Course Project Overview

Wednesday, January 24, 2024 5:06 PM

AIT500 - Course Project

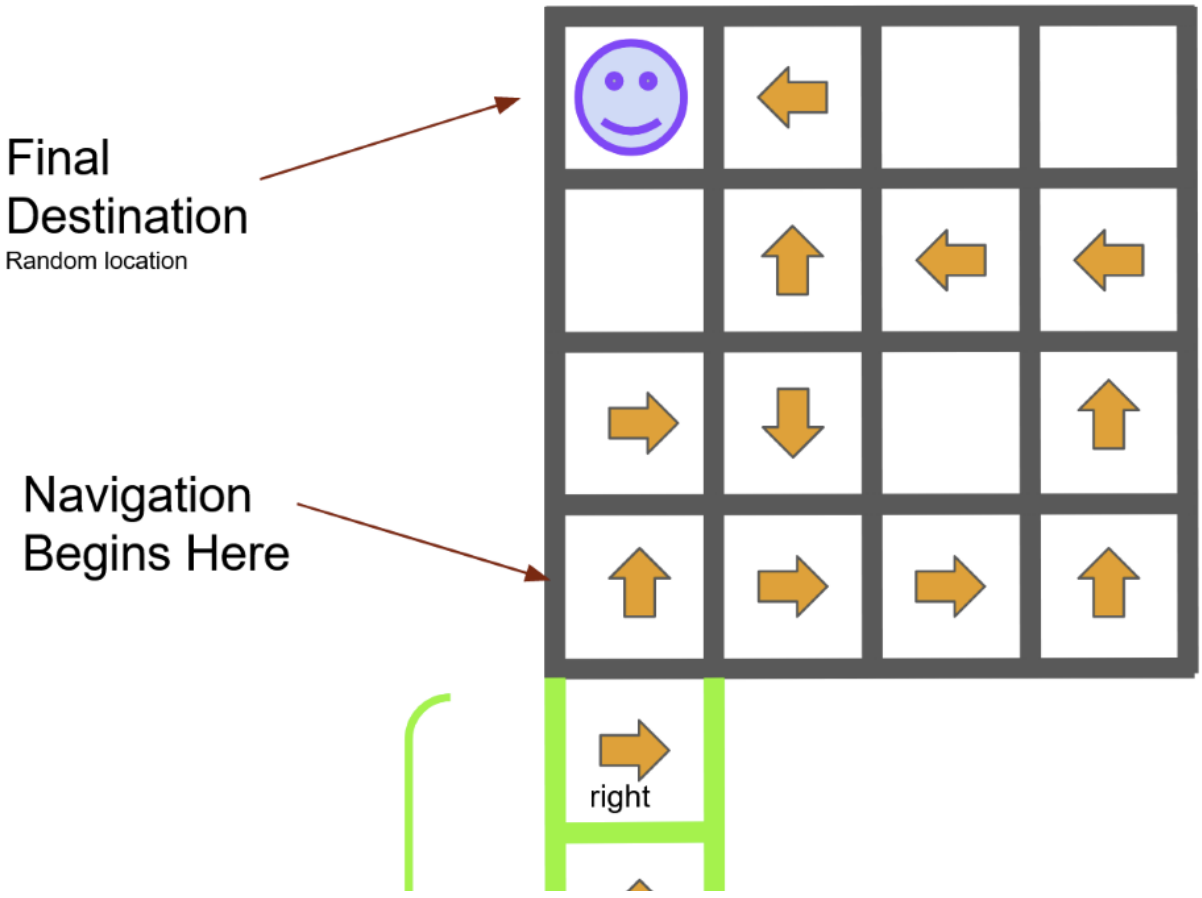
As a 6th semester course, the AIT500 course project aims to integrate your skills from the SEMET program. In order to succeed, you will need to combine knowledge in different areas during your time in the program. For example:

