Matt Fisher – madfish@ufl.edu Richard Orr – gautama@ufl.edu Brandon Swope – bswope@ufl.edu

Preliminary Design Report: Electric Super Bike

The Best Team in the World

Project Abstract:

Our project will consist of a central data display/controller run by a microprocessor mounted on an electric bicycle. The device will monitor the battery charge level as well as the speed and distance traveled. These values will then be displayed on an LCD attached between the handlebars to provide the rider with easy access to the information. The bicycle will also feature a feedback system that provides a rider-selectable level of motor assist.

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Project Features and Objectives:

Our design will be realized with relatively inexpensive components, compared to other products with some similar features. The features include:

- 600W brushed DC motor with 36V battery pack for speeds up to 20 mph
- LCD displaying speed, distance and battery charge.
- Adjustable motor control system allowing variable degrees of assistance.
- Sensors for detecting speed, distance, battery charge, and pedaling speed.

All sensor readings, data display, and motor control logic will be handled by a central ATMega microcontroller integrated with the display unit. The following criteria should be met:

- The data display should be accurate and update frequently.
- The motor should be responsive and adjust quickly to changes in both desired assistance and desired speed.
- All components should be reasonably weatherproof.
- Any component which requires its own battery should allow battery life comparable to the life of the component.

Concepts and Technology:

The Electric Super Bike faces a few challenges. These challenges include building an accurate speedometer for the bike, calibrating assist of the motor and keeping the design rugged and small enough for use on a bicycle.

The framework of our speedometer relies on Hall-Effect sensor pulses sent to our microprocessor to calculate the speed of the bike and the pedals. There are many possible inaccuracies, for instance Mike Stapleton pointed out that when a person is stopped and rocking the bicycle back and forth, the sensor would read many pulses in a short amount of time, resulting in a largely inaccurate speed calculation. This pitfall will be avoided in software (a sanity check for impossibly high speed) and/or the addition of another “trigger” sensor or second magnet if a bipolar sensor is used.

Calibrating the pulse width modulation to the amount of “assist” required will also be a challenge our group must face. Since we do not know how the motor's average torque will vary with the duty cycle of the motor, we will need to run many tests. Furthermore, we will then have to calibrate it with both the user’s “assist” preference and the speed of the pedals, which could prove to be quite difficult.

Finally, since this device is going to be mounted on a bike, another challenging aspect of the design is to keep it lightweight and durable. We plan on exploring different enclosures for our design that will keep it waterproof and secured.

We chose to use the Atmel ATMega128 controller because it offers many features that are needed for our project while having a moderate price as well. The level of programming difficulty is higher than the PIC, but easier than the MSP430. However, the AVR has built-in functions such as pulse width modulation and A/D conversion and does not draw a large amount of power.

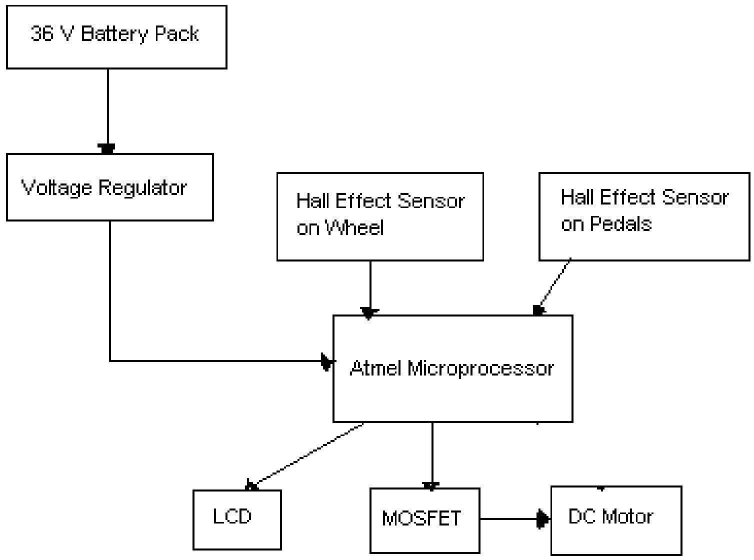
For the assist control of the motor, we opted to use an H9845 IRFP 150 Power MOSFET that can handle up to 20 Amps required to run the motor. Initially we thought about using a digital potentiometer to regulate the motor current, but we found it hard to find one that meets the high voltage and current rating. Also, using a resistor network made of high-power resistors would dissipate too much wasted heat energy.

For the measurement of the speed and distance traveled by our bicycle, we selected the 365-1036-ND Hall Effect Sensor. This device was chosen in part because it doesn't put wear on anything and is free to move. The sensor would simply be mounted on the frame, with the magnet attached to the wheel spoke. Another option would have been an accelerometer that would have to be interfaced with the microcontroller, however this is more prone to errors in the calculation of the speed.

