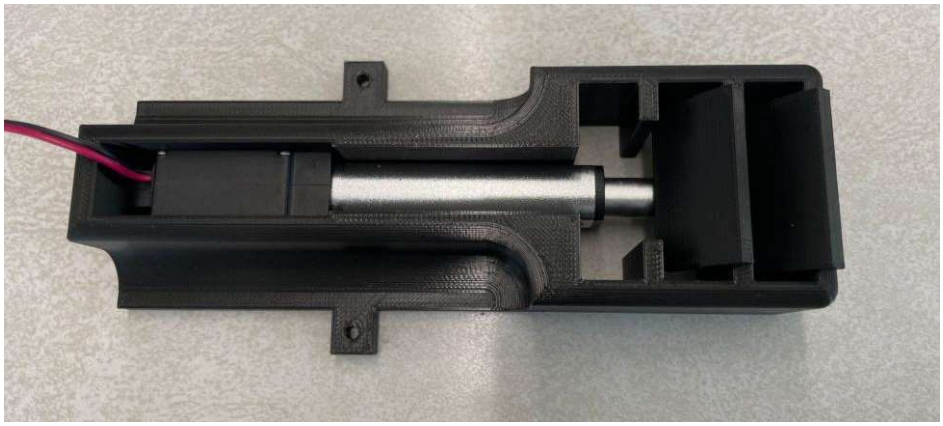
Based on the subsystem requirements listed in the previous section, the following design was proposed:

The linear actuator will be housed within a 3D printed housing. The electrical leads to the linear actuator will be connected to a breadboard housed on the main body of the robot. These leads will be controlled by a microcontroller which will be able to control the polarity of the input pins. The polarity of the input pins determines the direction of motion for the linear actuator.

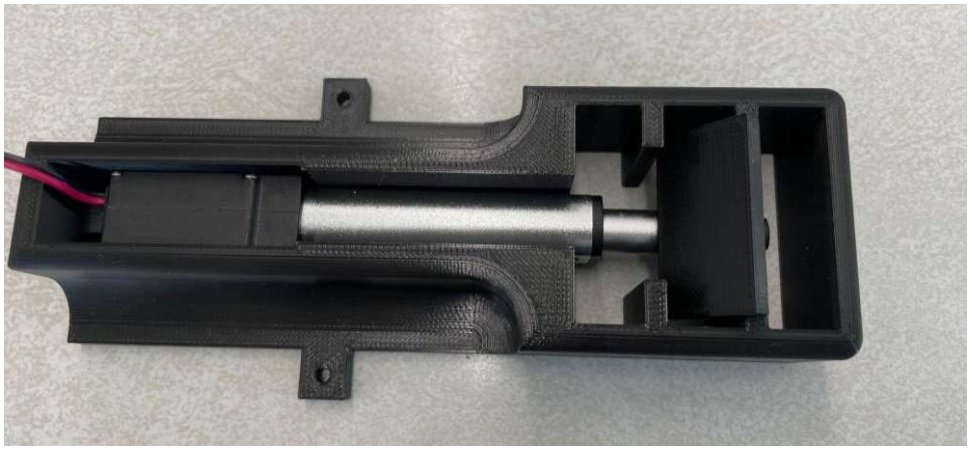
The housing of the linear actuator will provide 3 things to the robot. Firstly it will hold the linear actuator in place relative to the robots main body, by screwing into the frame with two screws. Secondly it will position 2 pucks to be able to be dropped when the linear actuator is retracted. Lastly, it will allow for the electrical wires to leave the housing and go to the microcontroller.

2.3 Definitions

Position 0



Position 1



Position 2

3 Verification

3.1 Required Materials

The following materials are required to construct the Humidex Dispenser.

- Linear Actuator
- Microcontroller
- 5V Power supply
- 3D printed housing
- 3D printed identifying pucks
- x2 3mm screws
- Breadboard
- Wiring

3.2 Verification Matrix

Requirement	Shall Statement	Verification Success Criterion	Verification Method	Verification test	Facility or laboratory	Acceptance requirement	Performing Team Member
1	Shall dispense puck #1 within 5 seconds of command	Timing from command at t=0 to t stop when the puck hits the ground	Physical testing	Test 4	Lab B233	yes	Aethan
2	Shall dispense puck #1 within 5 seconds of command	Same as above from position 1-2	Physical testing	Test 5	Lab B233	yes	Aethan
3	Shall reset upon receiving the reset command	Resets to position 0 from position 1 or 2	Physical testing	Tests 1, 2, &3	Lab B233	yes	Aethan
4	The housing shall not move compared to the robot	The housing stays stationary with enough pressure to move the robot	Physical testing	Test 7	Lab B233	yes	Aethan

3.3 Testing Plan

The test requires that the identification puck be released under any scenario combination of inputs and resets. By test each combination three times, we will be able to concur if the design will be appropriate to add to the robot.

The combinations include the following, assuming the scenario always starts from position zero.

Test	Scenario	Expected outcome

1	Reset command hit at position 0	The linear actuator does not move
2	Reset command hit at position 1	Linear actuator moves to position 0
3	Reset command hit at position 2	Linear actuator moves to position 0
4	Dispense command hit at position 0	Linear actuator moves to position 1 and drops puck
5	Dispense command hit at position 1	Linear actuator moves to position 2 and drops puck
6	Dispense command hit at position 2	Linear actuator stays to position 2
7	The housing does not move when the robot is pushed horizontally by contact with the housing	The robot and the housing act as one and do not separate

The tests scenarios will be carried out three times each. Each task will receive a pass or fail grade, and pass is needed across the board to have a successful Humidex Dispenser.