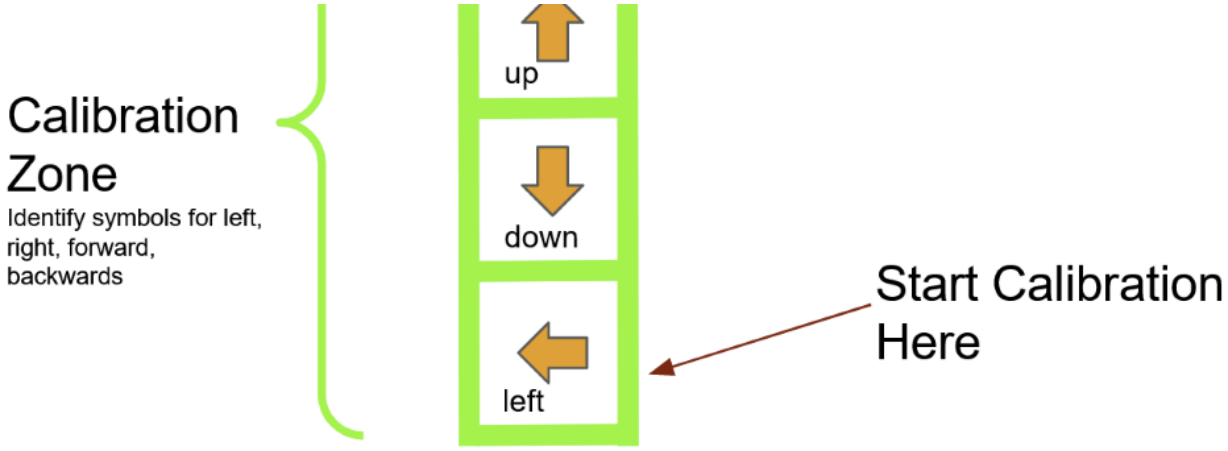
- Python programming
- Raspberry Pi
- Jupyter Notebooks
- Circuits and electronics
- Motor drivers

For the course project, you will build a motorized Raspberry Pi Robot that is able to navigate a room using input from:

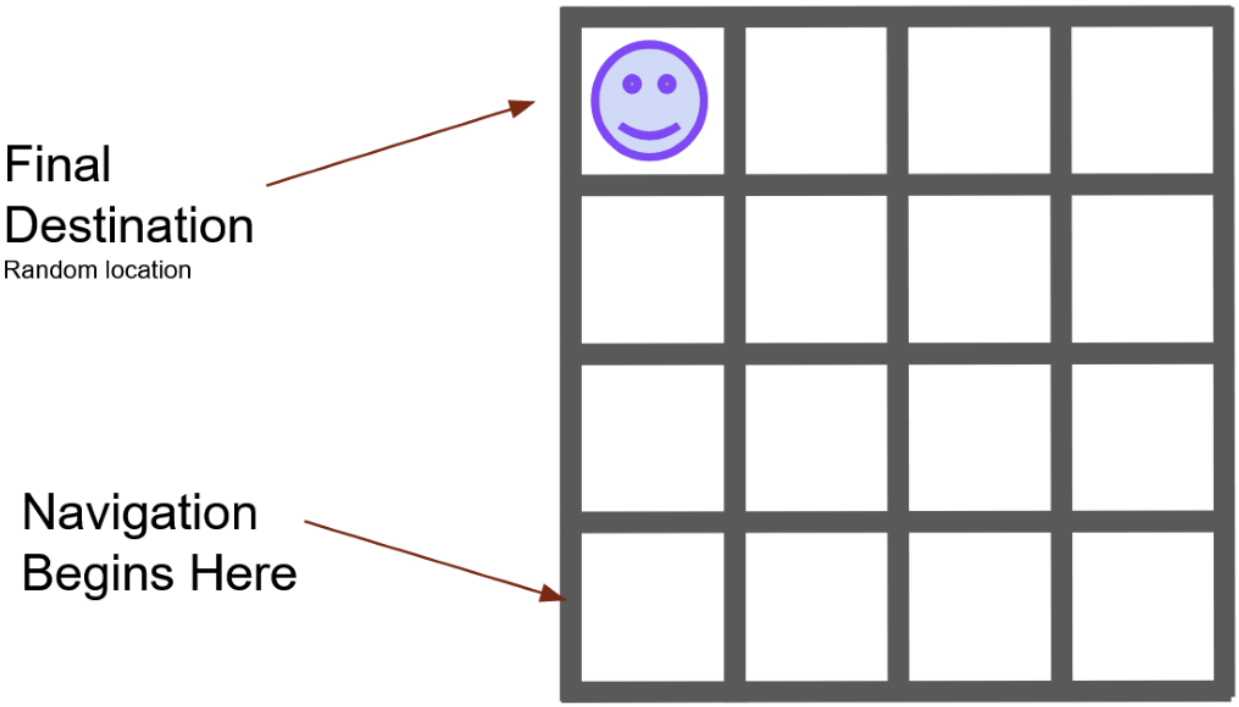
1. Temperature sensor BMP280
2. Image recognition
3. Communications with other Raspberry Pi Robots (optional)