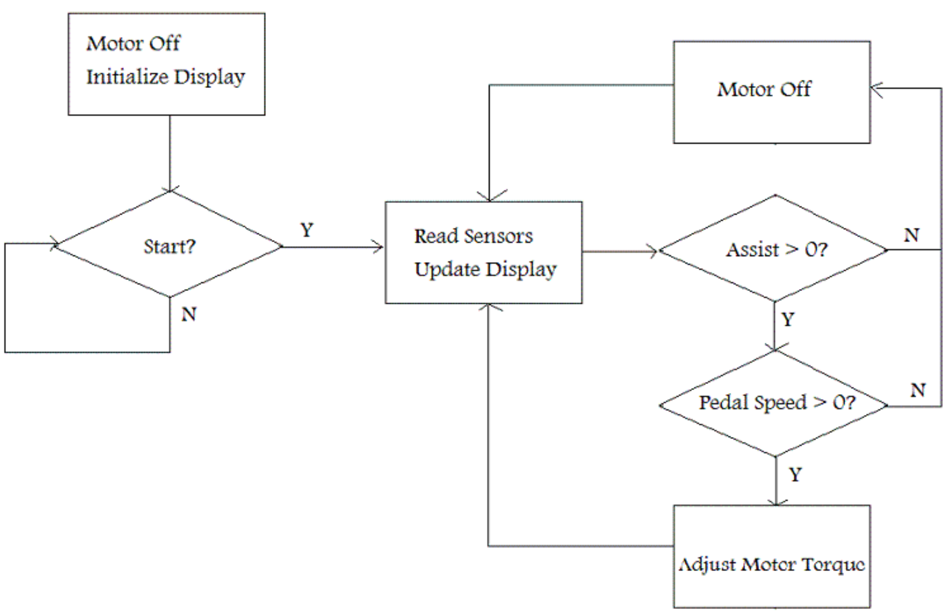
The 600W DC motor was chosen in order to provide the user with a high level of assist if necessary, as the bicycle can reach speeds of about 20 mph. This is helpful for traveling long distances, where the user might want to take a break from pedaling yet still move at a relatively high speed. In addition, a voltage regulator will be attached to the 36V battery in order to provide the necessary 5V to the microcontroller. This way, only one central power source is needed.

Flowcharts and Diagrams:

System Block Diagram



Simplified Control Scheme

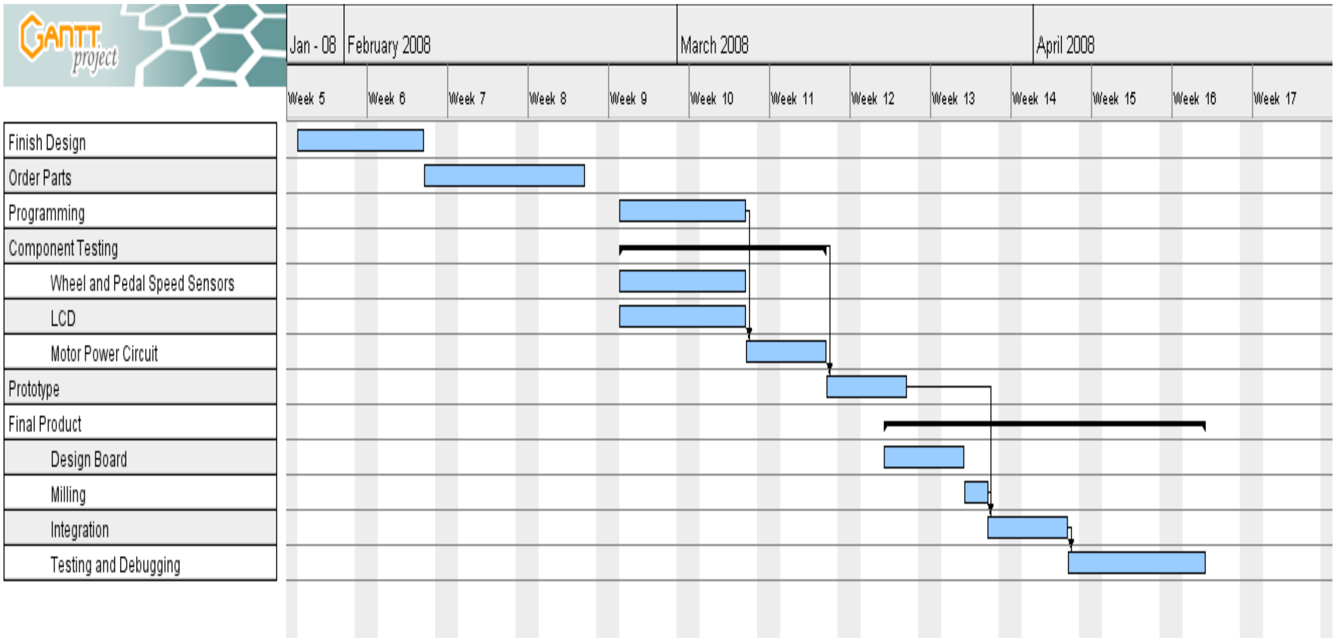


Division of Labor:

The following table gives a first approximation of how the tasks will be distributed. Further task enumeration and assignment will be done as design decisions are made. Assignments are non specific as we expect to be all up in each others' business anyway.

Brandon	Matt	Richard
Hall Effect sensor testing	PWM/Feedback Software	Display Software
Motor Testing	Motor Testing	Motor Testing
Board Design	Board Design	Board Design
Debugging	Debugging	Debugging

Gantt Chart:


GANTT project
Jan - 08
February 2008
March 2008
April 2008
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10
Week 11
Week 12
Week 13
Week 14
Week 15
Week 16
Week 17
Finish Design
Order Parts
Programming
Component Testing
Wheel and Pedal Speed Sensors
LCD
Motor Power Circuit
Prototype
Final Product
Design Board
Milling
Integration
Testing and Debugging