Control Module/Interface for Service Robots

Senior Design Team 315

Department of Electrical and Computer Engineering

Team Introduction

Brendan Laney

Project Manager

Software Engineer – Control Logic

Diego Guedez

Software Engineer – Imaging

Jerry Jean-Pierre

Software Engineer – Control Logic

Jossue Arzeta

Software Engineer – Control Logic

Kyle Crawford

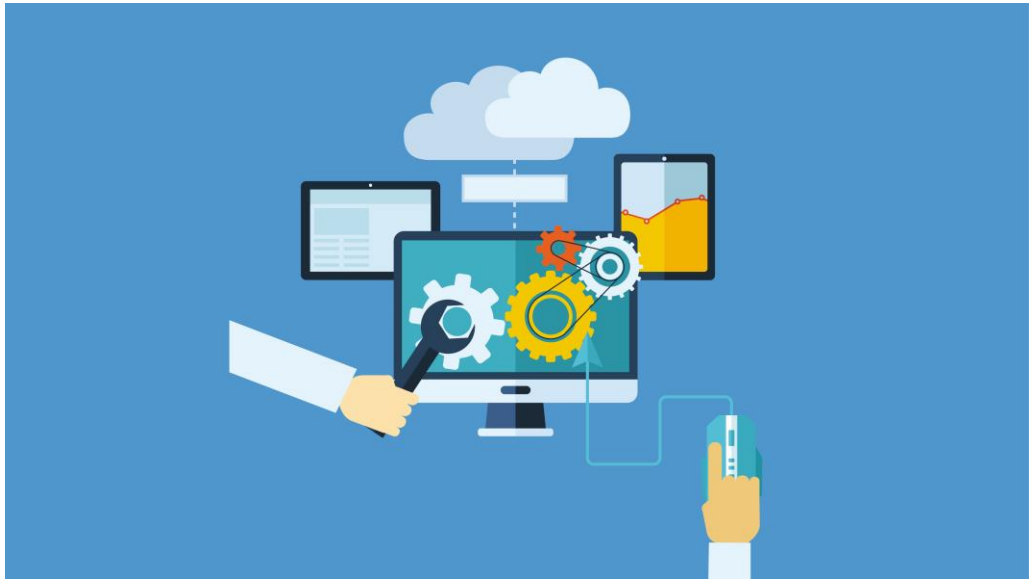
Applications Engineer

Scope of Presentation

- Project Background
- In-Depth View of Tasks
  - Completed
  - Ongoing – Progress Made
- Future Works

Project Motivation

- Automation, machine learning, and robotics
- Assisting manual labor
- These concepts can be applied to a motorized cart semi-autonomously following a user instead of a user manually pushing a cart
- Fulfillment centers, grocery stores, and hospitals



Design Concept

- Design a motorized system to semi-autonomously follow a user
- Use motorized wheelchair as base
- Follow the user and avoid other objects/people

[2] Robot Following Person

Design Implementation

Camera - Digital Camera

Smart Phone - Display

Phone App

Mode Command

Bluetooth Connection

Control Module

Image Processing

Mode Controller

Object Detection

Alerts

Pathfinding

Motor Controller

Power Supply

CAN Bus

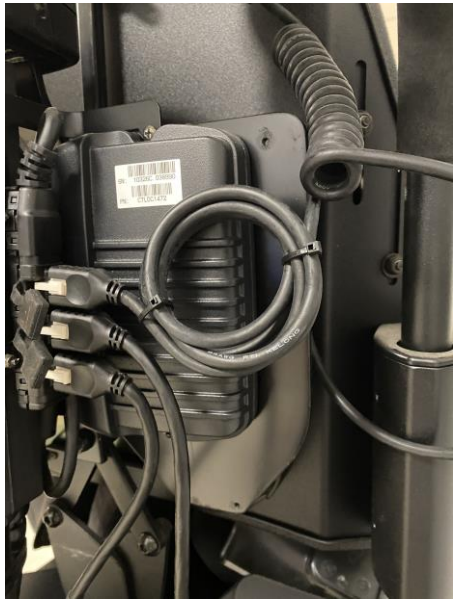
Motor(s)

Work Breakdown

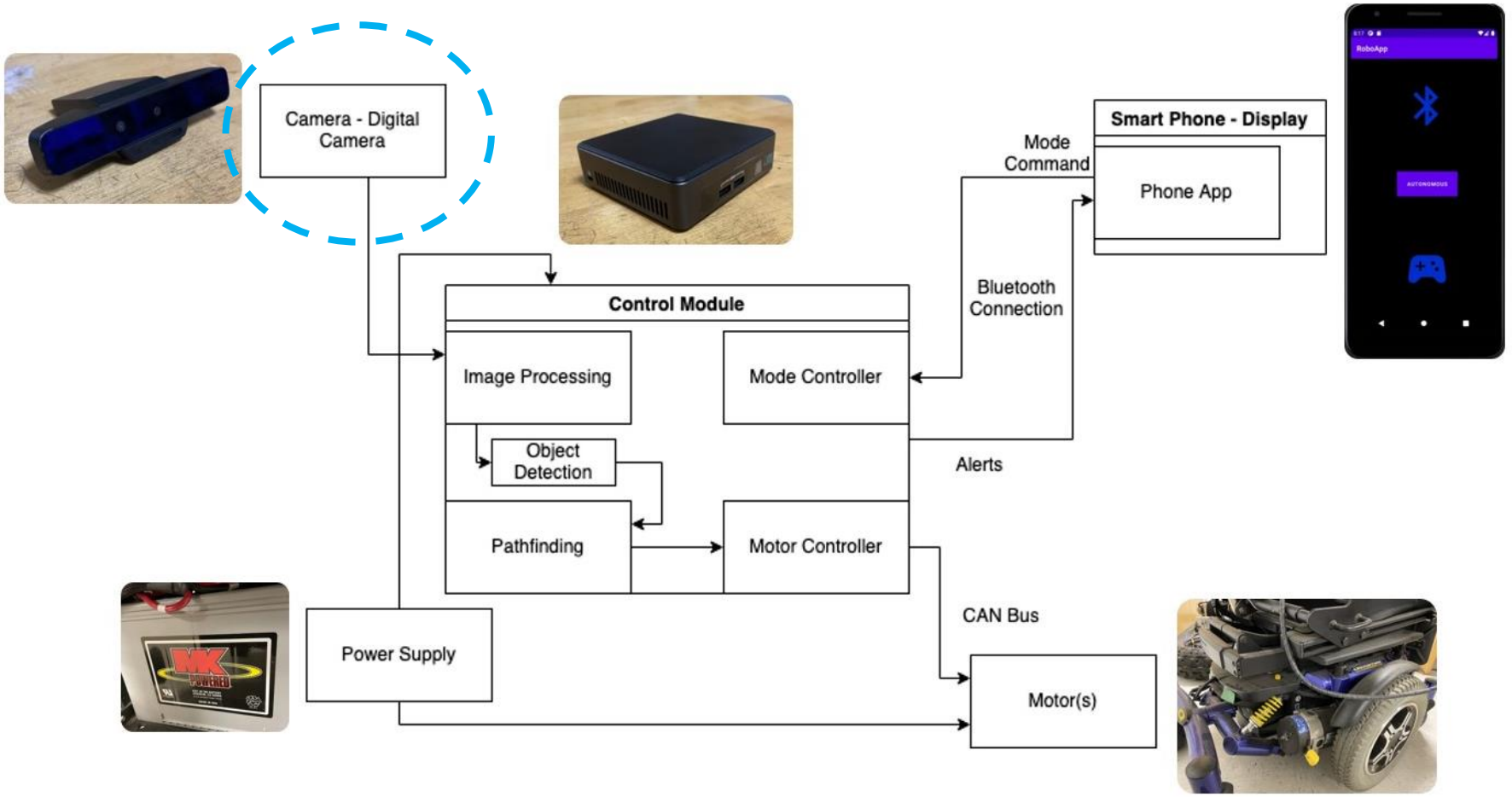
- Diego – Camera and Imaging
- Brendan and Ivan – Pathfinding Algorithm
- Jerry – CAN Bus Communication
- Kyle – App and Connections

