

Autonomous Navigation Robot Guide Dog

Nicole Lim and Elizabeth Lopez; Advisor: Dr. Seung-yun Kim

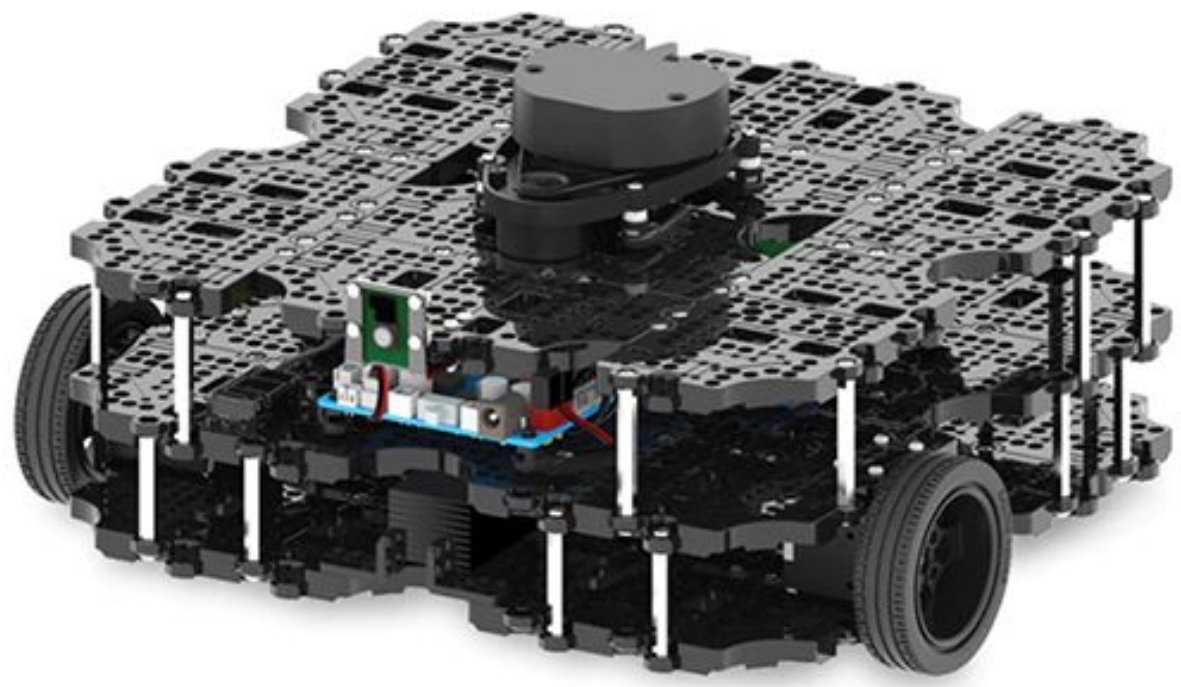
Department of Electrical and Computer Engineering, The College of New Jersey, Ewing, NJ



