

Super Mileage Vehicle Camera System

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# **Abstract**

The Super Mileage Vehicle (SMV) project focuses on increasing the safety of the driver by implementing a simple camera system. The previous method used by the driver was looking out of small cutouts on either side of vehicle and between the driver’s feet to the front windshield. The new system will be implemented by using three simple cameras connected to a Raspberry Pi, and the video will be outputted to a monitor inside of the vehicle. The purpose of this design project is to improve the safety of the driver by increasing the field of view (FOV) so that they can see more of their surroundings. This report shows the design requirements and objectives, as well as the expected operations of the system.

# **1. Problem Statement**

The problem presented to the team was that the driver of the Super Mileage Vehicle (SMV) had extremely poor visibility out of the windshields. As shown in Figure 1, the current SMV has small windows on either side and a curved front windshield. The curved front windshield creates a fisheye lens effect which distorts the driver’s visibility. The side windows are approximately three inches high and are partially covered by the wheels of vehicle. In order to increase the driver’s safety and visibility, we must implement a safer system through the use of cameras and digital technologies.



Figure 1: Super Mileage Vehicle

## **Needs Statement:**

The Society of Automotive Engineer’s club (SAE) is a club at Pennsylvania State University that competes to design a Super Mileage Vehicle.

The system needs to give the driver a minimum of 160 degree field of view from the front of the vehicle. Additionally, the system must allow the driver to see 1.5 meters above the ground and 6 meters out in front of the vehicle. The system will be low-cost, lightweight, battery powered, and have a minimum count of 720-1080 pixels resolution.

## **1.2. Objective Statement:**

The goal of this project is to design a low-profile camera system for the SMV in order to increase driver visibility and safety. In order to accomplish this, a low-profile camera system will be connected to a microcomputer with a simple Operating System (OS). The system will display the live feed of the driver’s surroundings to a monitor inside the vehicle. Depending on cost and time, the system may also implement an audio transceiver in order to communicate with the driver.

## **1.3. Background and Related Work:**

The Society of Automotive Engineer’s club (SAE) is responsible for building the SMV, which is capable of traveling 2,000-3,000 miles on a single gallon of gas. The multidisciplinary SAE club has multiple, small groups of engineering students (Mechanical, Electrical, Computer, etc.) working on each component of the vehicle separately. The society attends an annual competition in which universities and colleges all over the world can compete for the best fuel economy vehicle. Figure 2 shows the SAE club during the 2018 competition, with the previous SMV model. Each year the club looks to construct/improve upon the existing vehicle in order to maximize fuel efficiency.

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Figure 1.3: Society of Automotive Engineers (2018)

## **1.4. Time Pending Objective:**

Along with the camera system, the SAE team leader has asked if it will be possible to improve the communication system currently being used while on the course. The reason for this additional objective is because the current method of communication uses walkie talkies, which can lose signal after a certain range and can distract the driver while on the course. The SAE team would like to improve or change the method. In order to do this, a communication system that has a long range and is hands free would be most desirable. While this is not the main objective of this project, it would be very helpful to the team and the driver while competing in the competition.

