Project Plan: Group 13-22

Kart Team

Team Members:

- Adam Woody (Team Leader)
- Nick Marquardt (Webmaster)
- Kevin Flynn (Communications)
- Andy Goiffon
- Chris Larson

May 13-22 Kart Team
Project Plan

Executive Summary

The purpose of this project is to design and build a small electric vehicle with a 30 mile per hour top speed and an operating endurance of about four hours for the Paragon company. This car will be built on a custom frame assembled by the mechanical engineering team, and will use component already purchased for the project. The car will be used as a multipurpose vehicle in a fair or carnival setting on relatively flat terrain.

Project Objectives and Requirements

The primary objective is to build a vehicle capable of meeting the needs of day-to-day amusement park activities including:

- Stocking concessions with supplies,
- Carrying passengers to different areas of a park, and
- First aid response.

In most cases the car needs to travel no faster than 5 to 10 miles per hour, but it needs the capability to accelerate to 20 to 30 miles per hour. It should be able to carry an adult passenger as well as the driver, or as much as 250 pounds of gear or supplies in addition to the driver.

Division of Labor

Due to the size of the project team assigned to this project at the beginning, the group split into two separate groups that periodically meet and share information. This group handles the motor and power systems, as well as the lighting and safety systems of the vehicle, and the other group is handling the charging station component of the original project assignment.

System Concept

Originally this project was to be based around a go-kart frame, and the team was going to design the motor controller ourselves and purchase a permanent-magnet DC motor to drive the kart. However, after attempting to assemble the kart frame it was found that it was far too small to be used with an adult rider. When the team inquired into expansion and modification of the frame, it was determined that a mechanical engineering team was working on an electric vehicle project for Paragon and this project team joined up with that project, along with the charging-station team.

The current system is going to use the Curtis 1266 SepEx motor controller previously purchased for the Paragon project and a D&D Motor Systems 3.5-horsepower shunt-wound electric motor. This will be mounted on a custom frame built by the mechanical engineering team. The car will have three wheels and a top speed of 30 miles per hour, so that it can be classified as a moped by Iowa state law. This will simplify licensing as well as the requirements for the driver of the vehicle.

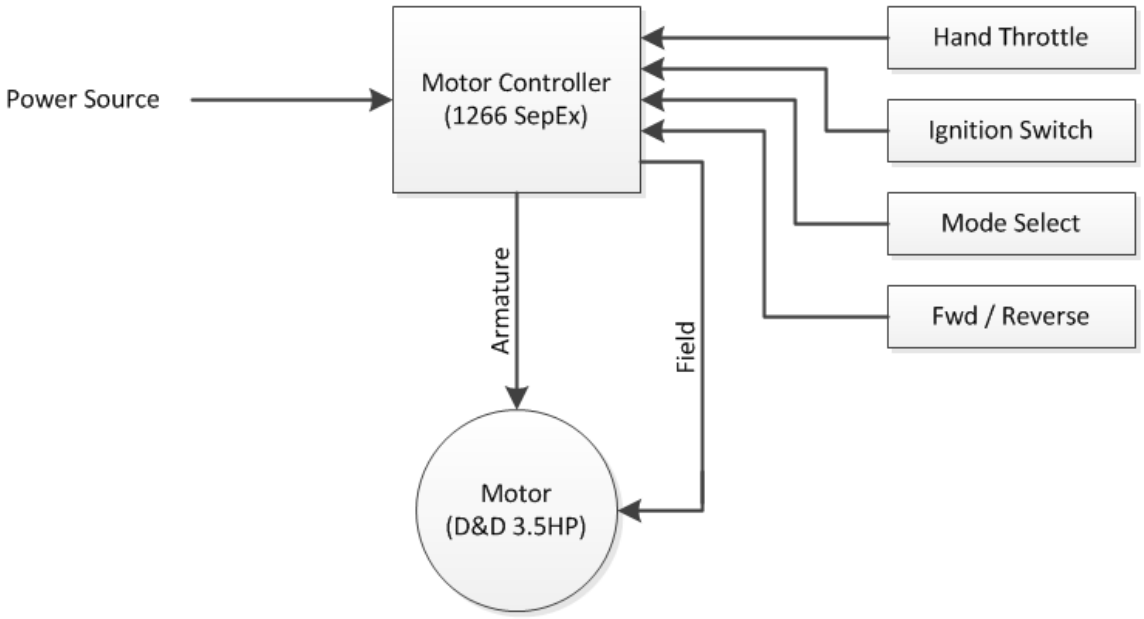

Figure 1 – Block diagram of motor controller system

Functional Description

The motor controller, a Curtis 1266 SepEx motor controller, takes power from the battery and distributes it to the motor's armature and field windings based on input from the controls. These controls include a forward/reverse selector switch, a mode selector switch, and ignition switch, and a hand throttle.

The forward/reverse select switch is a 3-way toggle with a middle "neutral" position that ignores the throttle input. When reverse is selected, the motor controller sounds an external buzzer and energizes the field in the opposite direction to make the motor spin the opposite direction from normal. Speed of the car is limited to a much lower value when it is in reverse.

