UCF

Project E-Bike

Group 12

Group members

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1 Project Narrative

1.1 Motivation

As we look into the technology of bicycles we have seen that emissions are increasing in part due to vehicles. In cities the amount of vehicles on the road is to the point of grid lock during times of high volume. Bicycles are smaller thus meaning smaller carbon footprint. The main point of using bicycles is to decrease emissions in the city. By switching to electric bicycles people will not need to have larger cars for the smaller things such as going to work. Some bicycles with a basket would also be viable to use for groceries. Not only would they provide less emissions but also better health. They would allow people who may not be able to bike on their own without some assistance to use an electric bicycle to help improve their health. The betterment of health is a large reason as to why we wish to design a product that can both aid the rider and environment.

1.2 Objectives & Functions

The main objective of this project is to take an already existing bicycle and enable the use of electric drive, provided with a few modes. The motivation behind this, along with what was previously mentioned, is something that we can make ourselves and continue using after the grading process. This gives us a better understanding of how the design process is executed; since we are the ones who built it, we can troubleshoot and fix issues that may arise.

On market conversion kits can cost from as low as $865 to $2800 in this example. An average cost would be around $1500. Ex: Electric bike Conversion Kit

Prebuilt off the shelf bikes range from $1500 starting to $2500. Ex: Retail Bike

Competitive market: https://radpowerbikes.zendesk.com/hc/en-us/articles/360045171734-Riding-Rad-with-Regenerative-Braking

We will use an already made bike and deploy all the components onto the chassis of the bike. The main idea of the project is ease of use and simple. This is to make sure that everyone will be able to fix any physical problems themselves.

1.3 Goals

Goals for this project include, but are not limited to:

- Fundamentals:
  - Being able to use the bike without pedaling.
  - Providing enough speed to maintain balance.
    - (Hopefully not fall off from going too slow)
    - The amount depends on the environment.
- Engineering Goals:
  - App
  - Throttle control for speed
  - Cruise control
    - Ensure a constant speed that the user decides.

Stretch/advanced goals that are not currently in the active scope, but can be worked on after main goals are met:

- Regenerative braking will help with the distance the electric bike will be able to go.
    - Energy generated from braking can be used to charge battery.
    - The amount depends on the environment.
    - There will need to be an analysis of the weight added to the energy given back.
        - (The video above says ~10% of the energy is recycled).

- Building an application that is paired via Bluetooth to send and receive information to and from the bike.
    - Such information will include, but is not limited to:
        - Battery level
        - Time spent on the bike for a specific event
        - Current speed
- Create a lighting system that would allow riders to ride safely at all times in the day.
- Providing an assist mode.
    - This mode will help you when pedaling.
        - For example, when going up a hill the force required to continue going up the hill increases.
        - When using assist mode, the motor will make up for the increase needed to go up the hill.

2 Requirement Specifications

These are the design specifications. We plan to follow these closely as we design and create our project. Though these specifications are subject to change at any point during the project, they will aid us in structuring the design and guide us in the right direction for success.

2.1 - Production Cost

- We are making efforts to keep the cost of all the components to under 1000 dollars.

2.2 - Weight

- The total weight of the project is going to be 35 lbs. or 15.88 kg.
- Most of the weight will be given from the bike frame that approximately 20 pounds.

2.2.1 - Motor

- A weight estimate for an electric bike motor is about 4 kg or 8.8 lbs.

2.2.2 - Power

- Batteries that are about 500-watt hours can weigh up to 6 – 8 lbs. or 2.7 - 3.6 kg.

2.3 - Dimensions

- 26in x 1.95in DW

2.3.1 - Motor

- 10 x 2 x 2 inches LWH

2.3.2 – Battery

- 400 x 150 x 100 mm LWH

2.4 - Speed

- At least walking speed (2-4 miles per hour)
- At most: electric bike Class 2 standards of 20 miles per hour.

2.5 - Power

- 250-350 Watts
- Frame mounted
- Rechargeable Lithium Li-ion

2.6 - Motor

- A brushless motor with sensors will be used for efficient operation
- We are trying to have the motor carry someone of about 250 lbs.