Setting Up the Wheelchair

- Batteries charged
- Fully operational
  - Move seat up and down
  - Move wheelchair around
- Determined motor connections

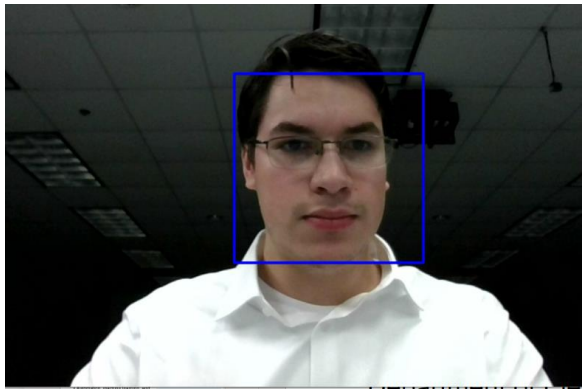


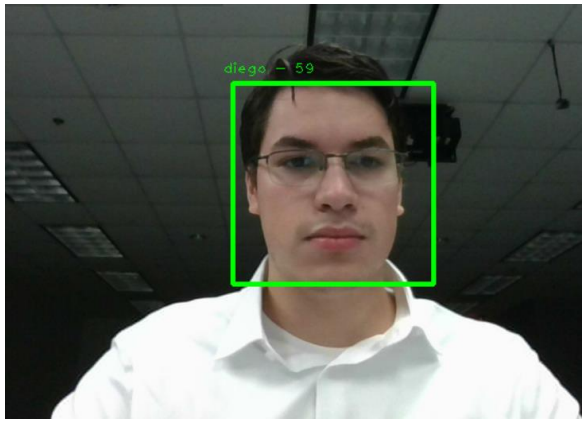
Camera/User Detection

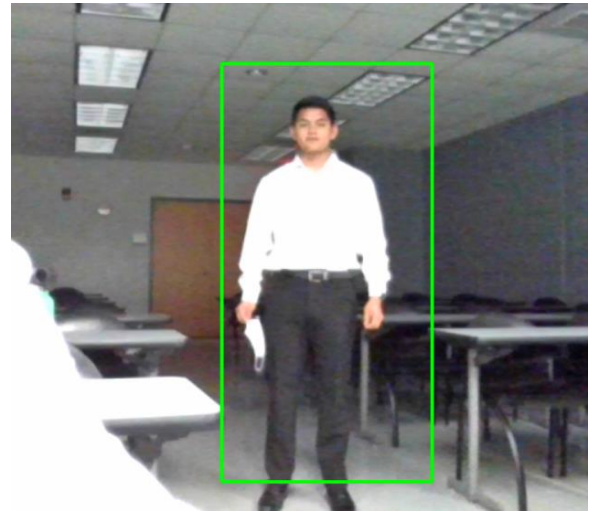


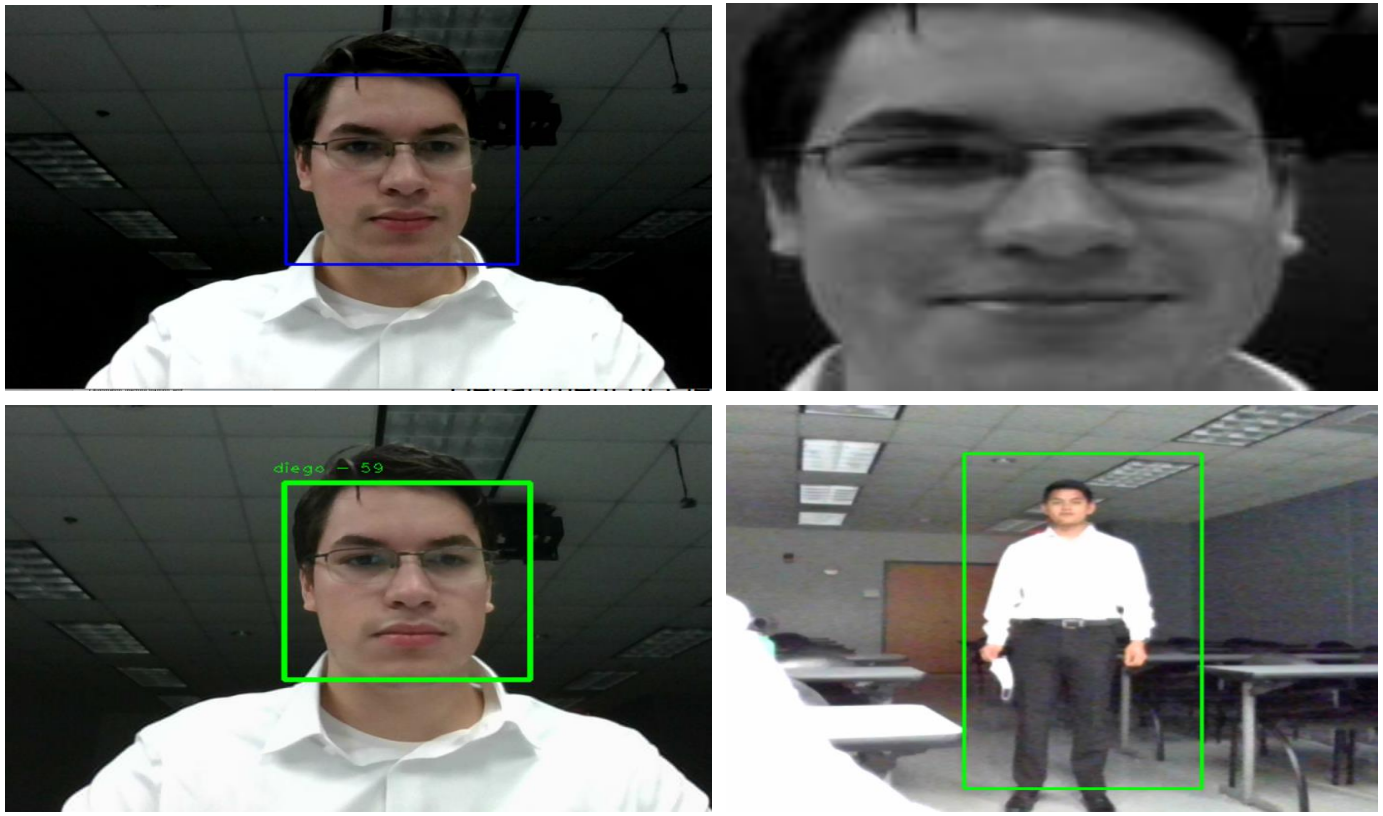
User Detection / Camera Status

- YOLO3, Haar Cascades, Histogram of Oriented Gradients
- User identification in a crowd
  - Recognizes other humans, but does not confuse them with user
- General object detection