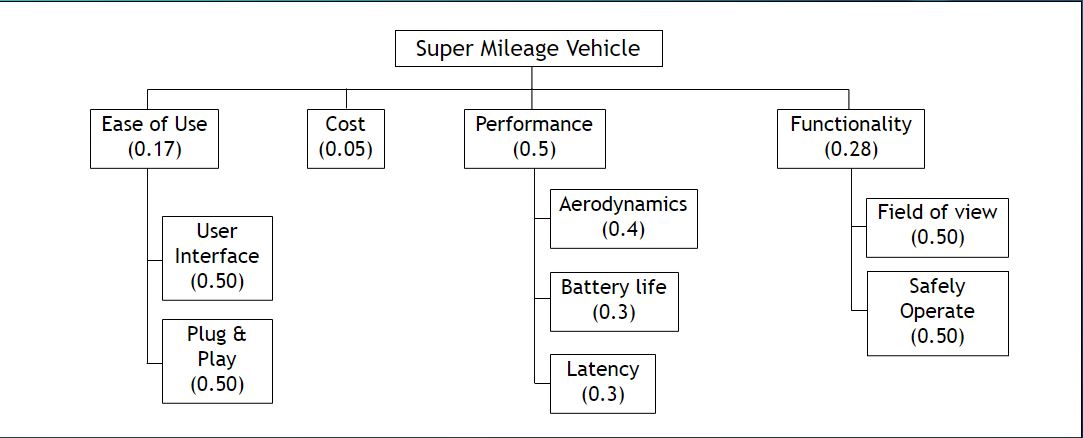
# **2. Project Requirements:**

## **2.1. Marketing Requirements:**

The Camera System Should:

1. Be easy to use
2. Provide an interface for the driver to access
3. Be low profile
4. Be easily upgraded and/or replaced if necessary
5. Provide clear field of view to driver
6. Be stable
7. Not affect the aerodynamics of SMV
8. Have a power supply/battery that is separate from the engine.

## **2.2. Objective Tree**



**Figure 2.1: Objective Tree**

**2.3. Engineering Requirements:**

|  |  |  |
| --- | --- | --- |
| **Marketing Requirements** | **Engineering Requirements** | **Reasoning** |
| **4** | **Cameras should be at least 720p.** | **The camera display to the driver will emulate windows that are being replaced.  Having top tier quality is important.** |
| **2,6** | **Cameras need to be small and should not require major modifications to SMV to attach them.** | **Per competition rules, the camera system needs to be low profile, and should not affect the performance of the SMV itself.** |
| **4** | **The camera feed should be able to view objects at least (0-5ft) from the ground.  They should also be able to view objects at least (0-20ft) out in front.** | **The driver should be able to see objects, vertically and horizontally as required, in order for them to see objects at a quicker rate.** |
| **3,7** | **The power supply being used should only apply to the camera system and should be easily replaced and/or upgraded.** | **Per constraints, any source of power that is chosen must only be used to power the camera system’s interface.** |
| **1,2** | **Driver must be able to access the camera interface inside the vehicle.** | **The driver should be able to edit the camera system’s settings in order to provide them with a safe and proper view of the track and its surroundings.** |
| **4,5** | **Cameras must remain in place and should be protected from potential damage.** | **In cases where the SMV may crash or collide with other vehicles, the camera system should still be in place and functioning properly.  If not, it should be easily replaceable.** |
| **Marketing**  **Requirements:**   1. Be easy to use 2. Provide an interface for driver to access 3. Be low profile 4. Be easily upgraded and/or replaced if necessary 5. Provide clear field of view to driver 6. Be stable 7. Not affect the aerodynamics of SMV 8. Have a power supply/battery that is separate from the engine. |  |  |

**Figure 2.2: Engineering Requirements**

## **2.4. Constraints:**

**Technology -** The programming of the camera system must be familiar with the rest of the SMV designing team(transmission, mechanical, etc.).

**Social -** The low profile camera system must be easily accessible by the driver.

**Measurables -** The cameras must be able to give the driver a clear field-of-view.  With a height range from the ground up to at least 5ft, and a view from up close out to at least 20ft in front.

**Usability** - The camera system’s interface will have very few instructions on how to operate it.

**Performance -** The cameras need to be low profile and must not affect the SMV’s aerodynamics.

## **2.5. Standards:**

1. Design Methods
   1. Architectural diagrams according to UML (Unified Modeling Language)
2. Programming Language
   1. Use of Raspberry Pi or NVIDIA command prompt, or use of python will be used
   2. All programming in python will follow PEP 8 Design Guidelines
3. Documentation
   1. All code will be clearly commented or command prompt lines will be shown
   2. All design diagrams will be compiled for documentation
4. Testing
   1. The testing aerodynamics of vehicle and camera system will be provided by the SAE team using a software of their choice

# **3. Design**

## **3.1. Preliminary Level 0 Architecture:**

As seen in Figure 3.1, the Design Level 0 Architecture shows the entire project as one module, in this case the Camera System. This module has no other modules entering it, as there is no need for any. This broad look at the system allows all inputs and outputs to be shown as they enter and exit the Camera System module. All of the inputs of the system will be set, unless later in design stages user inputs need to be implemented.