2.7 - Microcontroller

- Different sensor input detections (throttle, battery, fuel)
- Output comparison component
- Control of the brushless motor

2.7.1 - Speed Controller

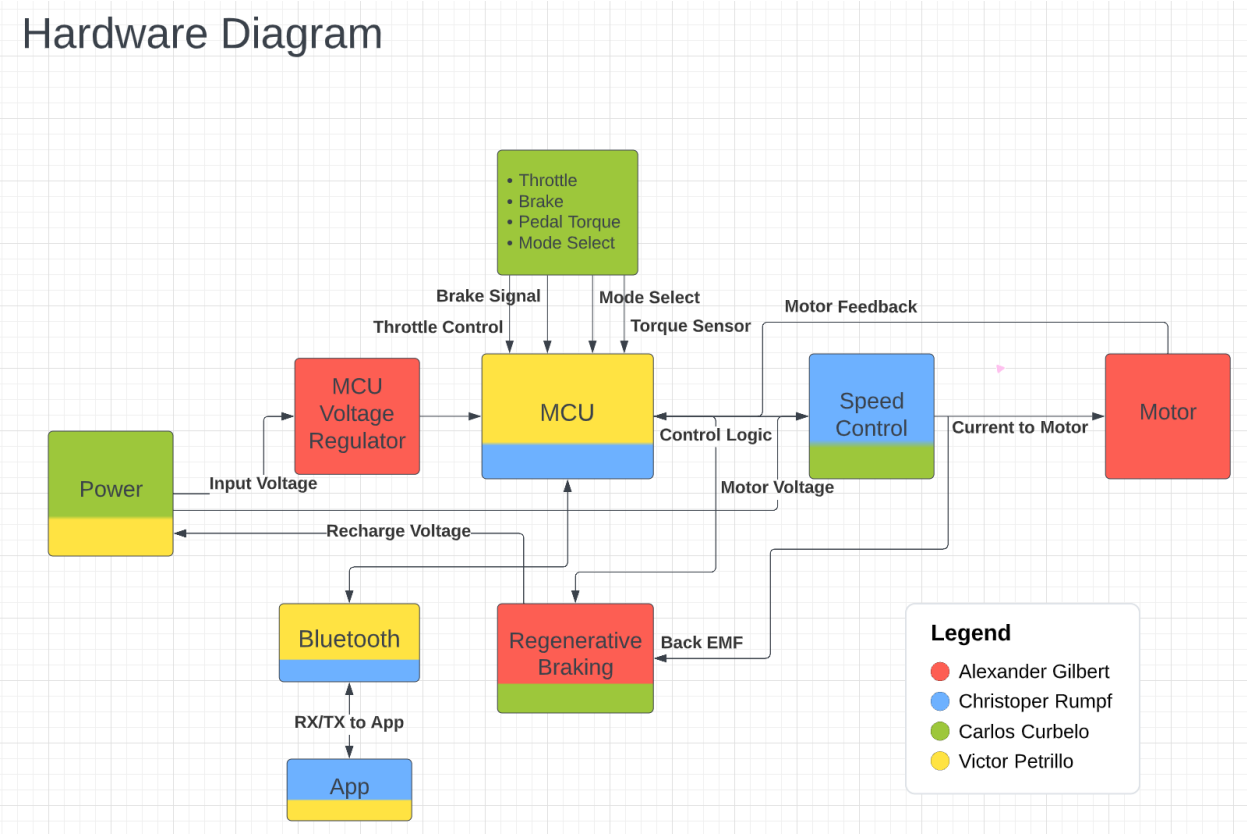
- Since in our design, we are using a brushless motor with sensors, we have the option of using either a sensor or sensor less speed controller.
- The use of a PID controller will be what we use for the speed controller.

3 Block Diagrams

3.1 High Level Overview

This diagram covers the main pieces of the bike as individual components. A central control module will use electrical power that can also drive the bike motor. Peripheral inputs, such as throttle control, brake levers, and mode selector also feeds signals into the controller to

determine the bike's behavior. The controller also outputs data and information to an app that can be used as a display or log that data.