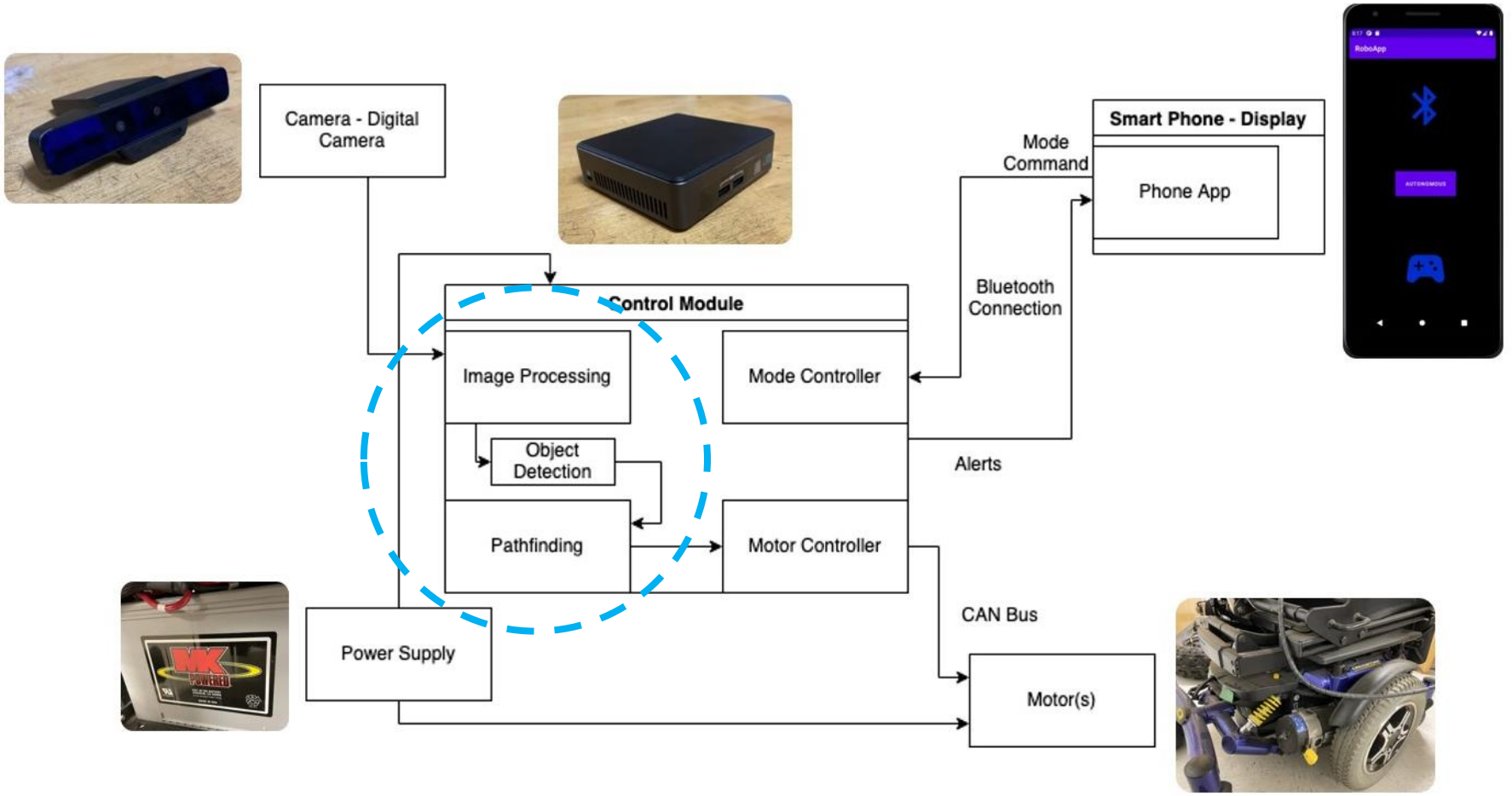







diego - 59

Camera/User Detection to Pathfinding



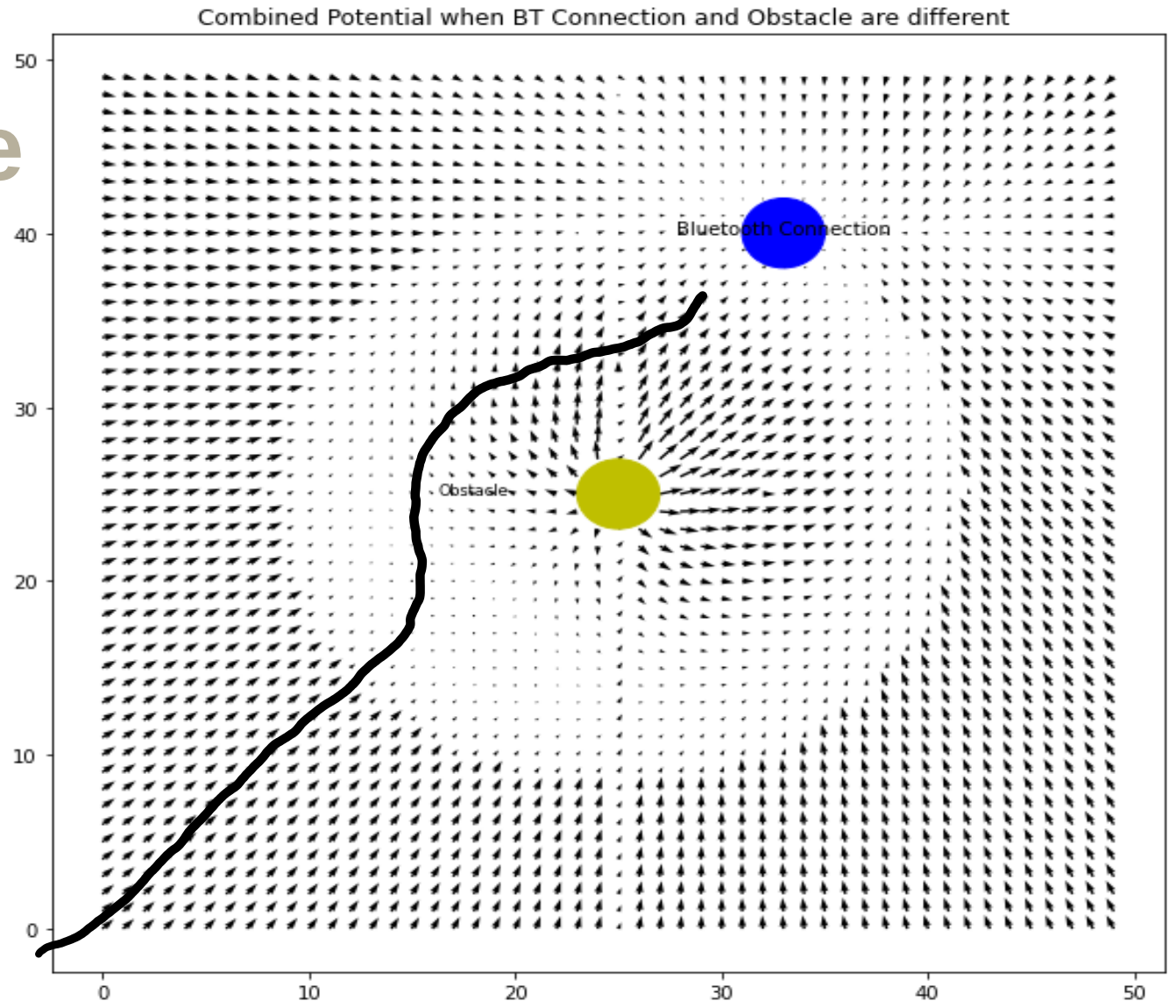
Pathfinding Equations

- A* Search
  - Informed
  - F(n) = g(n) + h(n)

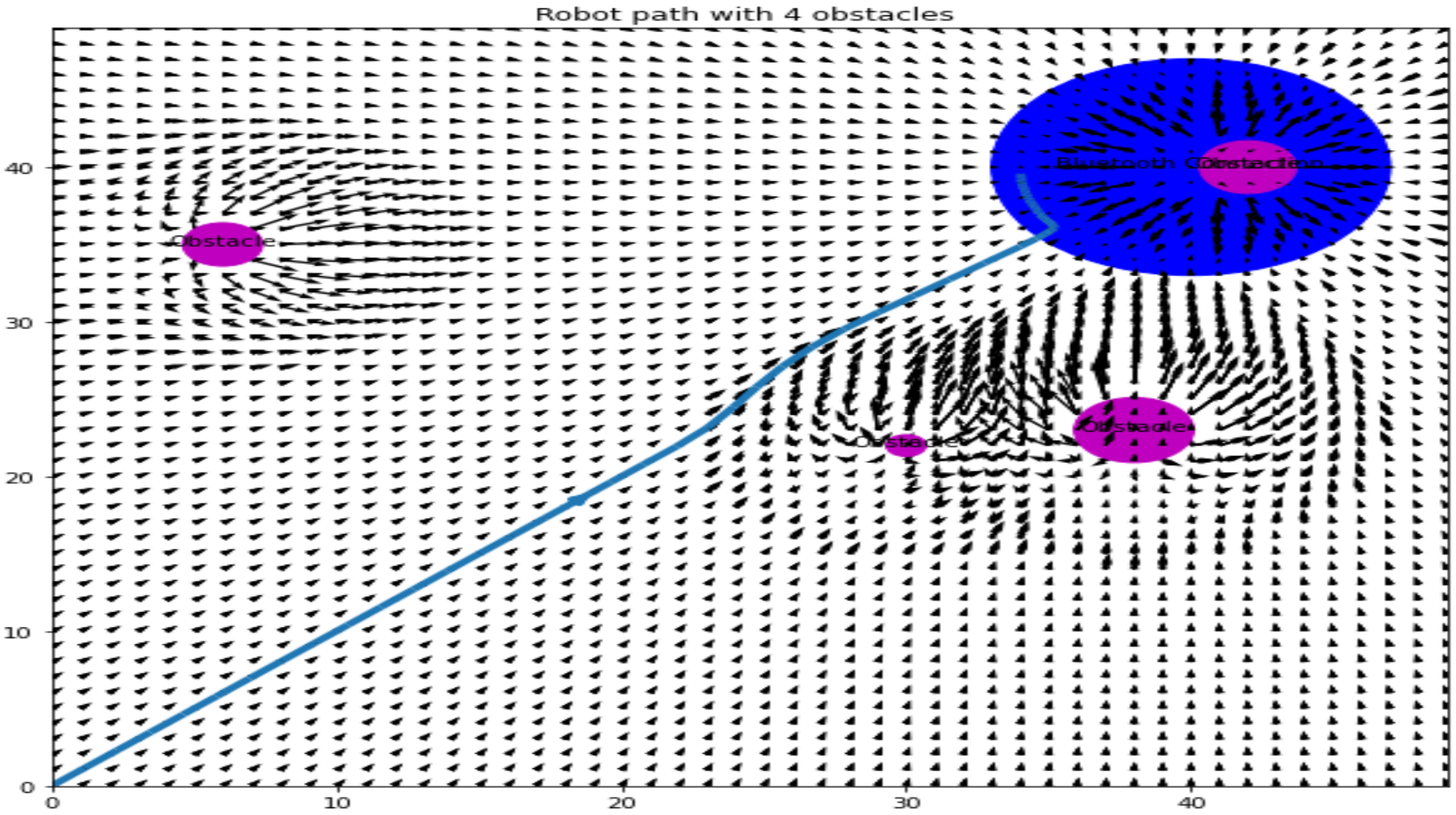
Figure 1. A implementation. Retrieved from "algorithm Tutorial => Introduction to A* (riptutorial.com)"*

Obstacle Avoidance

- Robot will follow person via Bluetooth connection (attractive potential)
- Avoid obstacles (repulsive potential)



