YoServe

- The Autonomous Appetizer Serving Bot -

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Overview

Autonomous systems can be found everywhere from cars to vacuum cleaners. While there are currently robots that autonomously clean floors and cut grass, we aim to bring robots to the cocktail hour scene. Our project is to design and build a robot that can autonomously navigate a room to serve appetizers to guests. Using thermal image processing and object detection, our YoServe Appetizer Bot makes serving guests as easy as loading up a tray and pressing go. In a smooth-floored room without furniture, our robot operates at human walking pace and safely approaches guests. It detects and stops operation when its tray is empty.

Approach

YoServe's pattern of operation is to rotate clockwise until it detects warm bodies. It then stops and drives in the direction of the people until it is roughly 1 ft away. Once it arrives, it stops and waits to allow guests to pick up appetizers. After a fixed amount of time, it begins the process again to serve a new set of guests. The robot detects when the food tray is empty using a load cell and stops moving until refilled.

YoServe uses a thermal camera to search for and identify people. It then conducts object detection via ultrasonic sensors to stop before running into people or walls. For mobility and balance, YoServe has a cylindrical design with a round chassis. This, combined with its two wheels being centered on the same axis, allows the robot to spin in place and rotate out of any corners. The chassis is stabilized by two tennis balls aligned orthogonally to the wheels. They also act as shock absorbers to minimize robot oscillation upon changes in acceleration. The wooden frame is light to reduce the work required from the motors and minimize momentum in the rare event of a collision.

Evaluation

YoServe successfully turns in 30-40 degree increments, drives forward at roughly 1mph, and stops without sudden jerks. The thermal camera can detect a single person or group of people. The load cell can detect food items on the tray and recognize when it is empty, as well as compensate for rapid addition or removal of items. Using the ultrasonic sensors, the robot can stop if a person moves in front of it. It also stops when approaching a wall. In general, the ultrasonic sensors take ~1.5s to detect obstacles and the thermal camera takes ~0.9s to detect humans. The start moving forward command takes ~0.9s to execute and the motor stop sequence takes 1.2s for the robot to come to a complete stop.

