Initial Project and Group Identification Document

Project title: **Garage Parking Aid**

Group Number: 25

Group Members:

Jennifer Castillo – Major: Electrical Engineering

Jorge Dardon – Major: Computer Engineering

Daniela Otero – Major: Computer Engineering

Nicholas Zollo – Major: Photonic Engineering

Project Narrative

Finding an idea for the Senior Design project proved to be difficult for our team. As a team with members from three different majors, any project must be diverse enough to provide a similar amount of work for all the members of the group. However, we also wanted a project with some practical applications, one that could help make our lives more convenient.

We came up with the idea for the project when one of our team members accidentally hit their front bumper of their car to one of the walls in the parking garage on their way to class. Thankfully, the car did not suffer any damage, but it was still worrying and inconvenient. What if there was a mechanism that told the person driving their vehicle that there is still space to move forward or to stop if you are close to the wall? Our design to create a parking garage aid would assist with just that. Parking in a garage can have several other difficulties as well, such as finding your car again later in the day or finding a spot to park in the first place. Our design will include solutions to these problems as well as other mechanisms to improve the overall experience of parking.

Project Goals and Objectives

The goal for this project is for it to be a self-contained system that can attach to the wall of any typical parking garage where a vehicle is parked and can detect the position of the car to avoid collision with that wall.

Another goal of this project is to design a raspberry-controlled camera that does a scan of the area in front of the vehicle where it is to be parked and to detect objects that can give the driver a hard time to park, or that may pose a threat to safe parking such as toys, pins, needles, and so on.

Project Objectives:

- Provide a working electronic system that is cheap to produce.
- Design and build a Printed Circuit Board (PCB) that will be used as the main controller.
- Build a LIDAR or infrared sensor that will me the main device component to measure physical distances.
- Create a camera detection system for objects that may present a difficulty to parking.
- Create a mobile phone application that provides a set of added features to the device such as (turn on and turn off, a counter for how long vehicle has been parked, and a usable interface for individual components that may be individually activated, among others).
- System provides clear output via some programmable LEDs.
- System is small enough to be viable for garages of any size.
- System can withstand splashes of water or contact with foreign substances.
- System is built with materials that are easily acquirable by large commercial enterprises like Walmart, Amazon,etc.
- System will be low power.
- System should measure where the car is likely to be parked (from data of at least a few parking attempts) and scan the area for parking obstructions or threats, hereby referred to as the bounding box.

- System should ignore objects outside the bounding box.
- System's mobile app should alert the use through notification if a threatening object is present for at least 10 minutes.
- System should ignore objects that are too small and/or pose no threat.

Function

The fundamental function of the garage parking aid is to alert a driver parking either forward or in reverse in a parking space if they are within near proximity from the wall. This device will hang from the wall with all its components compartmentalized in an enclosure. Visual LED lights would alert driver when it is okay to continue driving near the wall and then the color or pattern of light would change significantly enough to alert driver of high-risk proximity. Audio cues have yet to be determined but if possible, to integrate, will also enhance the garage parking aid in alerting the driver. A short-range detecting sensor is needed to be able to measure the distance between the wall and vehicle.

Currently, we are planning on designing a laser rangefinder to measure the distance, and we will attempt other methods if we are unable to make it work. The laser rangefinder shouldn't make a visible spot, so we should use infrared light of wavelength around ~900 nm. The laser rangefinder will be thoroughly tested, as its measurements need to be accurate and fast for our system. The entire system depends on the distance sensor, so errors will not be accepted. We are aiming for a refresh rate of at least 20 Hz and measurement accuracy of a few centimeters. If the infrared laser rangefinder does not meet specifications, we will try other distance sensors such as ultrasonic, interferometers, laser triangulation, or LiDAR.

Another function yet to be confirmed to be part of project is having the capability of locating vehicle. This would be accomplished by the driver being able to download an app that would have varying features related to parking in a garage. Not yet to be determined if a short-range wireless communication system would be used to communicate from the device to mobile application to aid in guiding driver to vehicle if feature enabled. Another method being considered to aid driver in locating vehicle via mobile application would be enabling an alarm with visual and audio cues to aid in locating vehicle without the need of wireless communications. Other features are in consideration to add to the mobile application idea involving aiding drivers with parking in a garage.

It is intended that the design and development of this project to be low in cost and power consumption, compact, resistant to outside conditions such as water, sunlight, high and low temperatures, etc. We want to use materials that are eco-friendly. It is intended to design the enclosure using NEMA 3 or higher for protection against outdoor conditions.