Potential Fields Implementations



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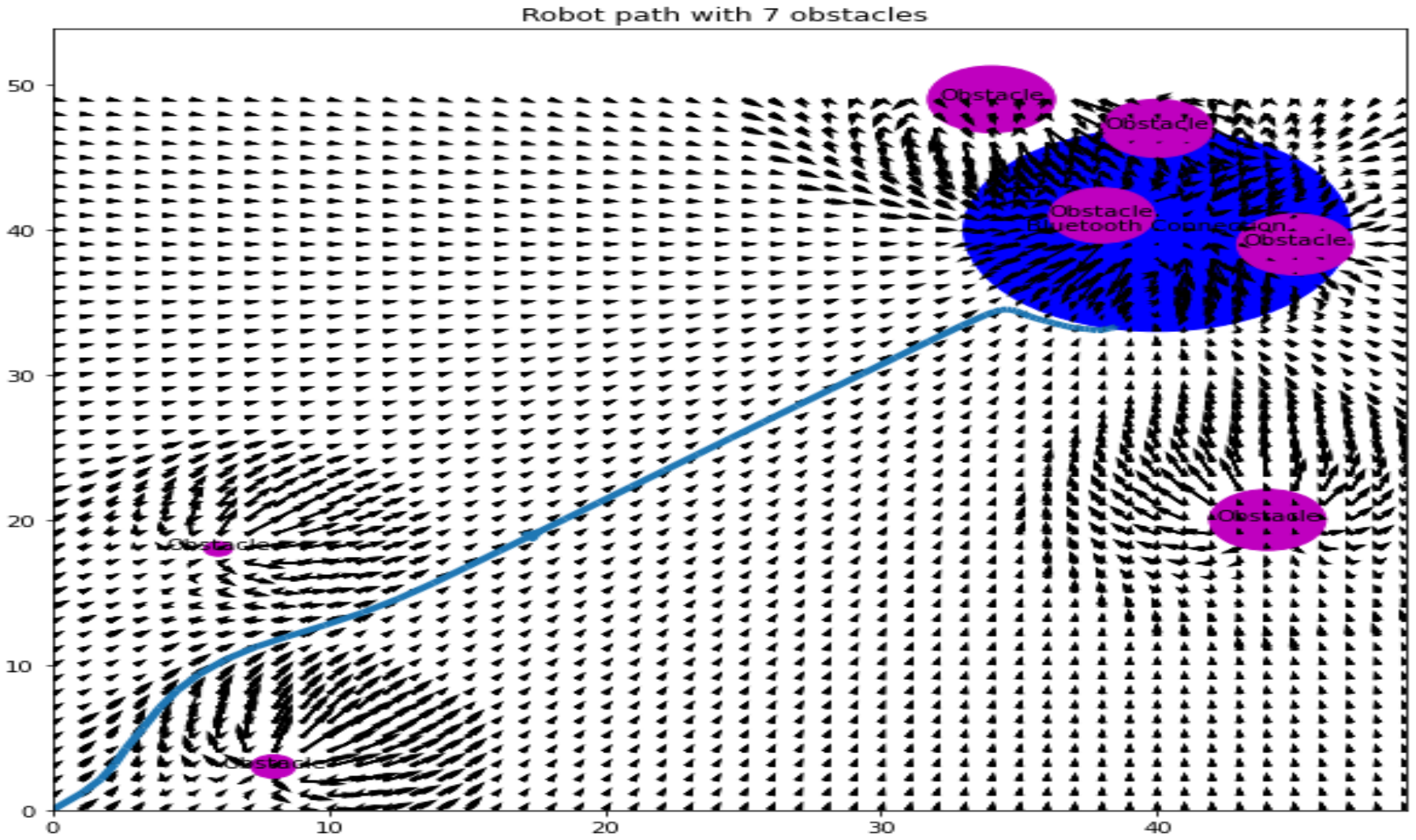
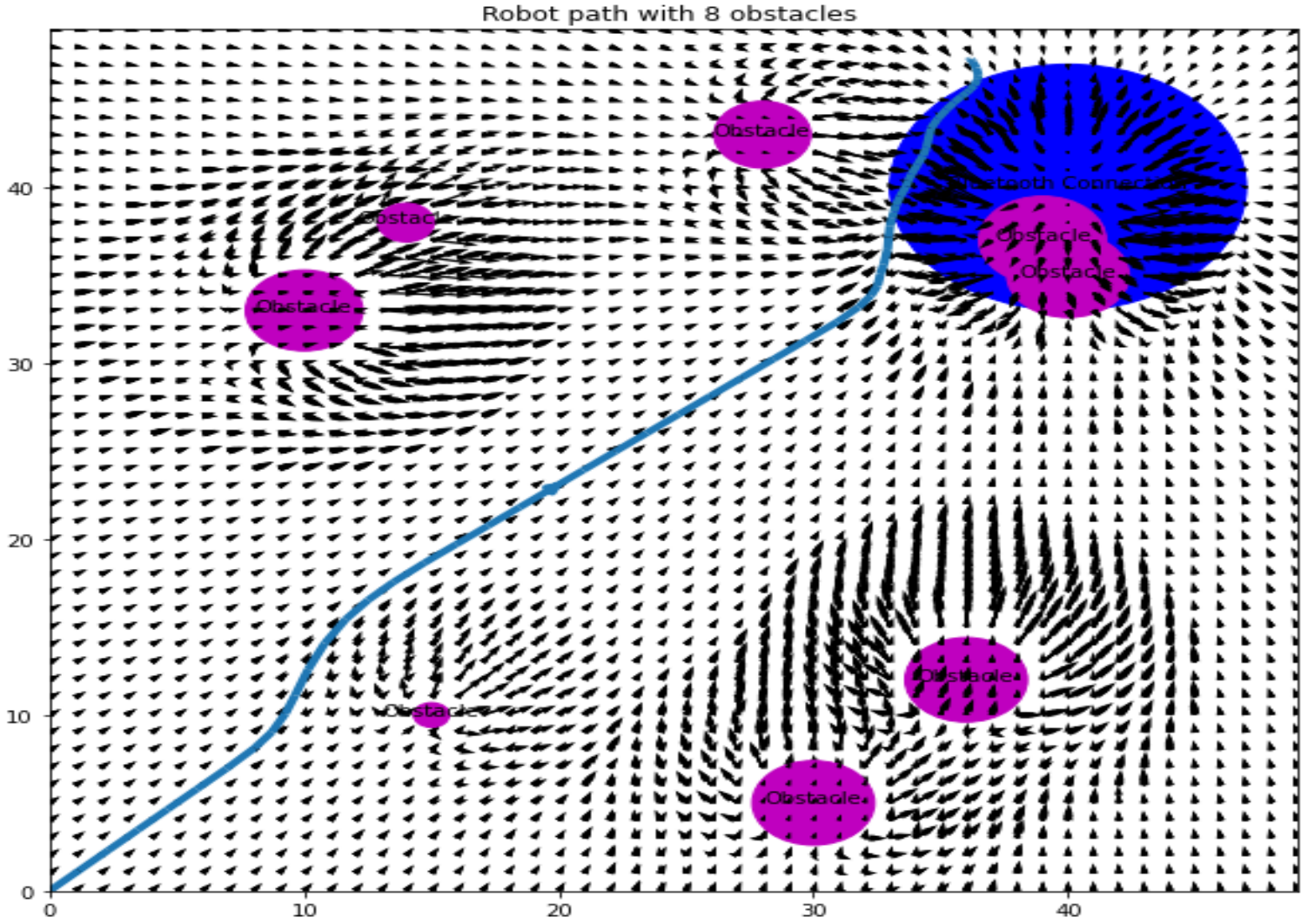
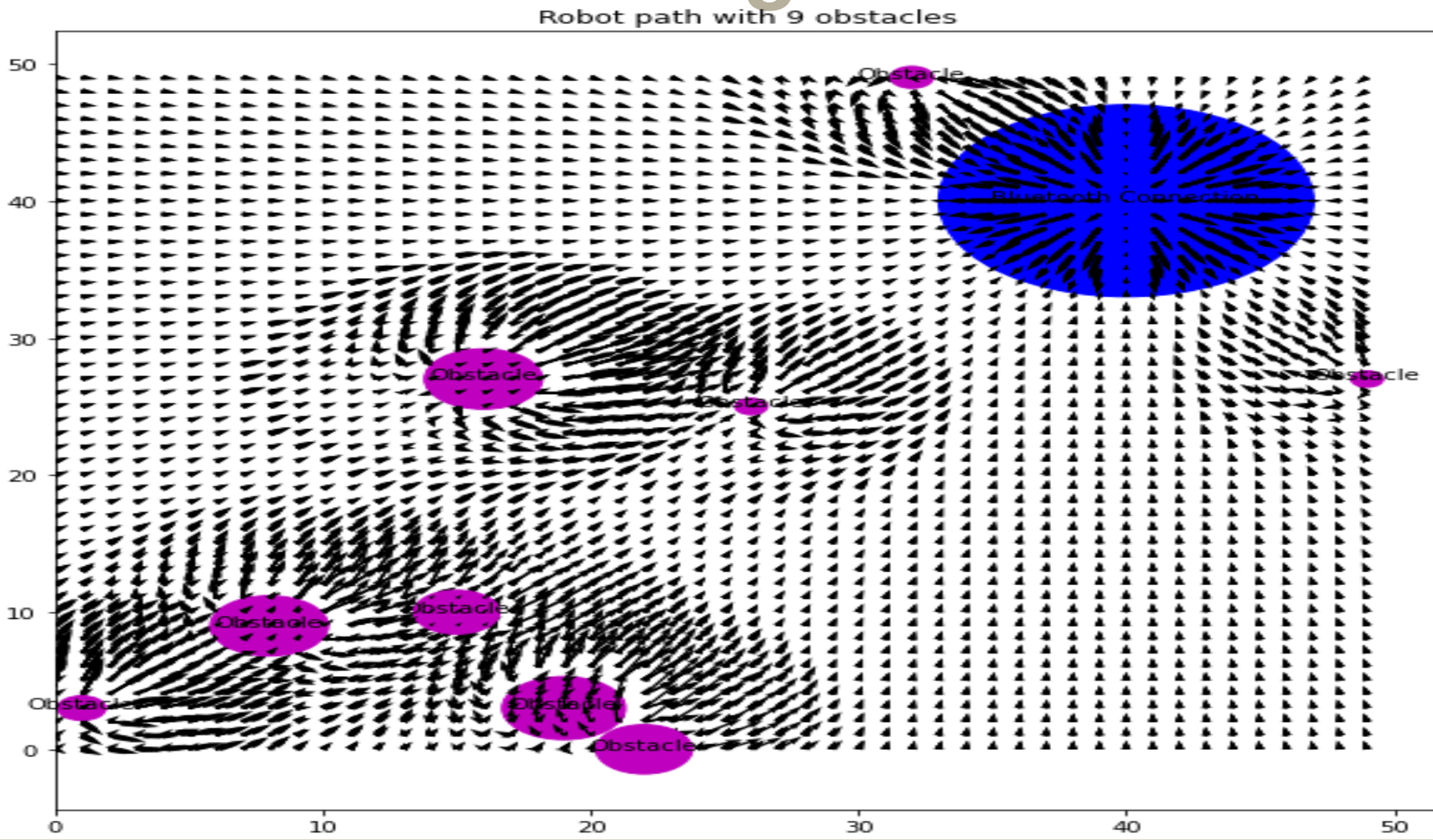