![PowerPoint

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generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAeAB4AAD/4RDuRXhpZgAATU0AKgAAAAgABAE7AAIAAAAMAAAISodpAAQAAAABAAAIVpydAAEAAAAYAAAQzuocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEFuZHkgQnJlaWVyAAAFkAMAAgAAABQAABCkkAQAAgAAABQAABC4kpEAAgAAAAM4NAAAkpIAAgAAAAM4NAAA6hwABwAACAwAAAiYAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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**Figure 3.1: Design Level 0 Architecture**

**Table 3.1: Camera System Behavioral Table**

|  |  |
| --- | --- |
| *Module* | Camera system |
| *Inputs* | -Power  -Surroundings |
| *Outputs* | -Camera feed |
| *Functionality* | Takes in power to power the minicomputer being used in the system, takes in the surroundings of the desired areas, displays the surrounding areas for the user to see as camera feed |

## **3.2. Preliminary Level 1 Architecture:**

As seen in Figure 3.2, this Design Level 1 Architecture shows more specific modules inside the Camera System. This shows which parts of the system take in the different inputs and how the result of the inner systems becomes the output of the total system. How the minicomputer and cameras are connected is shown which allows a better understanding of how the cameras and the minicomputer will be powered.

![Diagram

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAeAB4AAD/4RDuRXhpZgAATU0AKgAAAAgABAE7AAIAAAAMAAAISodpAAQAAAABAAAIVpydAAEAAAAYAAAQzuocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEFuZHkgQnJlaWVyAAAFkAMAAgAAABQAABCkkAQAAgAAABQAABC4kpEAAgAAAAM4MQAAkpIAAgAAAAM4MQAA6hwABwAACAwAAAiYAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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VGR0hJSlNUVVZXWFlaY2RlZmdoaWpzdHV2d3h5eoOEhYaHiImKkpOUlZaXmJmaoqOkpaanqKmqsrO0tba3uLm6wsPExcbHyMnK0tPU1dbX2Nna4eLj5OXm5+jp6vHy8/T19vf4+fr/xAAfAQADAQEBAQEBAQEBAAAAAAAAAQIDBAUGBwgJCgv/xAC1EQACAQIEBAMEBwUEBAABAncAAQIDEQQFITEGEkFRB2FxEyIygQgUQpGhscEJIzNS8BVictEKFiQ04SXxFxgZGiYnKCkqNTY3ODk6Q0RFRkdISUpTVFVWV1hZWmNkZWZnaGlqc3R1dnd4eXqCg4SFhoeIiYqSk5SVlpeYmZqio6Slpqeoqaqys7S1tre4ubrCw8TFxsfIycrS09TV1tfY2dri4+Tl5ufo6ery8/T19vf4+fr/2gAMAwEAAhEDEQA/APpGiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiuW+IttBeeEorW8hjnt5tW0yOWKVAySKb+AFWB4IIOCDQB1NFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNH/CuPBH/Qm+H/8AwVwf/E0AdJRXN/8ACuPBH/Qm+H//AAVwf/E0f8K48Ef9Cb4f/wDBXB/8TQB0lFc3/wAK48Ef9Cb4f/8ABXB/8TR/wrjwR/0Jvh//AMFcH/xNAHSUVzf/AArjwR/0Jvh//wAFcH/xNRfDq2gs/CUtrZwxwW8OranHFFEgVI1F/OAqgcAADAAoA6miiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACub8ef