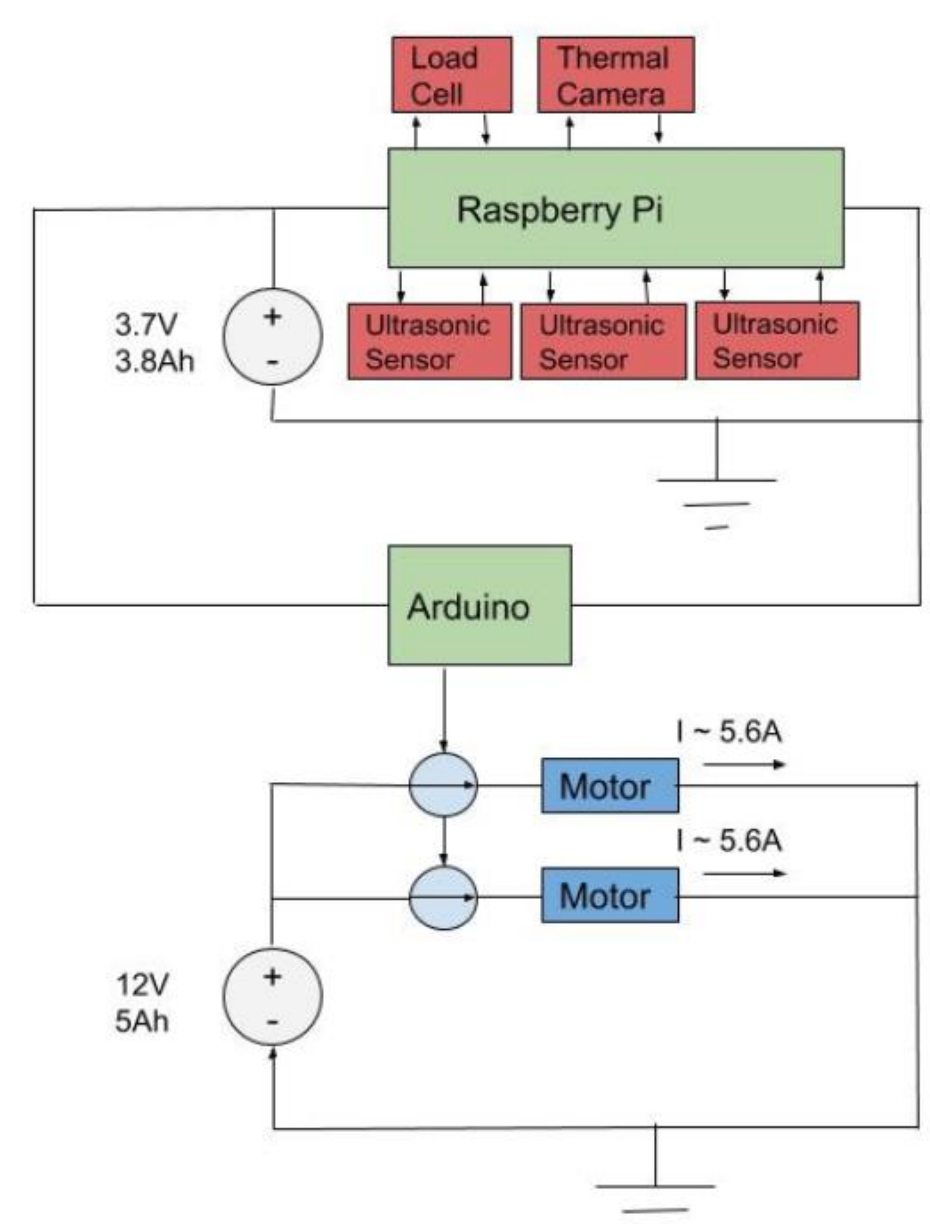
Motivation

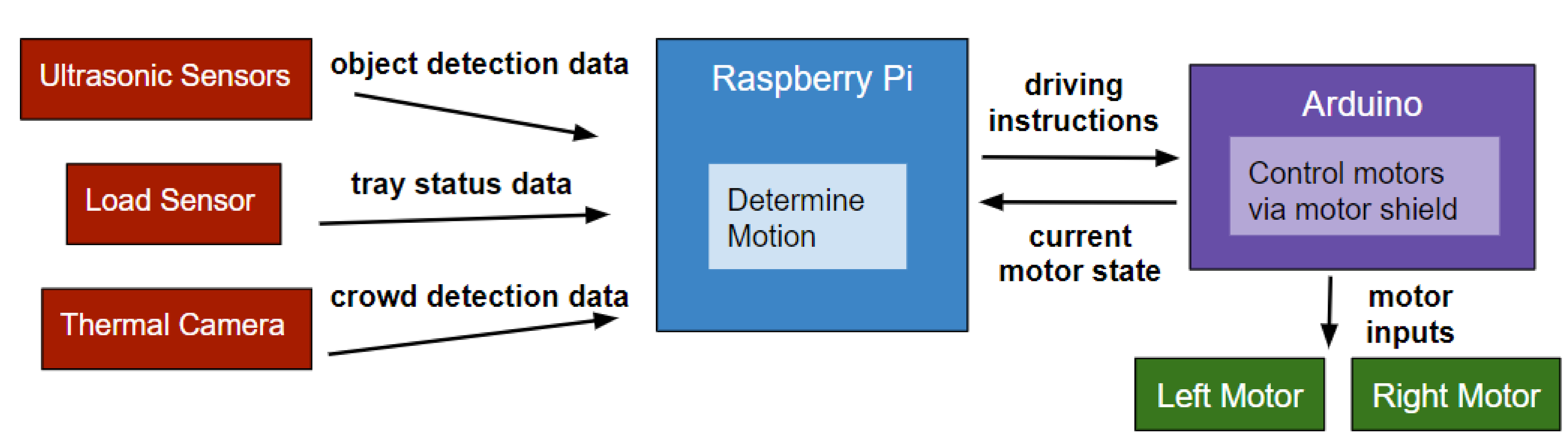
Have you ever been at an event or cocktail hour, hungry for some delicious appetizers, yet engaged in a conversation without any opportunity for escape? Have you found yourself wishing the food might just come right to you? Well YoServe will leave your mingle time undisturbed and your stomach satisfied!

Although robot technology is used throughout the food industry, they are typically stationary and perform singular repetitive tasks. A small number of companies have begun developing mobile food service robots. Unlike them, we aim to push this area of research further by developing a robot for the open, indoor environment.

System Architecture

YoServe utilizes a Raspberry Pi for sensor data processing, and Arduino for motor control. The Raspberry Pi takes in input from three different types of sensors: ultrasonic, thermal camera, and load cell. It then processes the thermal image and determines the direction to travel. After evaluating the ultrasonic data, it determines the desired motion. It passes the driving instructions to the Arduino, which uses the motor shield to control the Pololu motors and navigate the room.





Additional Information

Check out our website for more information about YoServe:
http://course.ece.cmu.edu/~ece500/projects/s19-teamd1/

To see short clips of YoServe in action:
http://tinyurl.com/yoserve-d1

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