Potential Fields Implementations



Potential Pathfinding Issues & Fixes



Potential Pathfinding Issues & Fixes

- No solution?
  - We've reached local minima
  - Solution?
    - Random movements
      - Example

```
If(local minima)
    Go left
  If(not possible)
    Go right
    If(not possible)
      Ping user
```

Pathfinding to Motors

Camera - Digital Camera

Smart Phone - Display

Phone App

Mode Command

Bluetooth Connection

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Object Detection

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Motor(s)

CAN Communication with Motors

- Connect to the joystick from the motors

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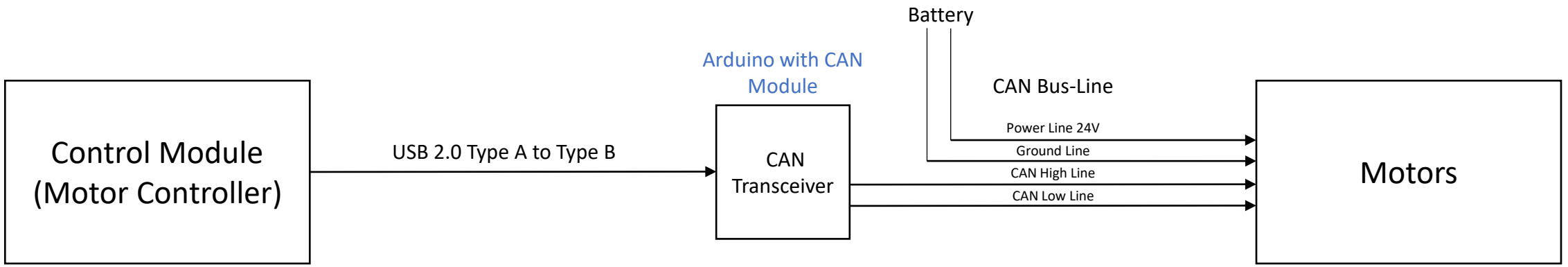
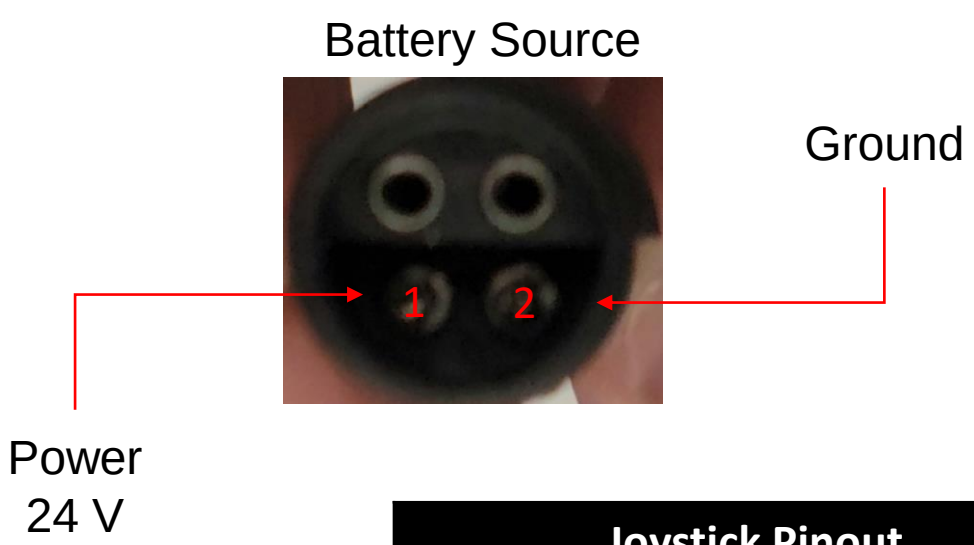
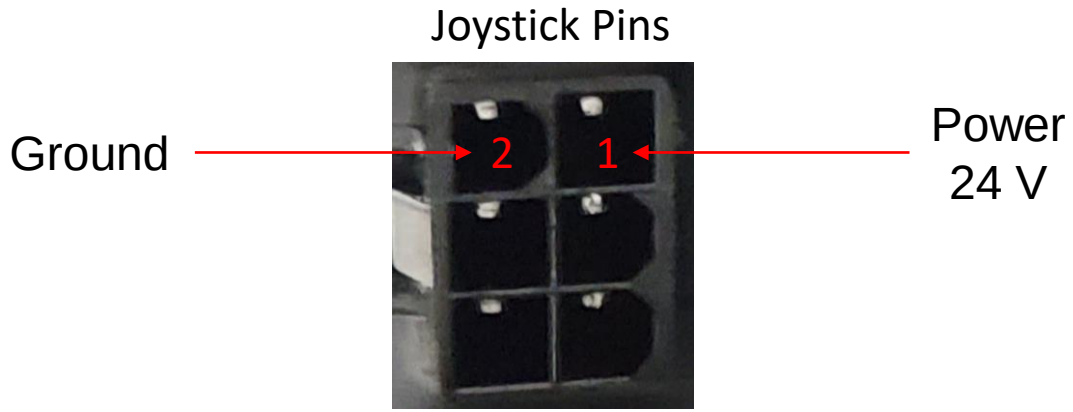


