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Ball Height Controller

Project Description

The goal of this project is to design software to interface with the provided ball height hardware so that the system can hover the ping pong ball at the desired height. This is accomplished through a fan and a valve to control how much air comes through to hit the ping pong ball. The ball will then hover at the height where a proximity sensor is set. The user can then raise or lower the ball through a command issued through a command terminal. I will use the STM32F103RB Nucleo board as the microcontroller.

Hard Requirements

- The system shall use the servo motor to control the fan valve to reach a desired height with the ping pong ball determined by the proximity sensor.
- The system shall read values from the infra-red sensor to locate the ball's position. It can then use these values to raise or lower the height to reach the desired position or as per the user's instruction.
- The system shall take user inputs from a terminal and perform the requested actions.

Soft Requirements

- I intend to use FreeRTOS to facilitate the concurrency of the actions of the servo and infra-red sensor as well as the command line interface.
- I am unsure what a reasonable tolerance for height reached is. For now I will say the tolerance is the center of the ball is within one cm. Depending on the accuracy of the infra-red sensor, the system may be more accurate than this.

Scenario

1. User begins initial height operation with the command line.
2. Fan is turned on. Servo is adjusted to change airflow from the fan with data from the infra-red sensor to make the ball hover at the appropriate level by the proximity sensor.
3. User enters a command to raise the ball.
4. Servo is adjusted once more with the infra-red data to raise the ball.
5. User enters a command to lower the ball.
6. Servo is adjusted once more with the infra-red data to lower the ball.
7. User enters a command to stop the system
8. Servo closes the valve and the fan turns off. The ping pong ball will sit at the bottom again.

Hardware Components

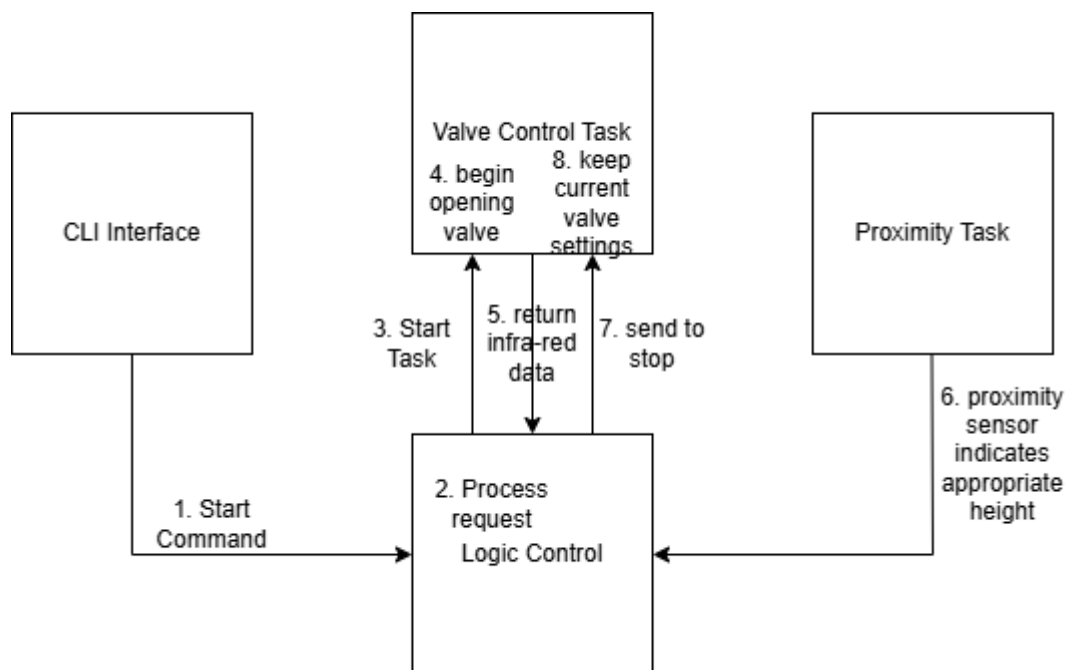
- DC fan
- Infra-red sensor
- Boolean proximity sensor
- Servo motor
- Keyboard and command line interface

Software Components

- Valve Control Task - Based on information from the infra-red sensor, the valve will be opened with the servo to adjust the ball to the right height.
- Proximity Task - Will alert when the ball has reached within the proximity sensor.
- CLI Interface - Will manage the command line interaction from the user to the board.
- Logic Control- Will manage the internal state of the system as well as Handling any other logic.

Design Alternatives

- If the implementation of the RTOS ends up adding more bulk to the system than it is worth, I will consider using a state machine design instead.
- From what Dr.Naqvi said, the infra-red sensor is not incredibly accurate so systems reliant on it might have to be altered or assisted in some way to account for this. This could also change the accuracy of the height produced by the system.



Example of system operation with respect to software subsystems.