SCHOOL OF ENGINEERING

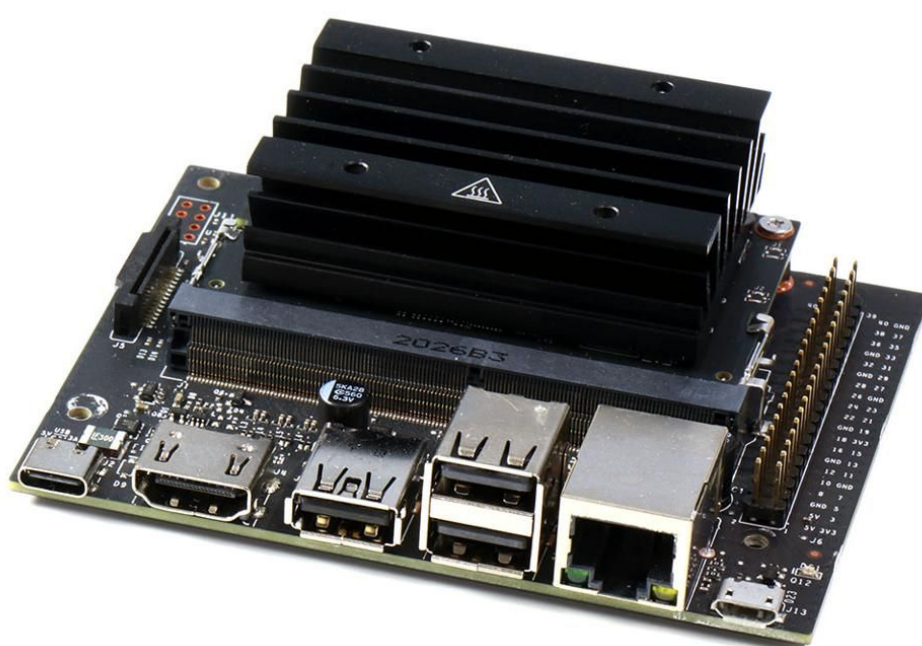
Project Overview

- Turtlebot3 Waffle Pi
 - Perform actions similar to a seeing-eye dog
- Safely escort the visually impaired to the identified classroom in Armstrong Hall
 - Autonomous Navigation
 - AprilTags
 - Computer Vision
 - Stereo Camera