CAN Bus Interface Wiring Diagram

CAN Communication with Motors





Joystick Pinout	Function
Power 24V	1
Ground	2
CAN Low	3
CAN High	4

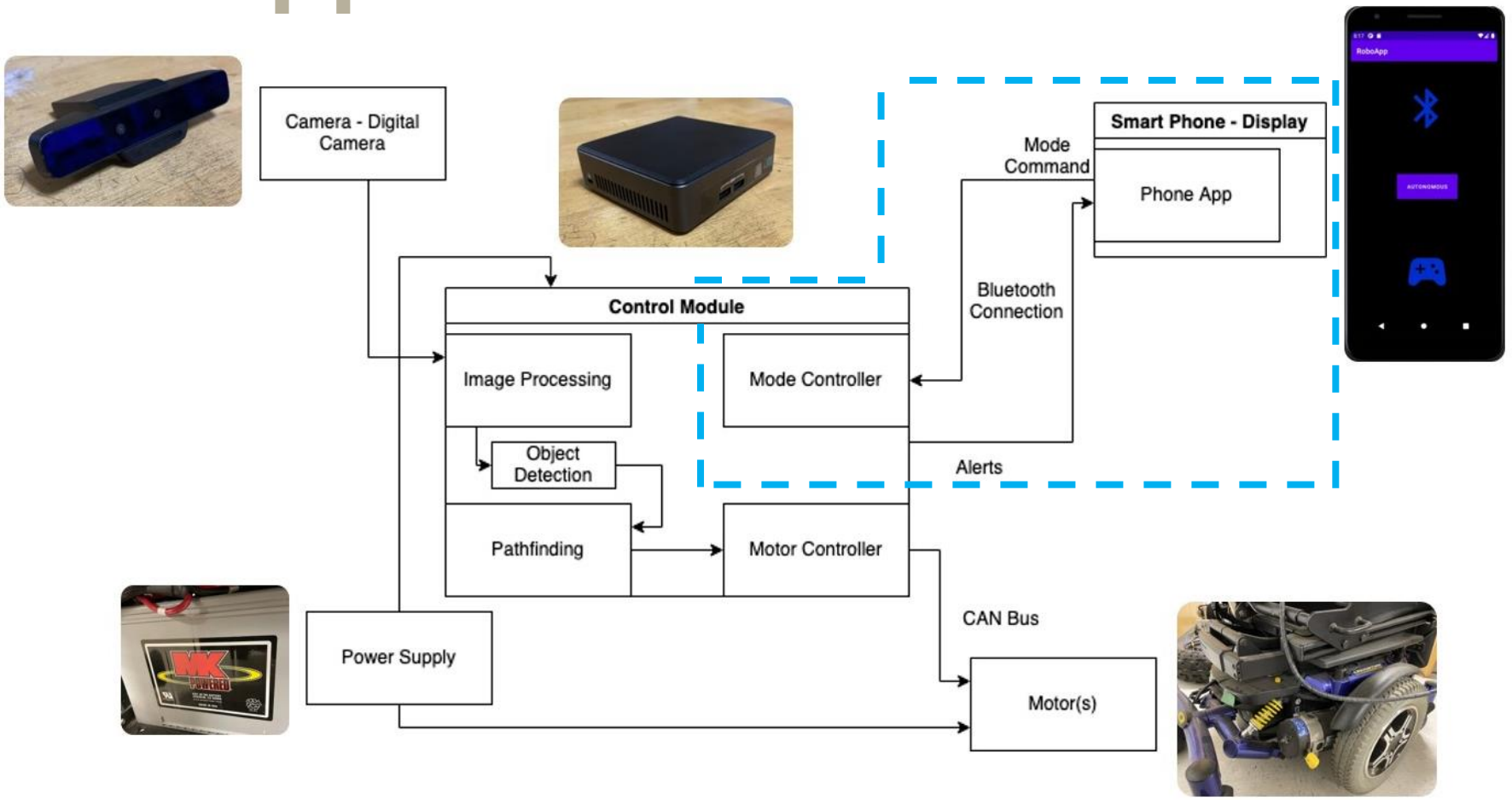
[3] Joystick Pinout

CAN Communication with Motors

- Define possible Joystick Commands
- Identify CAN messages for sending and receiving
- Build CAN frames to send

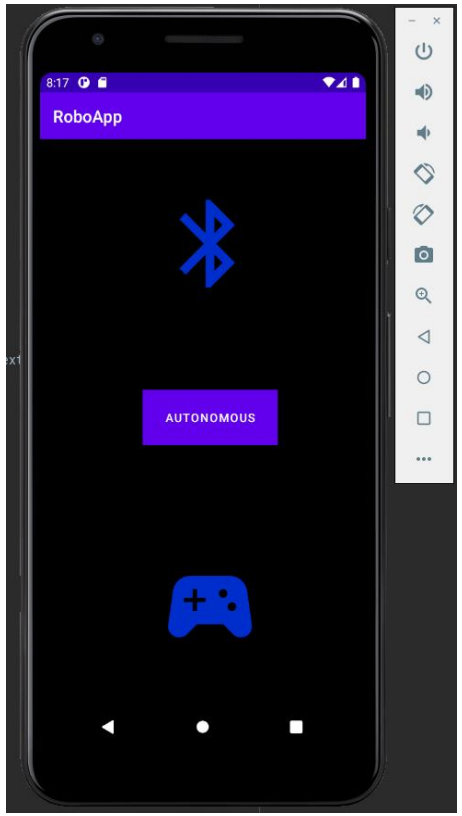
Command	Purpose	CAN Messages
Configure Communication	Exchange and Initialization	7B3# 1FRSTtUu#
Set Motor Speed	Sending	14300100#E802
Move Motors	Sending	02000100#XXYY

