1 Introduction

2 Design

2.1 Design Context

2.1.1 Broader Context of needs

The considerations that this team had to account for are listed below.

Area	Description	Examples
Public health, safety, and welfare.	The product must provide an option for entertainment and learning of different skills to the general public.	Product must offer interactive ways to learn new strategies by consumers. Product must be engaging enough to provide consumers with entertainment.
Global, cultural, and social	Value learning and adaptation.	Product fills the needs of curiosity in consumers. Products would pose challenges to consumers requiring some change in consumers' thinking.
Environmental	Disrupt the ecosystem with light pollution and noise pollution.	The game produces unnatural light from LEDs and noise from the speakers, which can distract the local wildlife immigration or hibernation.
Economic	Cost to consumers would be cheap to moderate to allow for a variety of consumer access.	Product needs to be affordable for consumers of various incomes. Product is low cost for the development team mitigating risks.

The Rocket League design will

3.1.2 User Needs

List each of your user groups. For each user group, list a needs statement in the form of:

User group needs (a way) to do something (i.e., a task to accomplish, a practice to implement, a way to be) because of some insight or detail about the user group .

The administrator needs to be able to correct errors in the code or bot and adjust game or player details, because if everyone had access to adjust how the bots or game operates that would defeat the purpose.

The players need to be able to customize their settings to have a unique experience, because everyone is different in play style and strategy so if the bot only had set difficulties the user wouldn't adapt to new situations as they play more.

A Maintainer needs to be able to update and fix code or bots, because admins will have access to everything from player details to code. While Maintainers will be allowed to do similar features besides adjusting or looking at player data and changing base game but can fix errors that come up.

3.1.3 Prior Work/Solutions

The Rocket league teams project references the work listed below while also project giving that well known game physical form.

Rocket League- This game is a video game in which soccer is being played by cars controlled by users.

Shortcomings: - Video game cars can be as responsive as the controller wants as there's not physical product

- Cost currently free to play online

- Customization of cars like decals on virtual cars

Advantages: - Physical product allows you to bring it around and play it with anyone

- Machine learning AI, we will have an ai robot to play against

- Desktop application that keeps track of profiles and data given by the bots

3.1.4 Technical Complexity

Our project covers being able to problem solve for solutions that we run into, as well as increase our own knowledge in our respective fields or interests. This project covers the design and creations of an autonomous bot and designing code that is reusable and well documented. We will be working with learning how machine learning allows for more versatile code. As well as, learning how to create a network connected bot to communicate with a control or default code. All of these requirements lead to a project of sufficient technical complexity.

3.2 Design Exploration

3.2.1 Design Decisions

The key design decisions that have been made:

1. What computer to use for the bots

   Raspberry Pi 3B+

2. Decide whether we are using embedded machine learning, or doing the computation on a server.

This project will utilize embedded machine learning as of now

3. Choose a frontend framework that enables cross platform development and has a low barrier of entry for new developers. (Flutter/Dart)
4. Choose programming language, framework(or not), and method of hosting for server. (Docker?, AWS?, Raspberry Pi?)
5. Choose database type(SQL/NoSQL).
6. Choose a transfer protocol for communication between bots and the application.

3.2.2 Ideation

For deciding what computer to use for the bots:

1. Arduino Mega - No one has used arduinos
2. Arduino Uno - No one has used arduinos
3. Arduino Nano 33 BLE Sense - No one has used arduinos
4. Raspberry Pi Zero WH - Works, but does not meet our computation/interfacing requirements
5. Raspberry Pi 3B+ - Works, but does not have the RAM requirements we may need for ML
6. Raspberry Pi 4

The Arduinos are microcontrollers and do not have the processing power for machine learning. The Raspberry Pi pico overheats and is also a microcontroller. The Raspberry Pi 4 is expensive, but will work well. The Raspberry Pi 3B+ has pins for I/O connections to easily test and should be powerful enough for machine learning. When we understand the processing power needed and power consumption, it may be feasible to switch to either the cheaper zero or more expensive 4.

3.2.3 Decision-Making and Trade-Off

Demonstrate the process you used to identify the pros and cons or trade-offs between each of your ideated options. You may wish to include a weighted decision matrix or other relevant tool. Describe the option you chose and why you chose it.

We first thought about the computing capabilities. We had to decide between Arduino Mega, Arduino Uno, Arduino Nano 33 BLE Sense, Raspberry Pi 3B+, Raspberry Pi Zero WH, or Raspberry Pi 4. Arduino is small and simple to use and interface with the software and other embedded hardware, butRaspberry Pi is an actual computer unlike the Arduino products, so we first narrowed it down to Raspberry Pi. Raspberry Pi Zero takes up less space and does not include extra components that we will not use, so we considered that. The Raspberry Pi 3B+ has more computing ability, so we first tried that. Raspberry Pi 3B+, with the A53 core, might not be able to classify the images for object detection quickly enough, so we may decide to go with the Raspberry Pi 4 (A72 core) instead. The Raspberry Pi 4 has a higher clock speed (1.5GHz vs 1.4GHz), more RAM (8GB vs 1GB), so it can accomplish machine learning much more quickly and efficiently. The RPi 4 uses more power than the RPi 3B+, but the performance is more important for our application than the power consumption.