Turtlebot3 Waffle Pi

Microprocessor Selection

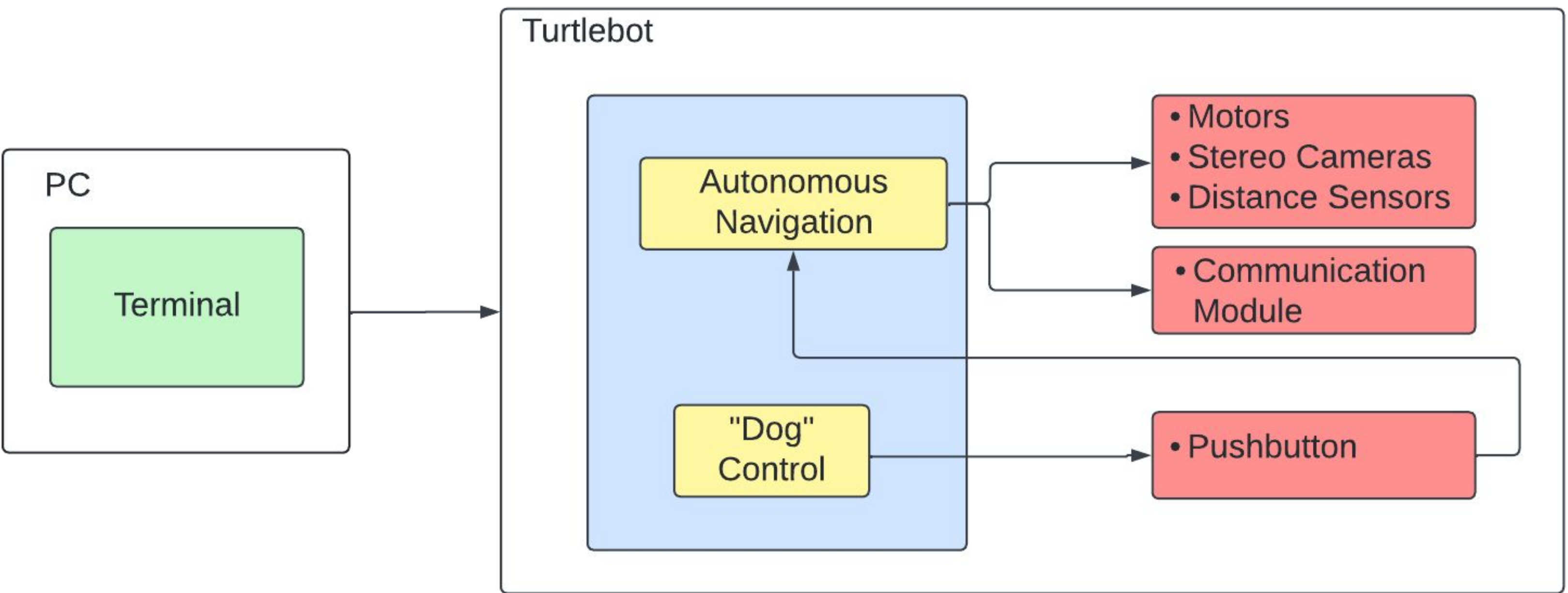


Nvidia Jetson Nano

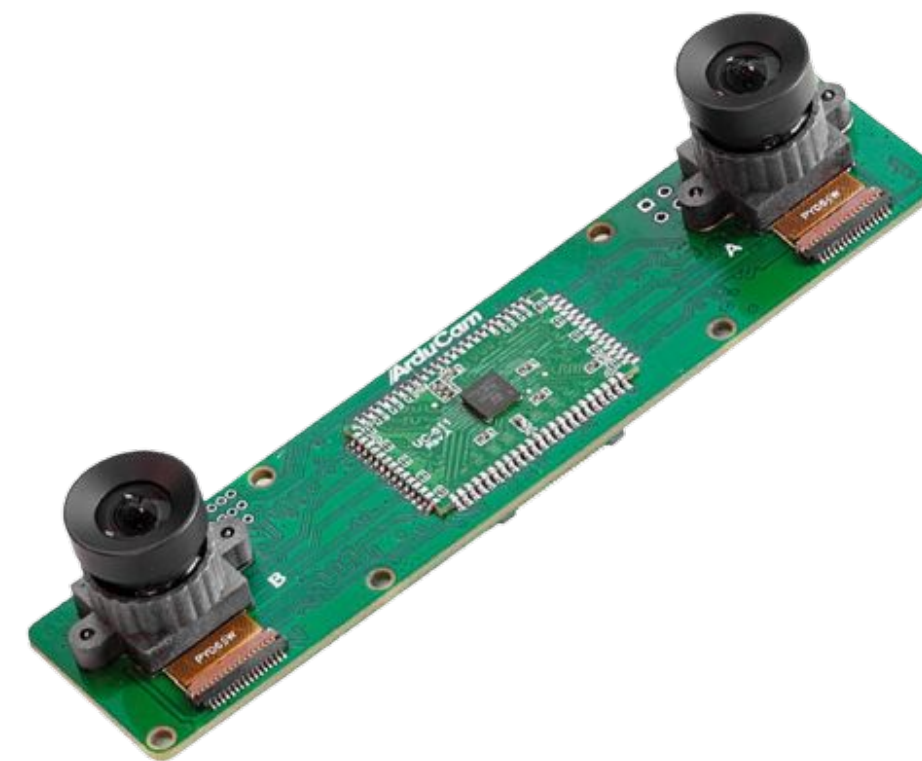
- Raspberry Pi had too many dependency and compatibility issues
- Inability for stereo camera to work in parallel with Raspberry Pi

| | Raspberry Pi 3 | Raspberry Pi 4 | Nvidia Jetson Nano |
|--------------|----------------------------------|----------------------------------|---|
| RAM | 1GB | Up to 8GB | 2 GB |
| USB | 4 Ports | 2 USB 2 Ports 2 USB 3 Ports | 1 USB 3 Type A 2 USB 2 Type A 1 USB 2 Micro-B |
| Connectivity | Ethernet Wi-Fi Bluetooth | Ethernet Wi-Fi Bluetooth | Ethernet 802.11ac Wireless |
| CPU | 900MHz 32-bit quad-core ARMv8 | 1.2GHz 64-bit quad-core ARMv8 | Quad-core ARM ® A57 @ 1.43 GHz |
| Power | 5V, 3A | 5V, 3A | 5V, 4A |
| Price | \$35 | \$53 | \$60 |