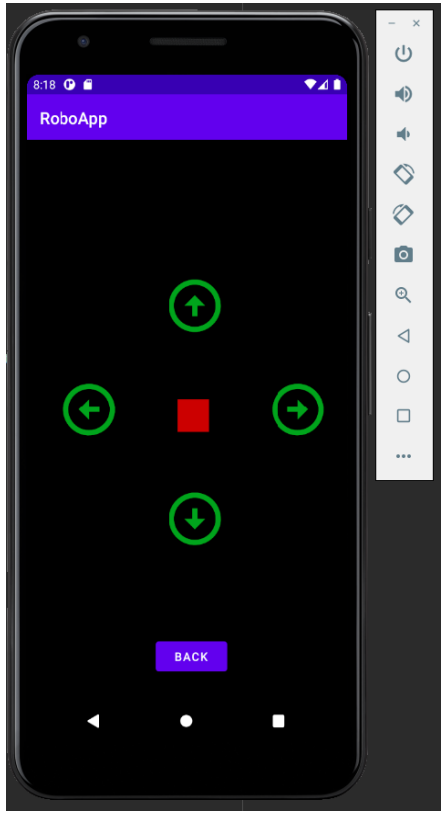
Mobile App to Control Module

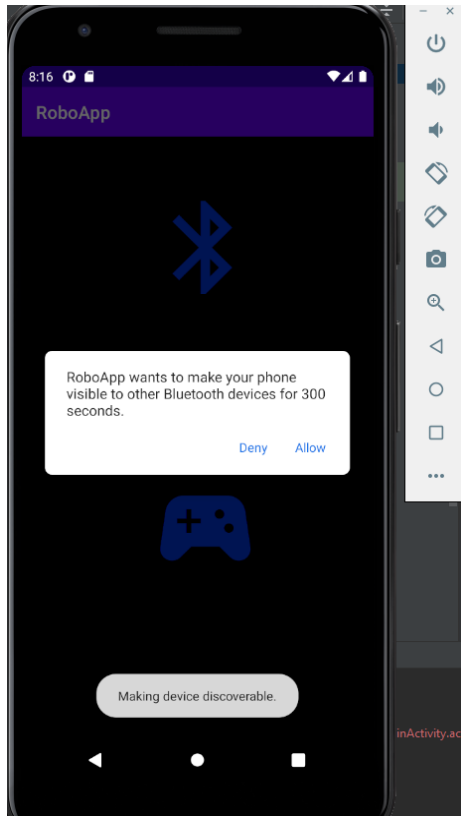


App Connection

- Currently Android only
  - Apple in future
- Bluetooth capable
- Controls mode of the robot
- Can be used to send manual commands

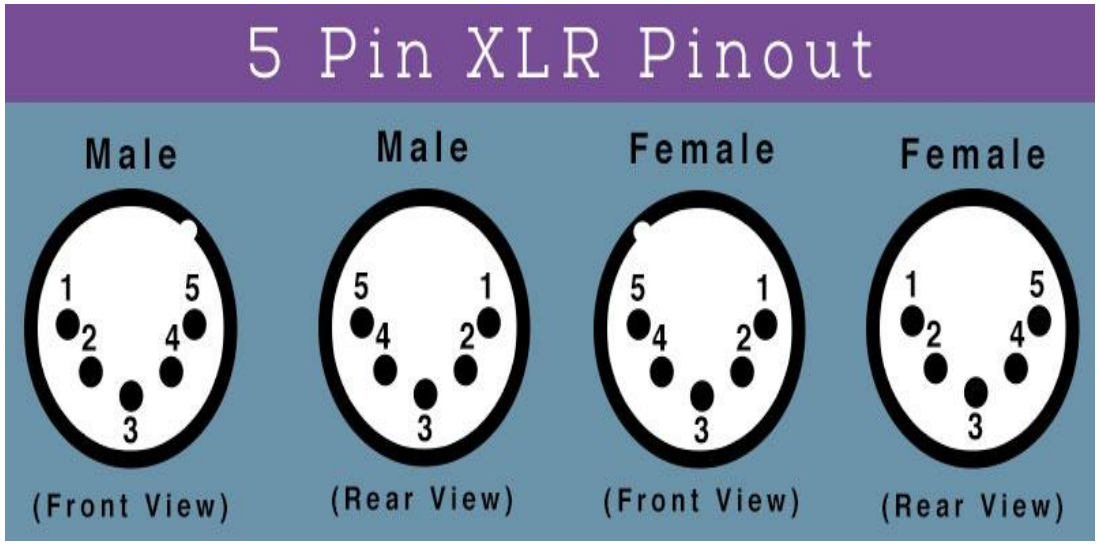






Powering the Service Robot

- Charging connection pins to charge battery

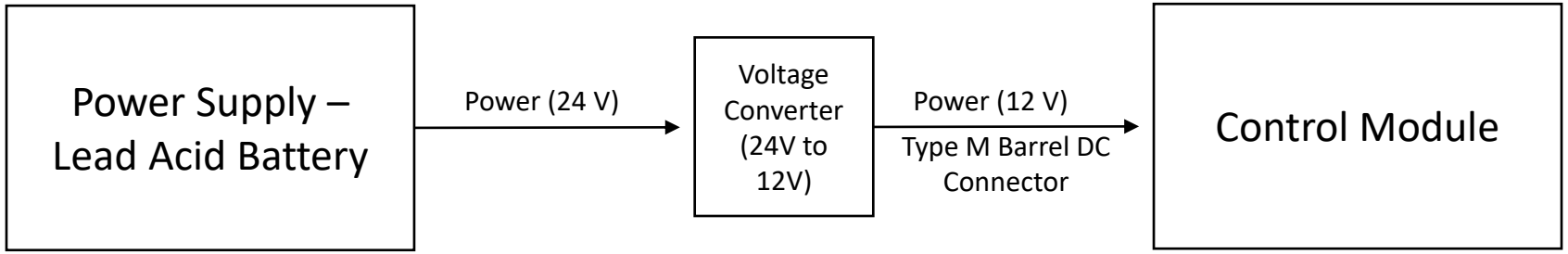


[4] Charger Port Pinout

- Pin 1: Shield (Common)
- Pin 2: DMX 1 Negative
- Pin 3: DMX 1 Positive
- Pin 4: DMX 2 Negative
- Pin 5: DMX 2 Positive

Powering the Service Robot

- Charging method to recharge the two wheelchair batteries
- Connection from battery to control module available



Future Works

- Send CAN messages to move motors
- Run commands with Bluetooth connection between mobile app and control module
- Test wheelchair operation with control module attached
- Calibration module to identify user from other people
- Integrate all modules and test complete functionality

Questions

Citations

- [1]"Person Following Mobile Robot Using Multiplexed Detection and Tracking". Agrawal, Kush and Lal, Rohit. [GitHub]. Singapore: Springer Singapore, 2021
- [2] Department of Electrical Engineering and Computer Science and Centre for Vision Research (CVR), York University, Canada, *Person Following Robot using Deep Learning in challenging situations.*, Jul. 9, 2017. Accessed on: Mar. 10, 2022. [Video file]. Available: https://www.youtube.com/watch?v=csUO6r4HtMA
- [3] PG Drives Technology, "R-NET Technical Manual," PG Drives Technology, 2009. [Online]. Available: https://www.permobil.com/us/wp-content/uploads/2016/11/R-net-Electronics-Technical-Manual-v6.pdf. [Accessed 9 March 2022].
- [4] A. Eden, "XLR Pinout Drawing and Colours," MediaRealm, 14 May 2015. [Online]. Available: https://mediarealm.com.au/articles/xlr-pinout/. [Accessed 9 March 2022].
- [5] Pride Mobility Products Corp, "Quantum Series Owner's Manual," Pride Mobility Products Corp, July 2011. [Online]. Available: https://www.manualslib.com/products/Pride-Quantum-6400z-4mp-3691821.html. [Accessed 9 March 2022].