8i7a/wDYa0r/ANOFvXSVzfjz/kXbX/sNaV/6cLegDpKKKKACiiigAooooArahqFtpWnz31/L5NtAheSTaTtX1wOawP8AhY/hb/oIyf8AgHN/8RUnxH/5JZ4r/wCwLef+iHrpKAOX/wCFj+Fv+gjJ/wCAc3/xFH/Cx/C3/QRk/wDAOf8A+IrqKKAOX/4WP4W/6CMn/gHP/wDEUf8ACx/C3/QRk/8AAOf/AOIrqKKAOX/4WP4W/wCgjJ/4Bz//ABFH/Cx/C3/QRk/8A5//AIiuoooA5f8A4WP4W/6CMn/gHP8A/EUf8LH8Lf8AQRk/8A5//iK6iigDl/8AhY/hb/oIyf8AgHP/APEUf8LH8Lf9BGT/AMA5/wD4iuoooA5f/hY3hf8A6CEn/gHP/wDEUf8ACxvC/wD0EJP/AADn/wDiK6iigDl/+FjeF/8AoISf+Ac//wARR/wsfwv/ANBCX/wDn/8AiK6iigDl/wDhY/hf/oIS/wDgHP8A/EUf8LG8L/8AQQl/8Ap//iK6iigDl/8AhY3hf/oIS/8AgFP/APEUf8LG8L/9BCX/AMAp/wD4iuoooA5f/hY3hf8A6CEv/gFP/wDEUf8ACx/C/wD0EJf/AACn/wDiK6iigDl/+FjeF/8AoIS/+AU//wARR/wsbwv/ANBCX/wCn/8AiK6iigDl/wDhY3hf/oIS/wDgFP8A/EUf8LG8L/8AQQl/8Ap//iK6iigDl/8AhY3hf/oIS/8AgFP/APEUv/CxvC//AEEJf/AKf/4iunooA5f/AIWN4X/6CEv/AIBT/wDxFH/CxvC//QQl/wDAKf8A+IrqKKAOX/4WN4X/AOghL/4BT/8AxFH/AAsbwv8A9BCX/wAAp/8A4iuoooA5j/hY3hf/AKCEv/gFP/8AEUf8LG8L/wDP/L/4BT//ABFdPRQBy/8Awsbwv/z/AM3/AIBT/wDxFH/CxvC//P8Azf8AgFP/APEV1FFAHL/8LG8L/wDP/N/4BT//ABFH/CxvC/8Az/zf+AU//wARXUUUAcx/wsbwv/z/AM3/AIBT/wDxFH/CxvC//P8Azf8AgFP/APEV09FAHMf8LG8L/wDP/N/4BT//ABFJ/wALG8L/APP/ADf+AU//AMRXUUUAcv8A8LG8L/8AP/N/4BT/APxFL/wsbwv/AM/83/gFP/8AEV09FAHMf8LG8L/8/wDN/wCAU/8A8RR/wsbwv/z/AM3/AIBT/wDxFdPRQBzH/CxvC/8Az/zf+AM//wARSf8ACxvC/w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Dqz4R0u+0jw+bfVVt1u5b28u5EtpWkjTzrmSYKGZVLYEgGdo5FbdFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFAH//Z)

**Figure 3.2: Design Level 1 Architecture**

**Table 3.2.1: Camera 1 Behavioral Table**

|  |  |  |
| --- | --- | --- |
| *Module* |  | Camera 1/Camera 2 |
| *Inputs* |  | -Power from computer (over USB 3.0)  -Surroundings |
| *Outputs* |  | -Current surroundings of vehicle (sides) |
| *Functionality* |  | Takes in power from the minicomputer, collects the surroundings from each side of the vehicle, forwards current feed to the minicomputer |

**Table 3.2.2: Camera 3 Behavioral Table**

|  |  |
| --- | --- |
| *Module* | Camera 3 |
| *Inputs* | -Power from minicomputer  -Surroundings |
| *Outputs* | -Current surroundings of vehicle (front) |
| *Functionality* | Takes in power from the minicomputer, collects surroundings from the front of the vehicle, forwards the current feed to the minicomputer |

**Table 3.2.3: Minicomputer Behavioral Table**

|  |  |
| --- | --- |
| *Module* | Minicomputer |
| *Inputs* | -Power |
| *Outputs* | -Current surroundings live feed |
| *Functionality* | Takes in power to power the computer, feeds power to each of the cameras, collects the surroundings from the cameras, feeds all of the surroundings into a single monitor |

