1. Introduction

1.1. PROBLEM STATEMENT

Lightweight electric vehicles, such as electric bikes and solar cars, face a significant challenge when it comes to selecting motor controllers, which are essential for efficient and smooth operation. Currently, available options are limited. Many controllers are sold as mysterious black boxes with little to no ability for users to configure or customize settings to meet specific needs. Some controllers that do offer customizations are extremely expensive, placing them out of reach for many DIY hobbyists and solar car teams. Even when customizations can be made, the configuration and troubleshooting processes are very complex and often missing features that some users desire. This lack of affordable, user-friendly motor controller options hampers the broader adoption and innovation in the lightweight electric vehicles. The problem has been expressed by anyone from Iowa State's own solar car team, PRISUM, to students looking to build electric bikes for transportation. In this project will we be designing the architecture and implementation of a motor controller for lightweight automotive use.

1.2. INTENDED USERS

We have identified three main user groups for our product. We categorized these main user groups as "Solar Vehicle Engineers", "Jonah", and "Old Man McGee". These three categories cover our range of users from collegiate organizations as well as knowledgeable and unknowledgeable individuals.

The generic solar car engineer is a student at your local university looking to build a vehicle for the American Solar Challenge. He is looking for a motor controller that allows reliable operation with good documentation that does not require in depth knowledge of the system to use but the ability to dig into more details later. This engineer needs a way to control motors on a budget because existing solutions are prohibitively expensive. This user group will be aided by our design by having an affordable and reliable motor controller that they can use for their competition vehicles.

Jonah is a bored biker that takes a lot of interest into mountain biking. He enjoys riding down slopes but not working his way back up to the tops of hills, and as such is hoping to motorize his bike in a high torque way that can move his bike under battery power to the top of trails so that he can fully enjoy the experience. Jonah needs a way to use the motor his bike while keeping costs low because existing solutions are either too expensive or not general enough for his use case. This user will benefit from an affordable product that has a relatively high output power.

Old Man McGee is not super tech savvy, but has a basic understand of what's important. He's interested in using this motor controller his work at a Detroit factory or personal transportation. Old Man McGee needs a way to move his custom vehicle that is easy to use as he isn't incredibly knowledgeable on motors. This user will benefit from the good documentation and easy debugging that the controller will have.

A.1. Empathy maps

Hears	Sees
• Does it work with my battery pack? • We need this to work all the time • Applause when your vehicle is successfully powered by the motor controller	• The wheel(s) spinning • Readable documentation • Easy to configure hardware interface
Says and Does	**Thinks and Feels**
• Compatible with my different scenarios • Easy to use and configure! • Connects the motor to other systems	• Pride that the project works • Not frustrated with configuration • Don t need to worry about the product breaking their hardware