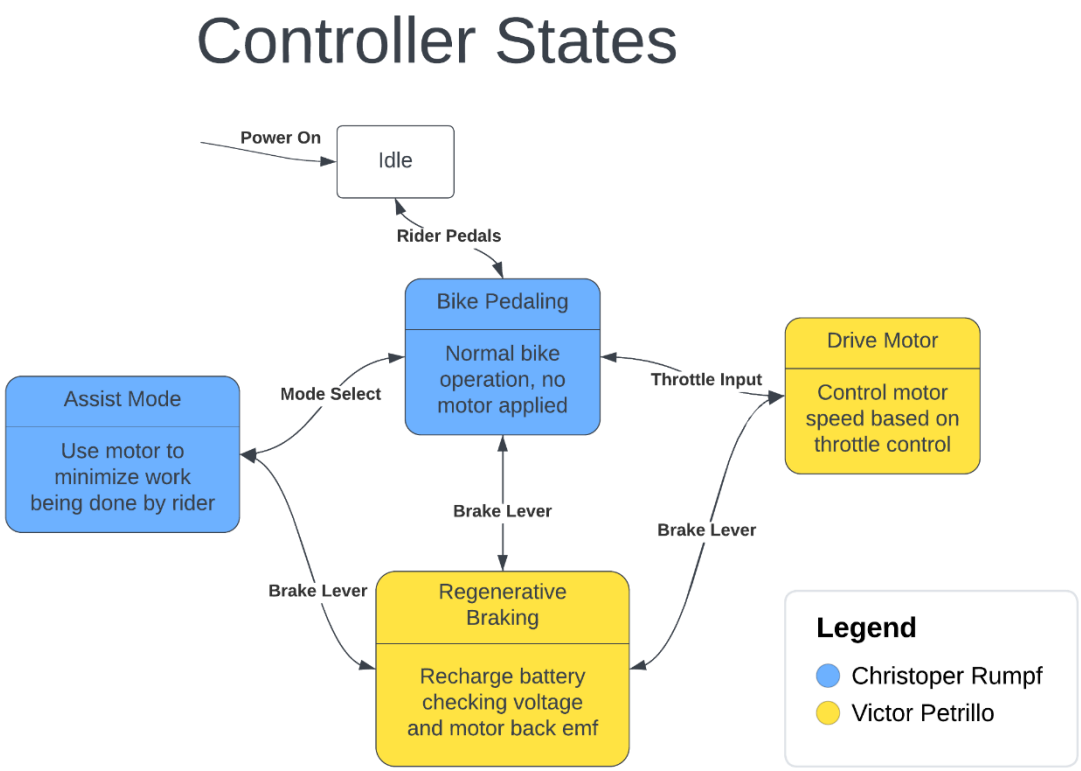
3.2 Controller Diagram

Within the control board the main logic of the bike will be a microcontroller (MCU) that will take in all the signals and data. The MCU will be powered by the bike's main input power using a voltage regulating circuit. Motor control is done via a speed control circuit. The MCU will use feedback from the motor to regulate speed based on the bike's signals and feedback. Also, a regenerative braking circuit will be able to take the counter-electromotive force (back EMF) from the motor to recharge the battery. Any data that is logged, displayed, or input signals from the app will communicate to the MCU via a Bluetooth module.

3.3 Logical State and Flow

This state diagram shows the logical flow of the bike's MCU. When initially powered on the bike would be in an idle position where the bike can then be used as a bike with no electrical input or change into a powered mode using the motor. Using the throttle would put the bike in a driven state where the bike is powered by the motor regardless of the rider pedaling. An assist state is also available where the motor is used only to help the rider pedal such as making going

up a hill require less work. When the brake lever is pulled, the controller will attempt to recharge the battery using back EMF from the motor.



4 Project Budget

This is essentially a targeted budget of what we would need through our early research of the project. The items and pricing of them are willing to change as we progress further into the design and assembly of the project.

Item	Estimated Price
Motor (1 unit)	$200
PCB (3 – 5 units)	$20
Batteries (1 unit)	$250
Sensors	$50
Circuit components	$100
Forecasted Total	$620

5 Project Milestones

These are the milestones set for our group as directed for both Senior Design 1 and Senior Design 2. Completion of each milestone is subject to change as each due date passes. Any updated dates will be changed in the updated version of the document.

5.1 - Tentative Senior Design 1 Milestones

Due Date	Milestone
Week 1 (1/29/23-2/4/23)	Divide and Conquer
Week 2 (2/5/23-2/11/23)	Divide and Conquer Meeting
	Editing and making changes of the Divide and Conquer
Week 3 (2/12/23-2/18/23)	Divide and Conquer website update
Week 4 (2/19/23-2/25/23)	15/60 Pages
Week 5 (2/26/23-3/4/23)	30/60 Pages
Week 6 (3/5/23-3/11/23)	45/60 Pages
Week 7 (3/12/23-3/18/23)	Spring Break & 60/60 Pages
Week 8 (3/19/23-3/25/23)	60 Page Draft
Week 9 (3/26/23-4/1/23)	60 Page Feedback | 75/120 Pages
Week 10 (4/2/23-4/8/23)	PCB Designing | 90/120 Pages
Week 11 (4/9/23-4/15/23)	60 Page website update | 105/120 Pages
Week 12 (4/16/23-3/22/23)	Review, Editing, Polish BOM | 120/120
Week 13 (4/23/23-4/29/23)	120 Page Final Report
Week 14 (4/30/23-5/6/23)	In-between weeks
Week 15 (5/7/23-5/13/23)	In-between weeks

5.2 - Tentative Senior Design 2 Milestones (WIP according to future knowledge)