3.3 Proposed Design

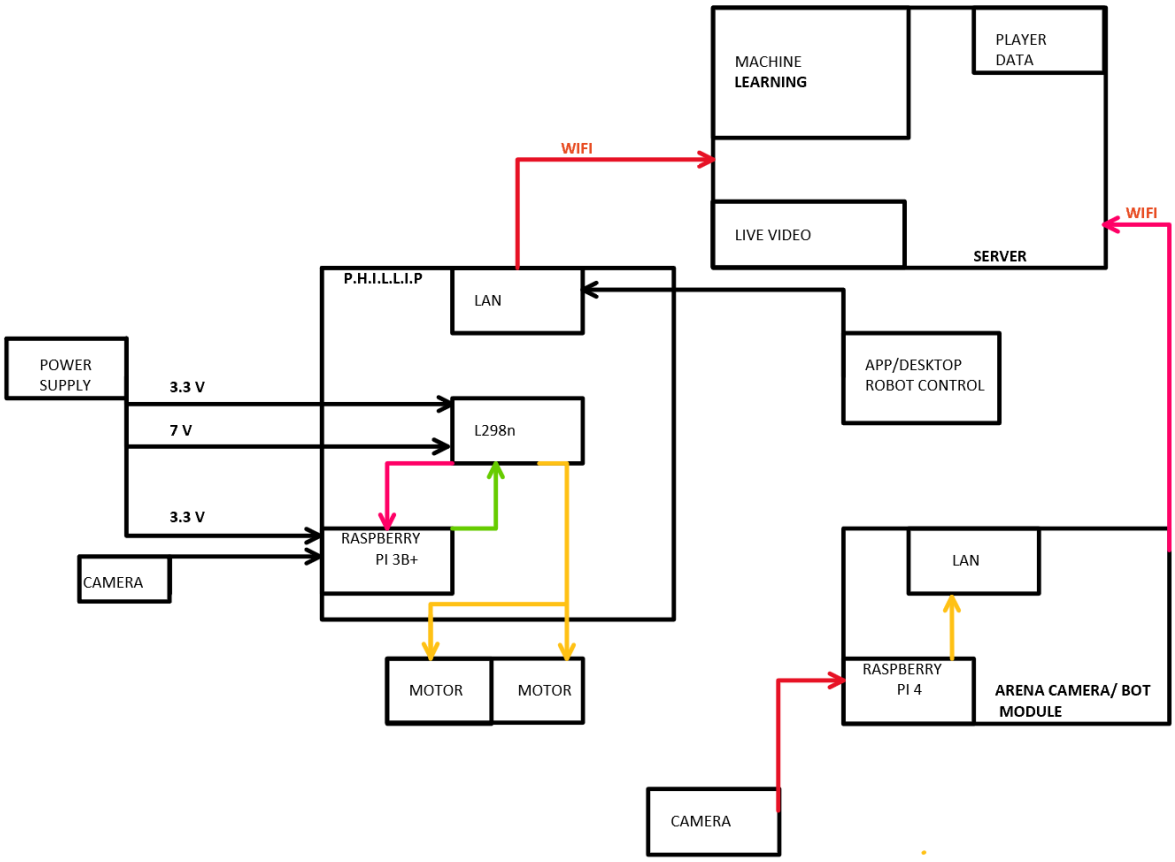
Discuss what you have done so far – what have you tried/implemented/tested?

We built the first prototype in order to test some of the parameters that we were not sure of. Through testing and some basic object detection implementation we have determined that the current camera that we have is not compatible with the standards for the object detection that we will require for the final project. Through our prototyping we have figured that the power supply that we originally designed does not have enough amp hours to supply the bot with enough power to drive. And in an attempt to test variable speed control of the motors using Pulse Width Modulation, it was determined that the motors were not complex enough to be utilized for lower speeds.

3.3.1 Design Visual and Description

Include a visual depiction of your current design. Different visual types may be relevant to different types of projects. You may include: a block diagram of individual components or subsystems and their interconnections, a circuit diagram, a sketch of physical components and their operation, etc.

Describe your current design, referencing the visual. This design description should be in sufficient detail that another team of engineers can look through it and implement it.