**Table 3.2.4: Monitor Behavioral Table**

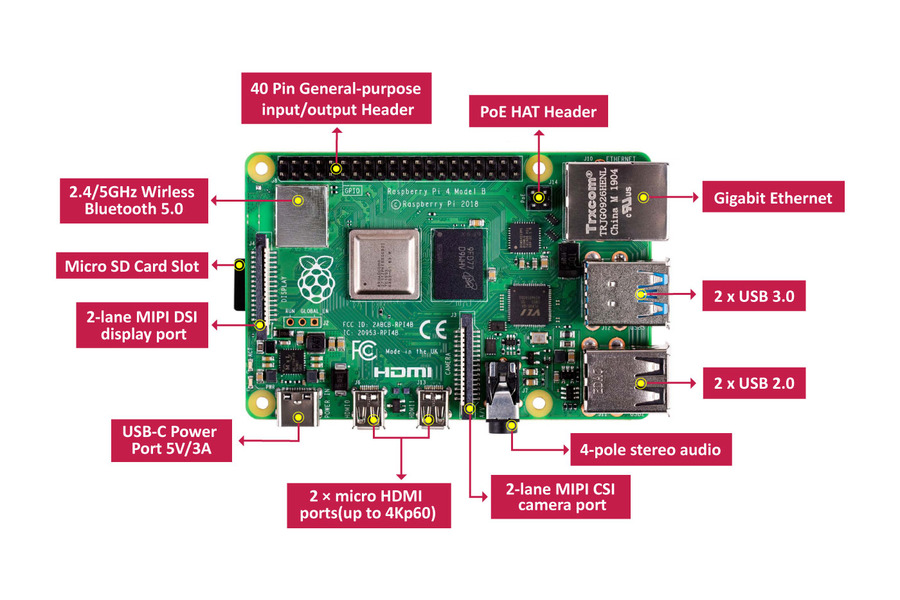
|  |  |
| --- | --- |
| *Module* | Monitor |
| *Inputs* | -Power (either battery or from minicomputer)  -Current Surroundings live feed |
| *Outputs* | -Camera feed |
| *Functionality* | Either takes in power from the minicomputer or will be battery powered, connected to minicomputer to pass the cameras view to monitor, camera feed is outputted from monitor and shown to user as camera feed |

## **3.3. Possible Minicomputers To Use:**

There is an abundant number of affordable and powerful minicomputers on the market today. However, the one needed for this project has to be powerful enough to power up to 3 cameras (2 being USB 3.0 and 1 using the camera module). As these designs are preliminary, a decision has not been made and research is still being done to find the right minicomputer that fits all the needs for this project. Following are the possible minicomputers that could be used for this project and some specifications for each.