Requirements and Specifications

Hardware Requirements:

1.1	The system will be able to accurately measure distance to a car pulling in
1.2	The system will have RGB lights to indicate distances
1.3	The system will be accurate for most car designs and heights
1.4	The system should be attachable to an existing parking garage
1.5	The system will be safe for users, particularly the laser rangefinder used
1.6	The system will have a separate display which can have various functions
1.7	The system should be able to work in different weather conditions
1.8	The system should not stick out far from the wall, so that it may be easily implemented
1.9	The system should be able to be powered and remain turned on indefinitely
1.10	The laser spot should not be visible to human eye
1.11	The system will be powered by one main power source
1.12	System overall will be low voltage
1.13	System will follow NEMA enclosure requirements
1.14	System must have a method of disconnect

Software Requirements:

2.1	Use Raspbian Operating System.
2.2	Use of an iOS app building Software (Swift) to create the app.
2.3	The system will code how to display the LED lights (colors, speed, patterns, etc./)
2.4	The system should update the distance measurement and lights at a high refresh rate.
2.5	The system will detect when a car is parked in a spot and show a different state.
2.6	The camera will only find objects within a bounding box
2.7	The bounding box should be determined by previous parking location data
2.8	The camera will ignore objects that are smaller than a certain size (without sharp edges)
2.9	The camera will ignore objects that are not stationary for more than 10 minutes
2.10	The system will use computer vision algorithms, either built in with OpenCV or coded from scratch
2.11	The iOS app should provide an accurate reading to the nearest .1m of the physical distance between the vehicle and the LEDs
2.12	The app should send a notification (if enabled) to the user when their vehicle is in proximity of the system, letting users get quick access to the app

Possible Project Constraints

We are early in the design process, so we have not come across the problems that will decide most of our constraints. However, since our project is now entirely self-funded, cost and budgeting will be a major factor. We are going to have to research different components that will give the same results but for cheaper prices, and good for the environment as one of our objectives is to be low cost and eco-friendly. Optical components are expensive, so there will be a tradeoff between the quality of our rangefinder and the cost of its components. Another constraint will be the size of the rangefinder. Many rangefinders act like pointers and are long in the direction they point towards, but this is not permissible for our design as we don't want the components to stick out a significant distance from the wall.

Some of the more physical constraints involve the visual and audio cues that would be used to alert the driver parking the vehicle near the wall. The lights would have to counteract and still be noticeable to the red rear brake lights or white front lights in most commercial vehicles. The system cannot fully operate in environments where the light level drops too low as it can interfere with the functionality of the camera. The audio cues would also have to be loud enough to alert driver and yet still be safe and within regulation of garage and building code.