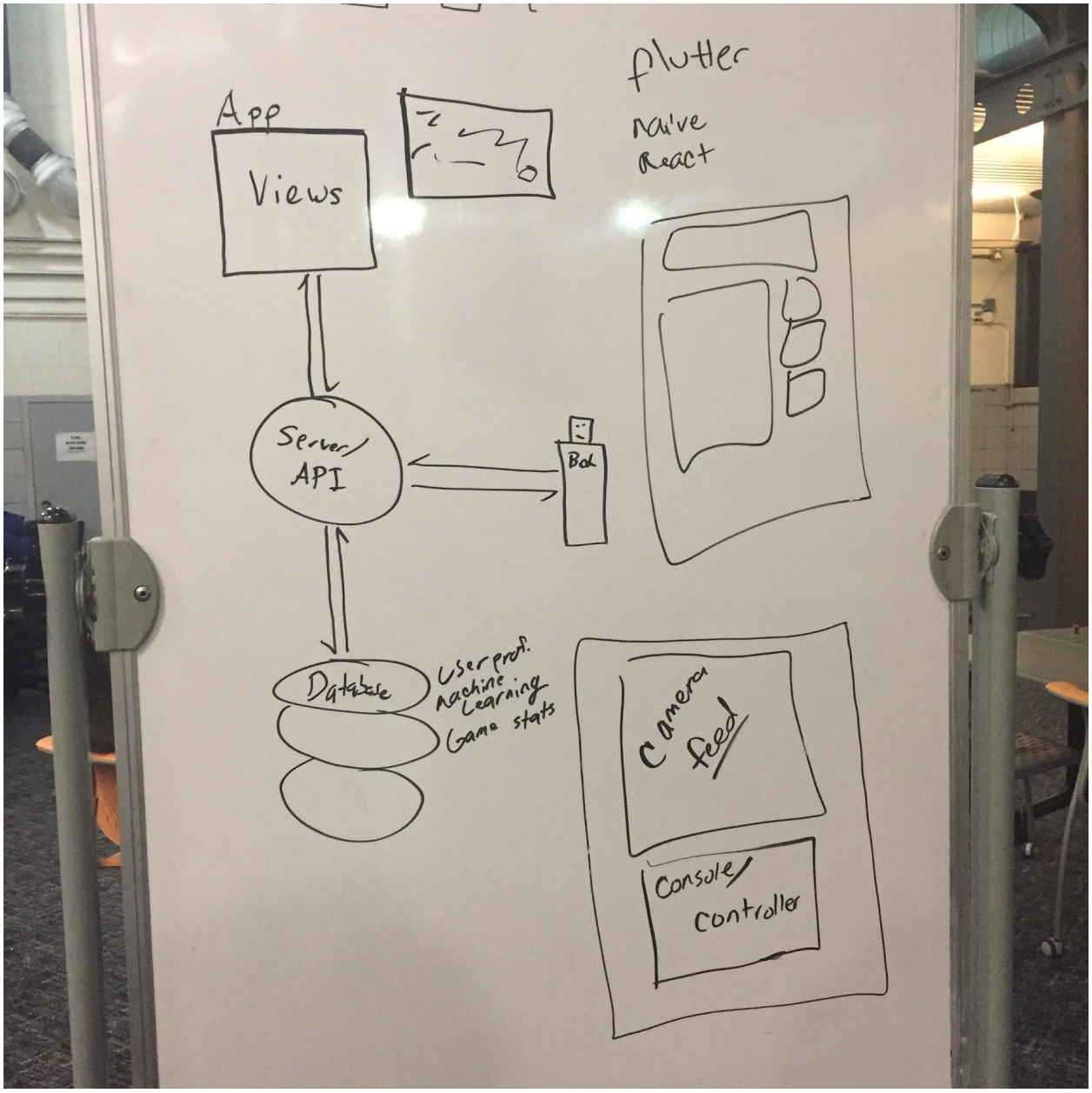


The robots consist of a physical car with the Raspberry Pi (serving as the onboard computer), L298n motor driver shield for the wheels, battery pack, a camera, and 2 motors. The robots will be connected, via WiFi, to a server. This server will interface with the application in which the user will interact to control the bot and view the livestream of the game. The server also has a database that can store the user profile information, leaderboard, etc. The arena will have a camera on the top looking down upon the game space, and this will be used for the input for object detection using machine learning. The arena camera will also be visible for the users to see the locations of the items in the game (the two bots and the game ball).

3.3.2 Functionality

Describe how your design is intended to operate in its user and/or real-world context. This description can be supplemented by a visual, such as a timeline, storyboard, or sketch.

How well does the current design satisfy functional and non-functional requirements?



Users would be able to control the bots using an application on desktop and view arena for bystanders.

3.3.3 Areas of Concern and Development

Based on your current design, what are your primary concerns for delivering a product/system that addresses requirements and meets user and client needs?

What are your immediate plans for developing the solution to address those concerns? What questions do you have for clients, TAs, and faculty advisers?

We are concerned how much AI feed we will need for the game to be fluid. For example, we need to recognize when the ball crosses the goal line, where the bots are located, and create an AI that plays well against a player.

We will have multiple members work with the AI as it seems like a huge portion and we have some ways we can use already developed models to curve some of the AI training.

Question for TAs/Advisors- Are there any glaring problems with our current structure of our system?

NOTE: The following sections will be included in your final design document but do not need to be completed for the current assignment. They are included for your reference. If you have ideas for these sections, they can also be discussed with your TA and/or faculty adviser.

3.4 Technology Considerations

Highlight the strengths, weaknesses, and trade-offs made in technology available.

Discuss possible solutions and design alternatives

3.5 Design Analysis

- Did your proposed design from 3.3 work? Why or why not?
- What are your observations, thoughts, and ideas to modify or iterate over the design?

3.6 Design Plan

Describe a design plan with respect to use-cases within the context of requirements, modules in your design (dependency/concurrency of modules through a module diagram, interfaces, architectural overview), module constraints tied to requirements.