**3.3.1 Raspberry Pi 4:**

Shown below is Figure 3.3.1, which shows the Raspberry Pi 4 and its ports



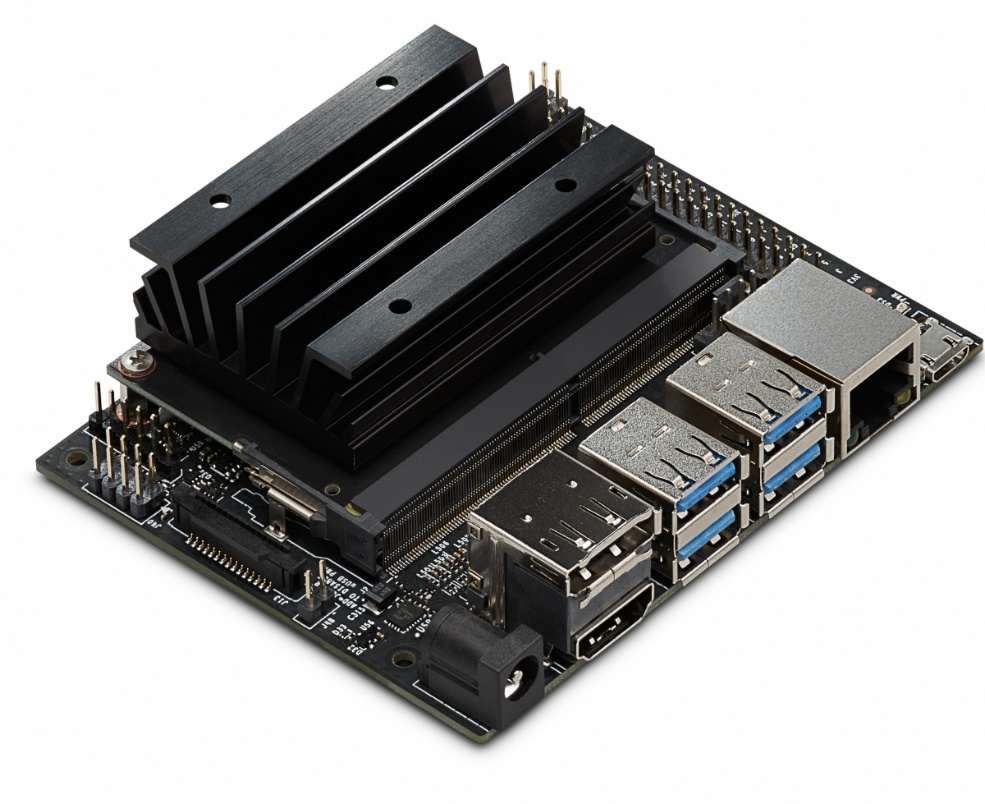
**Figure 3.3.1 Raspberry Pi 4**

This minicomputer is equipped with the following specifications:

* USB-C Power Supply
* Gigabit Ethernet
* 2x Micro HDMI Ports
* 2x USB 2.0 Ports
* 2x USB 3.0 Ports
* Choice of 2GB, 4GB, 8GB of RAM
* 1.76 ounces

For the current design idea, this minicomputer would best suit our needs for this project. However, further testing needs to be done to ensure that this minicomputer meets all of the marketing and engineering requirements.

**3.3.2 NVIDIA Jetson Nano**

Shown below is Figure 3.3.2, which is called the NVIDIA Jetson Nano

**Figure 3.3.2: NVIDIA Jetson Nano**

This minicomputer is equipped with the following specifications

* Micro-USB Power Supply
* Gigabit Ethernet
* 4x USB 3.0 Ports
* HDMI Output Port
* DC Barrel Jack
* MIPI CSI-2 Camera Connectors

This minicomputer would also work for the current design idea. Again, further testing needs to be done in order to make sure that this minicomputer would work for the camera system and meet all the requirements.

While both of these single board computers offer very similar abilities, more testing needs to be done in order to make a better and more well informed decision.

## **3.4. Design Alternatives**

While our design consists of 3 cameras connecting to a single microcomputer outputting to a single monitor, there are other design ideas that are possible. Another possible design could be to use 3 cameras and connect them to 3 separate monitors for the driver to see. In order to compare this design to our initial design, testing is required. Once tested, a design choice will be made and new level 0, level 1, and further designs will also be created to reflect the decision made by the team.

# **4. How to Test**

In order to test this system, we have decided to use a Raspberry Pi 3. This has been decided because this is already in our possession and it will set a good baseline for the system. This is being done so that if upgrades are necessary, then we have an example to base future work on. This also applies to the cameras and monitors being used. We will be using cameras and monitors already in the teams’ possession so that we are able to improve the system as needed. Finally, this testing has NOT been completed, we believe that this would be a good start to testing the project.

# **5. Conclusion**

Overall, the Super Mileage Vehicle project focuses on increasing the visibility of the driver by implementing a simple camera system. The system’s simple user interface allows the driver to easily view and identify objects at a minimum of 1.5 meters from the ground and 6 meters in front of the vehicle. This will allow the SAE team to eventually replace the current method of using window cutouts, which will improve the aerodynamics, visibility, and field of view. This project will also allow future mechanical engineers to create a gyroscopic mount to reduce video sway.

# **6. References**

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