3.4 Uncertainty Analysis

When incorporating the Humidex Dispenser onto the main robot, the dispenser will be sharing the Arduino and its power source with other functions. If the supplied voltage or current to the linear actuator changes it will change the speed at which the arm extends, hence changing the accuracy of the drop of the puck.

There will only be one integration into the robot, so this scenarion will only happen once. However, when the robots power supply varies the power to the Arduino will vary and could cause potential catastrophe.

The consequences of this happening would be for the identification puck to not drop, or drop on the wrong spot on the course, costing the team up to two inaccurate locations of pipe leak and 10% decrease in value.

4 Design Specifications

The following are attributes about the Humidex Dispenser. The linear actuator was purchased from Digikey. The rest of the electronic components come from the repository of Aethan Cubitt's Collection. The 3D printed parts, including the housing and the pucks were printed in the Dalhousie Electronics lab.

Linear actuator

The linear actuator is a 220 mm long mechanical actuator. It has a range of 100mm of linear movement retracted from the 220mm extended length. This is a key component to dispensing the pucks, as it holds the puck in its place until it acts and releases the puck onto the floor to identify and mitigate the leak.

The linear actuator has 3 positions within the housing as shown in section 2.3.

Linear actuator 3D printed housing

The printed housing as shown in Figure 1 below, holds the linear actuator in place, as well as the pucks. This allows for the pucks to be released when the linear actuator retracts from each position.

Dispensed pucks

The dispensed pucks are small and rectangular. They fit into the linear actuator 3D printed housing and are dropped onto the game field on the release command.

5 Results

Test 1: Reset command hit at position 0

Pass: The linear actuator does not move

Fail: The linear actuator moves in either direction

Subtest	Pass/Fail
1	Pass
2	Pass
3	Pass

Result: Pass

Test 2: Reset command hit at position 1

Pass: The linear actuator moves to position 0

Fail: The linear actuator does not move to position 0

Subtest	Pass/Fail
1	Pass
2	Pass
3	Pass

Result: Pass

Test 3: Reset command hit at position 2

Pass: The linear actuator moves to position 0

Fail: The linear actuator does not move to position 0

Subtest	Pass/Fail
1	Pass
2	Pass
3	Pass

Result: Pass

Test 4: Dispense command hit at position 0

Pass: The linear actuator moves to position 1

Fail: The linear actuator does not move to position 1

Subtest	Pass/Fail
1	Pass
2	Pass

3	Pass

Result: Pass

Test 5: Dispense command hit at position 1

Pass: The linear actuator moves to position 2

Fail: The linear actuator does not move to position 2

Subtest	Pass/Fail
1	Pass
2	Pass
3	Pass

Result: Pass

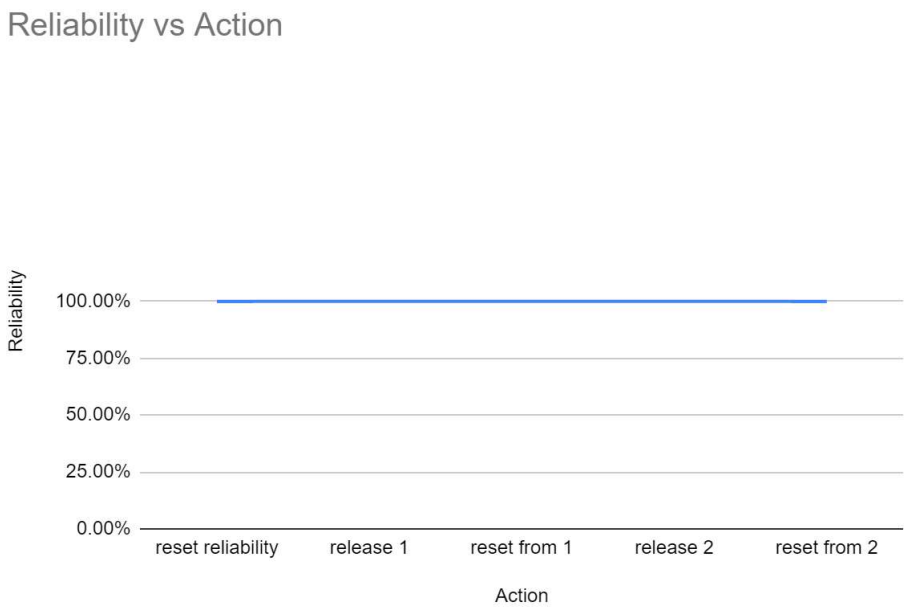
Test 6: Dispense command hit at position 2

Pass: The linear actuator does not move

Fail: The linear actuator moves

Subtest	Pass/Fail
1	Pass
2	Pass
3	Pass

Result: Pass



This graph shows the reliability of the action after 3 iterations of a test. As is shown the test average is 100% showing that the Humidex Dispenser is a reliable subsystem of the robot.

After conducting tests one through six, the Humidex Dispenser passes all the tests and receives an overall grade of pass. This product works as expected and will contribute as a reliable component of the robot.

6 Conclusion

After successful design and construction of the Humidex Dispenser, it consistently achieves the intended functionality without any issues. An area identified for improvement in the robot's design is to incorporate a command within the code for setting or resetting the linear actuator, eliminating the need for an input pin. This enhancement offers operational convenience and streamlines the robot's architecture eliminating one microcontroller.

The humidex Dispenser fulfills all of the test criteria demonstrating its ability and compliance with the specified requirements. The Humidex Dispenser works as is required for the component and meets all of the test requirements set for its purpose.

The total readiness level of the Humidex Dispenser is at a TRL six. The subsystem has been demonstrated in the relevant ground space. The environment is similar, but not exact to the actual environment, making the TRL a level six but now qualifying for a TRL seven. By reaching this demonstration level the Dispenser has earned its readiness level.