System Architecture



Camera Selection

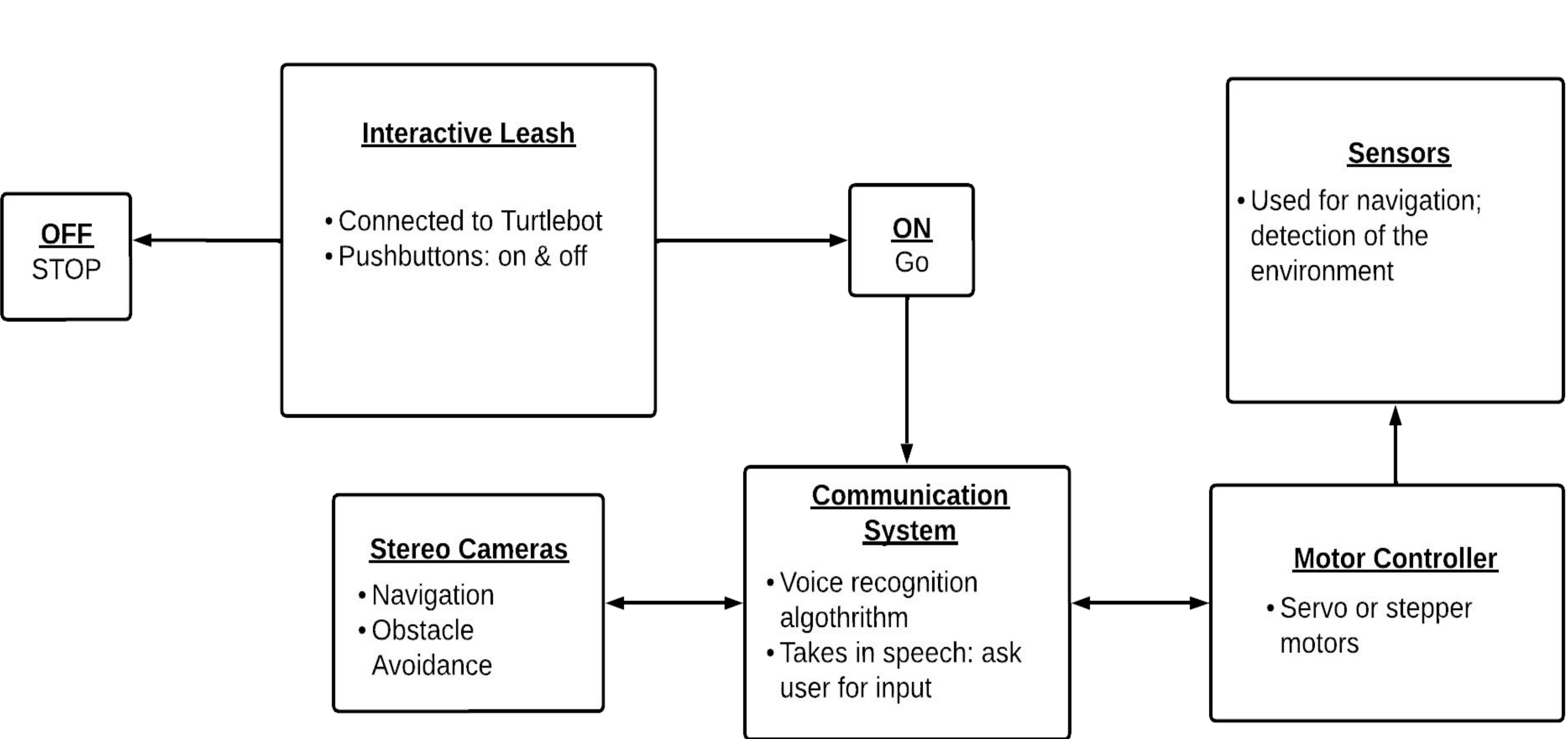


Arducam Stereo Camera 2MP*2

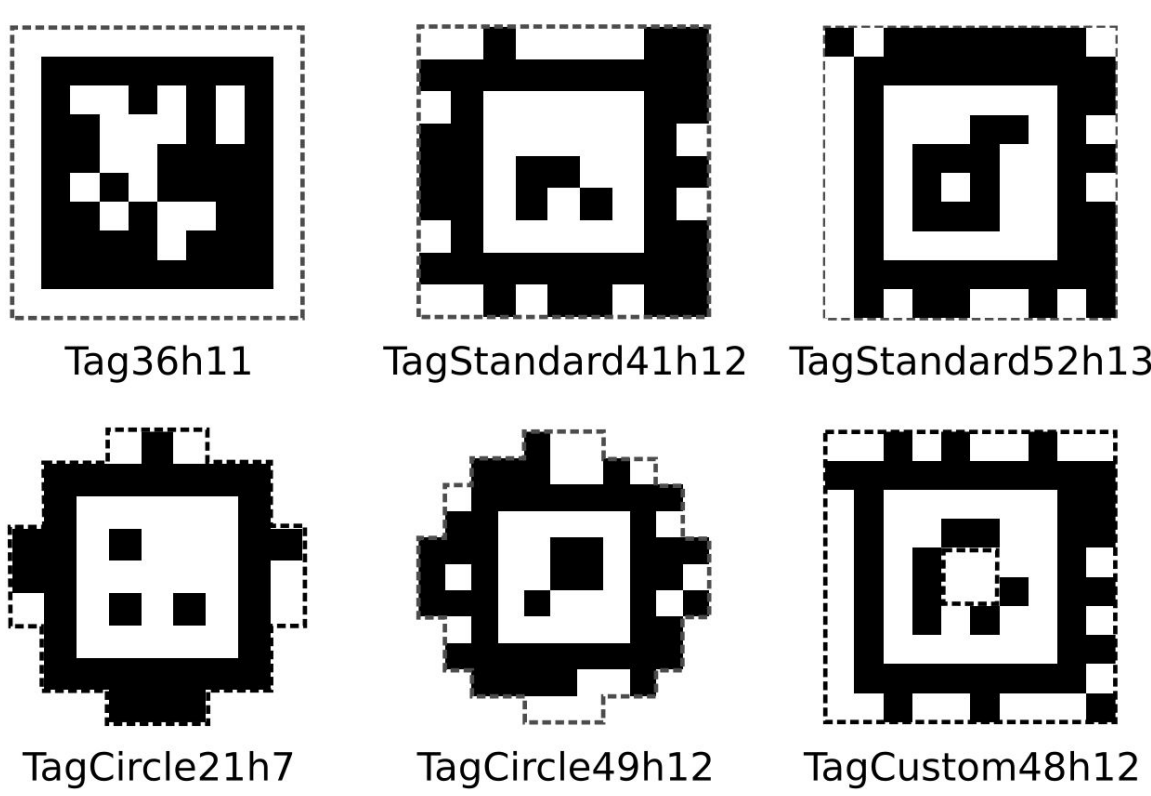
- A dual camera method to replicate human vision and the ability to view depth and create disparity maps
- Allows for object detection and depth estimation

| | Arducam 1MP*2 Stereoscopic Camera Bundle Kit | Arducam Stereo Camera 2MP*2 | Arducam 8MP Synchronized Stereo Camera Bundle Kit |
|------------------|--|--|---|
| Support Platform | Raspberry Pi and Jetson Nano/Xavier NX | Raspberry Pi and Jetson Nano/Xavier NX | Raspberry Pi |
| Resolution | 1 MP | 2 MP | 8 MP |
| Price | \$164.99 | \$149.99 | \$129.99 |