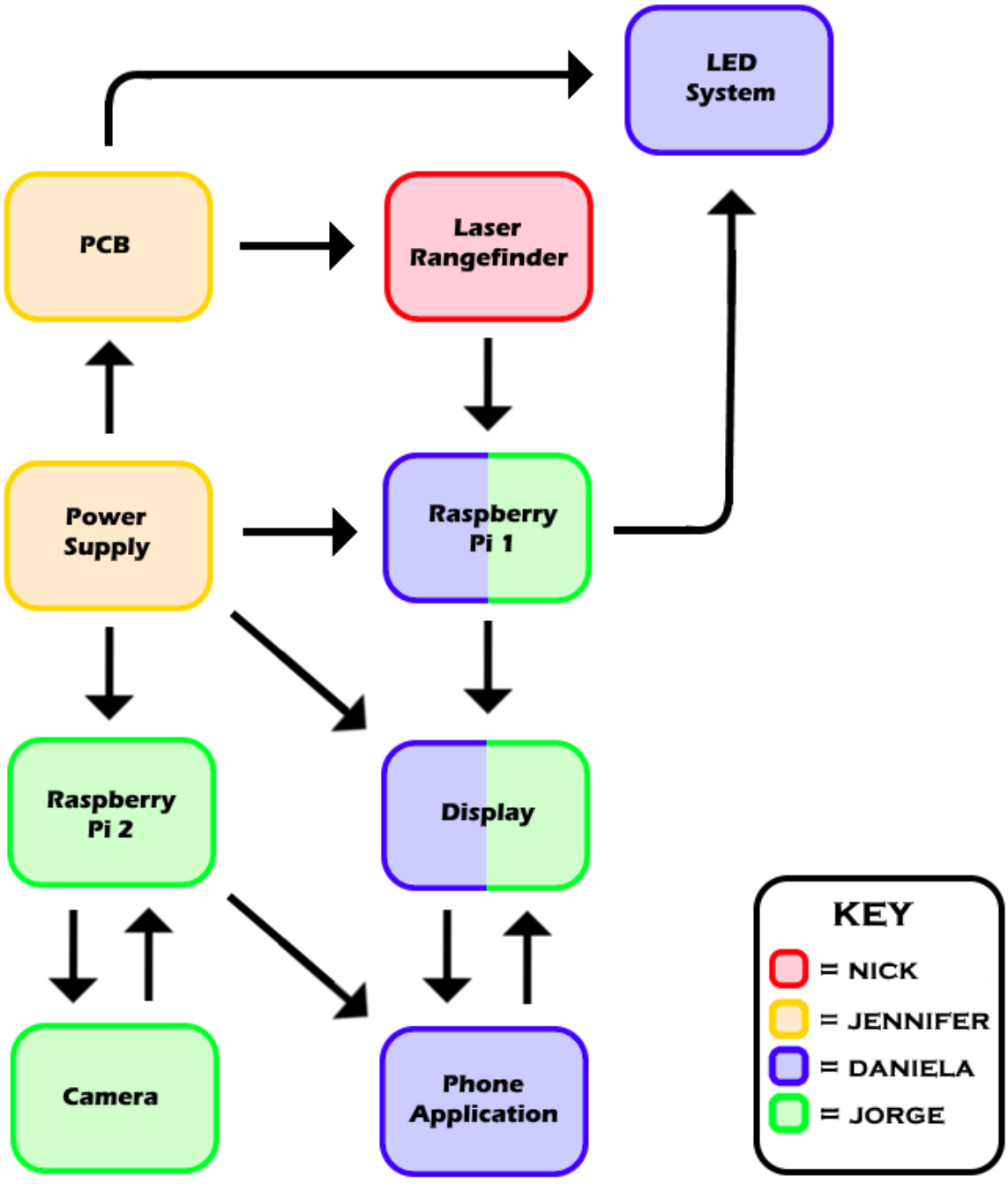
Another constraint could be if we end up needing to use a 3-D printer to create a closure around the Raspberry Pi and a railing to hold the LED lights.

In consideration of adding a feature to the mobile application involving locating a vehicle from a short or long range would involve constraints of mobile app user and Garage Parking Aid device being able to communicate either short range distances (e.g. Bluetooth), or long-range distances.

More common restraint is that this device will be ideally located in outdoor conditions inside a parking garage. Requiring that the deice can withstand outdoor conditions such as extreme weather, rain, wind, and snow.

Another constraint would be in how we test the Garage Parking Aid. We would only be able to test it in parking garages for short and long ranges, as well as testing the audio cues, since we won't have access to the parking garage as often as we would like, we would have to do the beginning stages of testing at a home garage.

Block Diagram



Budget and Funding

Currently, the plan for our project is to be entirely self-funded, although we may search for sponsors in the future.

Item	Quantity	Price Estimate
NEMA 3 or higher enclosure	1	$50
Outdoor Strip Lighting	1	$30
PCBs	N/A	N/A
Raspberry Pi	1	$50
Camera	1	$10
Components (Resistors, Capacitors, etc.)		$5
Infrared Laser Diode	1	$50
Lenses	2	$40
Infrared Filter	1	$100
Photodiode	1	$20
AC power converter or batteries	1	$15
TOTAL	N/A	$370

Senior Design 1 Project Milestones

Milestone	Planned Week of Completion
Get approval/suggestions for project by Dr. Wei	5
Research different components	5
Complete initial rangefinder design and order parts	6
Updated Divide and Conquer	6
Choose components	6
Calculate power loads to design PCBs	7
60 page SD1 Draft	8
Complete building rangefinder	9
100 page SD1 Draft	10
Test rangefinder	11
Test programming on commercially bought infrared sensors	11
Final Draft	13

Senior Design 2 Project Milestones

Milestone	Planned Week of Completion
Order all materials not acquired from SD1	1
Assembly of materials in enclosure	4
Attaching sensor to PCB and microcontroller	5
Camera object detector confirmed working	8
Testing	8
Phone application complete	10
Final Draft	12
Presentation	13