Example Navigation using image recognition to follow arrows





Example Navigation using image recognition without provided arrow



Performance Metrics

How well your robot performs will be based on different metrics such as

1. Time it gets to the final target
2. Number of mistaken moves
3. Robustness of design (ex: number of mechanical or electronic breakdowns)
4. And other metrics

Hardware Requirements

1. Build a mobile Raspberry Pi 2-wheeled robot

2. Connect the BMP280 and be able to capture live temperature data
    a. Build fixture to attach BMP280 to Pi robot securely
3. Connect a camera and be able to capture live images
    a. Build fixture to attach camera to Pi robot securely
4. Connect remotely (wirelessly) to the Raspberry Pi and be battery powered

The department has provided these components to you in the course kit.

You are responsible for additional parts when building out the chassis

- 2x https://www.pishop.ca/product/gear-motor-with-wheel/
- 1x https://www.pishop.ca/product/dual-max14870-motor-driver-for-raspberry-pi-assembled/
- 1x https://www.adafruit.com/product/2651 BMP280
- 1x https://www.pishop.ca/product/raspberry-pi-camera-module-3-wide/
- 1x https://www.pishop.ca/product/adjustable-raspberry-pi-camera-mount-protector/
- 1x GeeekPi GPIO Screw Terminal Block Breakout Module for Raspberry Pi 4, GPIO Expansion Board Breakout for Raspberry Pi 4B/3B+/3B/2B/B+/Pi Zero/Pi Zero W
- 2x Pololu Ball Caster with 3/4" Plastic Ball

Resources

Some online reference sources:

Mobile 2-wheeled Robot

Some examples include:

1. Build a robot buggy
2. https://learn.adafruit.com/adafruit-raspberry-pi-lesson-9-controlling-a-dc-motor/overview

Camera:

3. https://raspberrypi-guide.github.io/electronics/using-usb-webcams
4. https://www.raspberrypi.com/products/camera-module-v2/
5. https://www.raspberrypi.com/products/camera-module-v3/

BMP280 Temperature/Pressure Sensor

6. BMP280 and the Raspberry Pi (PRG550-2022)
7. Build your own weather station

Project Timeline and Deliverables

Course Project Checkpoint 0

1. Acquire materials to build 2-wheeled robot

2. Acquire raspberry-pi compatible camera
3. Demonstrate electronic connectivity and successful operation of:
    a. Motors
    b. Camera
    c. BMP280

Course Project Checkpoint 1

1. Demonstrate motorized movement
    a. Forward, backward, turn left, turn right
    b. From stationary location (measure start and stop coordinates of robot)
        i. Consistently move forward 12 inches (less than 2” variation between 10 trials)
        ii. Consistently move backwards 12 inches (less than 2” variation between 10 trials)
        iii. Consistently turn left and move forward 12 inches (less than 2” variation between 10 trials)
        iv. Consistently turn left and move backward 12 inches (less than 2” variation between 10 trials)
        v. Consistently turn right and move forward 12 inches (less than 2” variation between 10 trials)
        vi. Consistently turn right and move backward 12 inches (less than 2” variation between 10 trials)
2. Demonstrate continuous movement for more than 2 minutes
    a. Capture live data from BMP280
    b. Show on screen (ex: via notebook)
3. Capture images from camera
    a. Display on screen (ex: via notebook) or transfer image to PC
4. Provide experimental analysis of the robot’s consistency of movement
    a. Chart measured results
    b. Provide analysis and summary statistics of measured results of movement consistency

Course Project Checkpoint 2

1. Demonstrate successful navigation using BMP280 temperature to navigate robot to target

Course Project Checkpoint 3

1. Demonstrate successful ML algorithm to categorize live images captured from the Raspberry Pi

Course Project Final Demo

1. Demonstrate successful navigation using image recognition to target
2. Robot must process a calibration step to identify image patterns that correspond to left, right, forward, and backwards movement

Project Grading

Project Journal (3%)

- Journal or blog notes should allow someone new to recreate your final design

- Step-by-step documentation process as you develop your Robot
- Content should include:
  - Description, steps taken to install software or library, bugs or issues encountered and how they were resolved
  - Steps taken to build, connect, test each part of your robot (can include pictures, or videos)
- Example Project Journal

Project Checkpoint 0 (2%)

Project Checkpoint 1 (5%)

Project Checkpoint 2 (5%)

Project Checkpoint 3 (5%)

Project Final Demo (5%)