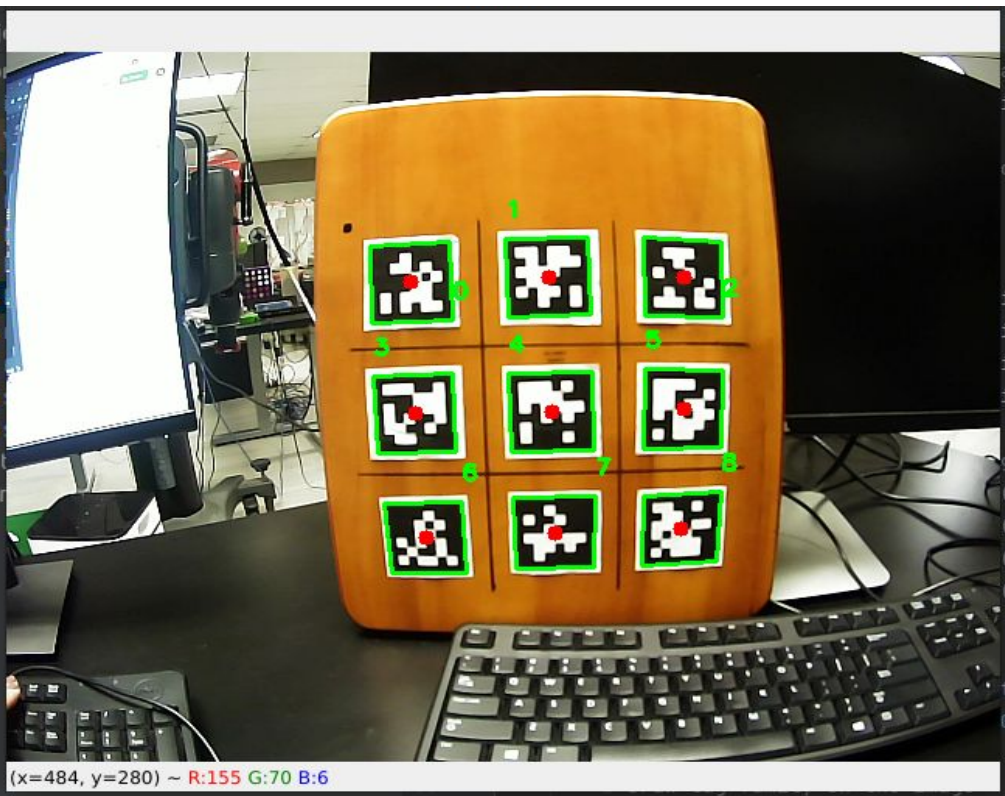
System Block Diagram



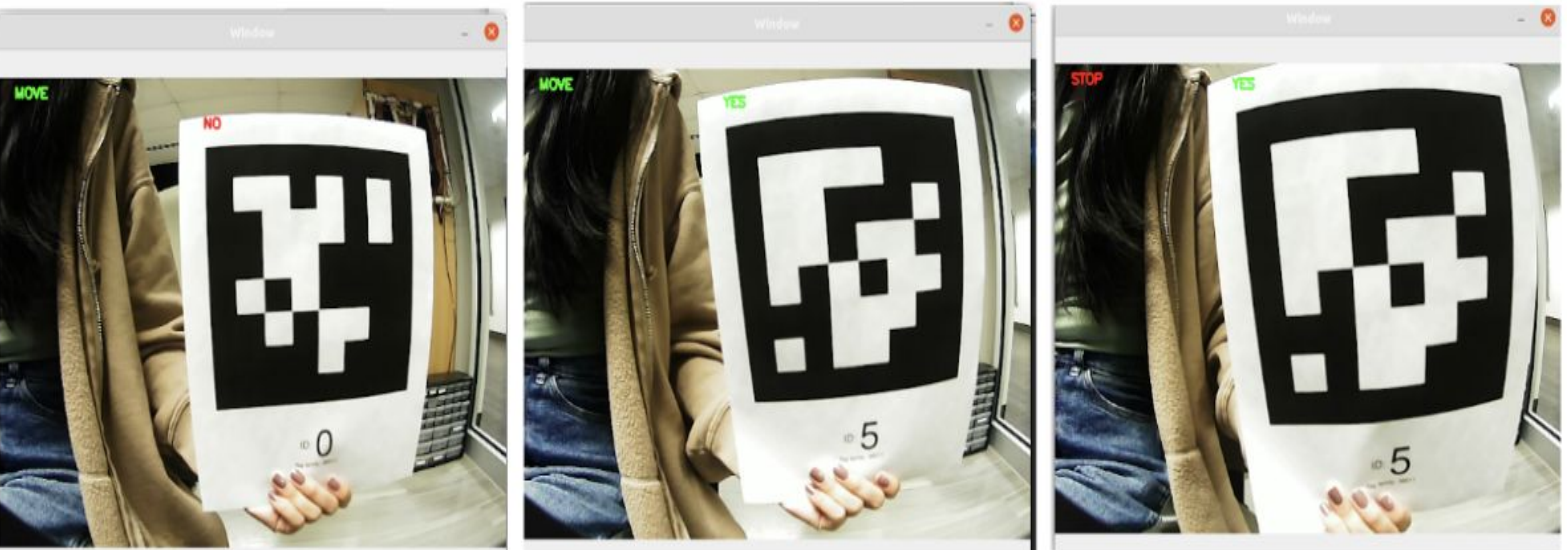
AprilTags



Tag Families



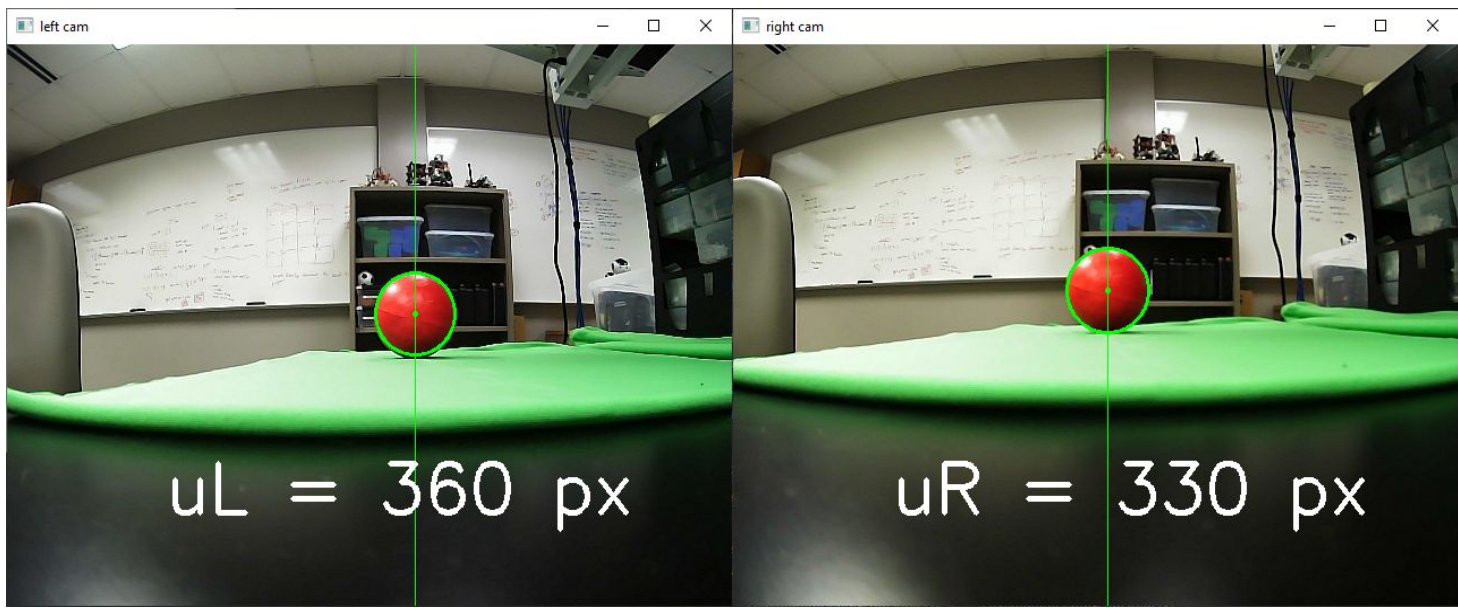
Live Feed - 36h11 Tag Detection



External Camera Navigation Simulations