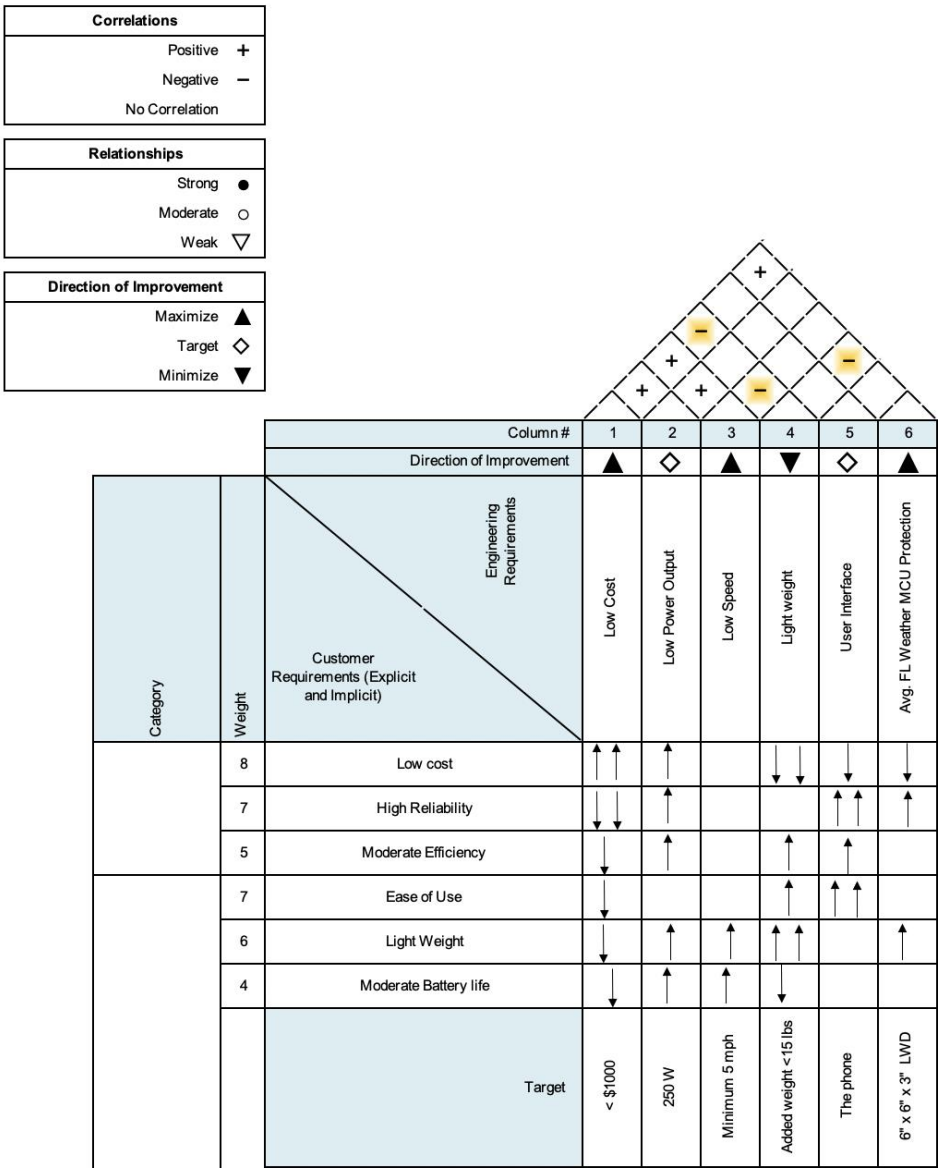
Milestones to enter because we don’t know when they’re happening:

CDR Presentation
Conference Paper

Dates	Milestone
Week 1 (5/14/23-5/20/23)	Build
Week 2 (5/21/23-5/27/23)	Build
Week 3 (5/28/23-6/3/23)	Build
Week 4 (6/4/23-6/10/23)	Building / Testing
Week 5 (6/11/23-6/17/23)	Testing
Week 6 (6/18/23-6/24/23)	Middle Term Demo
Week 7 (6/25/23-7/1/23)	
Week 8 (7/2/23-7/8/23)	
Week 9 (7/9/23-7/15/23)	
Week 10 (7/16/23-7/22/23)	
Week 11 (7/23/23-7/29/23)	Final Presentation and Demo
Week 12 (7/30/23-8/5/23)	Senior Design Web Exit Interview

6 House of Quality

The most important engineering criteria and the critical marketing requirements will be systematically laid out in the house of quality that we created. This product needs to meet several important criteria in order to be marketable. We identified six areas where we would like to meet clients after carefully examining the market of the product. Regarding how we will meet the marketing needs, engineering requirements are the key focus. To pique consumer attention, we must address six crucial components of engineering needs.



Keeping the development cost low for the group typically has a negative correlation with certain customer requirements. Having a lower power output correlates positively with most of the customer requirements because having a lower power output can result in increased longevity and efficiency, a lighter weight, and a lower cost. The speed of the bike doesn't correlate much with the customer requirements at all, other than how heavy the bike is and how much battery life is left.

Works cited

[1] https://www.eia.gov/energyexplained/gasoline/use-of-gasoline.php

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