- Visual fiducial system used in robotics and for camera calibrations
- Allows for longer detection ranges and accuracy

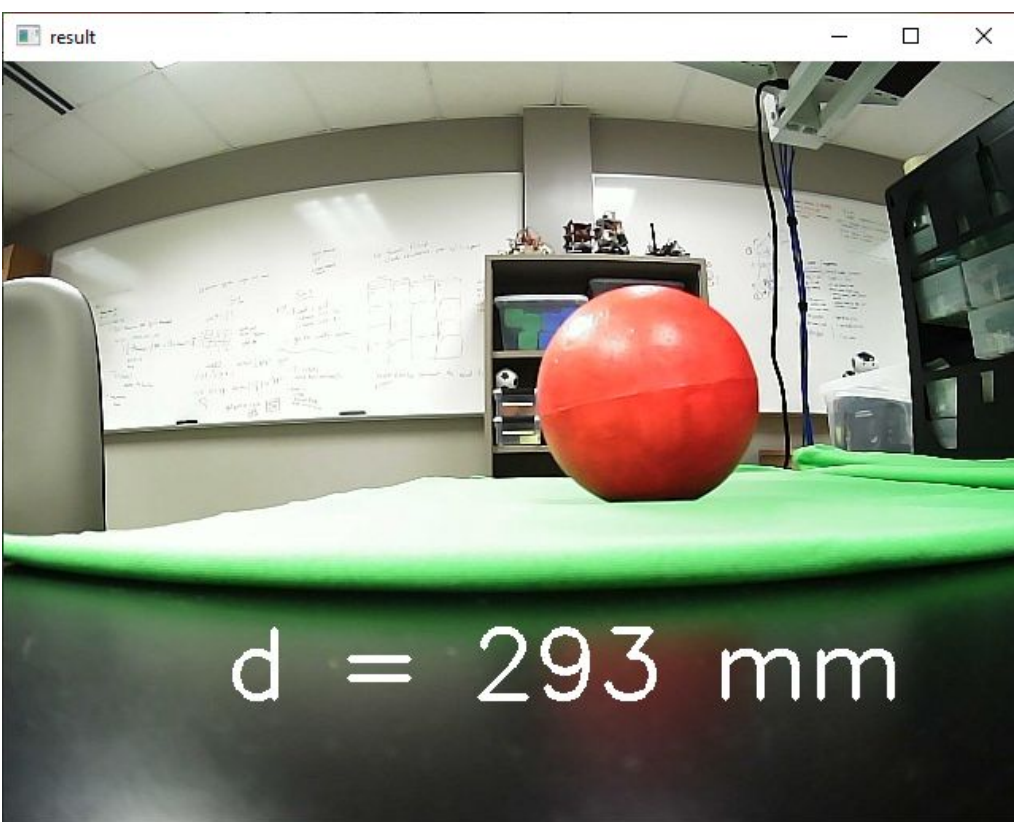
Obstacle Avoidance/Navigation



Stereo Disparity Calculations



HC-SR04 Ultrasonic Distance Sensor



Depth Estimation Result

- Object detection with depth estimation for obstacle avoidance
- Depth estimation used for stopping and steering controls
- Distance sensors for wall detection and navigation guidance