When the car is in forward, there are two possible modes in the controller. The mode select switch is used to switch between these two modes. Mode 1 is the standard full-speed mode. For testing a maximum speed of 20 MPH was used, but in a final version the maximum speed will be 30 MPH. In the second mode, the controller limits the speed of the car to 10MPH and increases the throttle sensitivity to improve handling in a crowded setting.

The hand throttle outputs a voltage range between roughly 0.7 and 4.3 volts, as measured on the signal wire, when given a voltage of 5 volts. The controller provides this voltage. It is a solid-state throttle using a Hall-effect sensor chip to vary the output voltage with respect to the position of the handle, which is more sophisticated than a simple potentiometer throttle but more reliable. This throttle came from a Chinese-built "bubble car" type vehicle that Paragon purchased for the team to disassemble and rebuild.

Non-functional requirements

There are several non-functional requirements that are necessary for the car to be licensed as a moped and to be used safely in a variety of environments. These include lights, audible warning devices, weather protection, safety, and speed and battery state-of-charge indication.

Lights

In order to be licensed as a moped, the vehicle needs at least one headlight and tail-light. It also requires turn signals. The lights and turn signals will be provided by a circuit of the team's design which will interface with switches on the hand controls and will be powered off of the main vehicle power system.

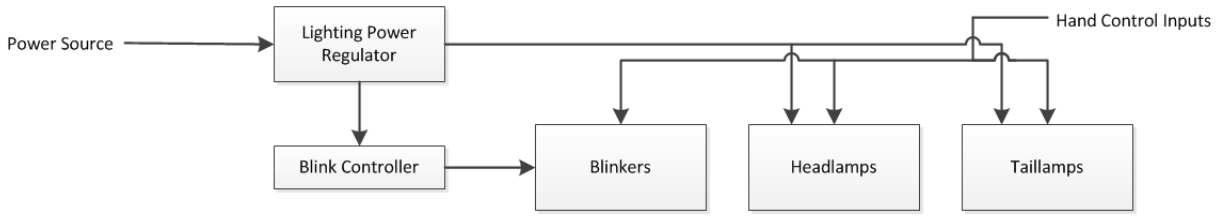

Figure 2 – Block diagram of the lighting system

All lights including the headlamps are LED-based lighting, so the power regulator will be a buck convertor providing 5 volts to the systems. The blink controller will be based around a 555 timer and will simply provide a pulsing 5V waveform to the LEDs that need to blink.

Audible Warnings

The reverse buzzer is a simple piezo-electric buzzer that, when voltage is applied to it, it produces a constant tone. The motor controller energizes this circuit when the forward-reverse select switch is set to "reverse".

There will also be a warning buzzer controlled directly from the hand controls. This is salvaged from the same "bubble car" from which the hand controls were salvaged. This will be the horn for the car. Originally it is designed to be operated on 48 volts, but it will operate at 36 volts without issue.

Weather Protection and Safety

The final project's wiring will be weather-proofed using silicone sealant around the exposed terminals on the motor and the controller. The controller is designed to be used on a golf cart, so it is relatively robust for weather condition. However, the exposed terminals will still corrode if left exposed to the environment. The top terminals of the batteries used (lead-acid batteries) will be protected from corrosion with commercially-available automotive battery terminal protectant.

In the event that the car needs to shut down immediately, we will be including a kill switch that will immediately interrupt current to the motor. It will be easily accessible to the driver for safety reasons. There will be a fuse box and fuses near the motor controller to protect the various components from overload conditions.

Speed and State-of-Charge Indication

While the motor controller uses a speed sensor, this will not provide the necessary indication to the operator of the vehicle as to the forward speed. In order to provide this indication during testing, the team will use an off-the-shelf bicycle speedometer mounted on the vehicle's handlebars, using the front wheel as an indication of speed. Eventually there will be a display located at the center of the steering column that will display a speed indication.

For battery state of charge, the team will work together with the charging team to provide this, as it is based on their components.

Deliverables

At the end of this project the team will deliver a working vehicle meeting all of the functional requirements. It will based around the motor controller and motor provided and will include components made by the team, including lighting a lighting control board.

Project Plan

Work Breakdown:

Item	Status
Determine final frame configuration	Will be done by the mechanical engineering team
Select / purchase motor	Done: D&D Motor Systems separately-excited 3.5-horsepower DC electric motor.
Design / program motor control circuit	Controller: Curtis 1266 SepEx motor controller previously purchased by the mechanical engineering team. Programming: Can be accomplished through USB connection using software supplied by Curtis.
Standards	AWG standards for current-carrying capacity of wires. Standards for battery sizes. Our own standards for wire color based on purpose.
Functional and Non-Functional Characteristics	Done
Regenerative braking implementation	Done: Integral to the motor controller.
Design UI	In-progress; moped-like interface. Switches and twist throttle.
Test Individual and Integrated Systems	Partially done
Extras	Adding as needed.
Final Build	In progress

Project Schedule:

Week 1: Split group into Kart group and Charger group
Week 2: Motor selection discussion.
Week 3: Decided on DC permanent magnet motor, began determining power requirements.
Week 4-5: Attempted go-kart assembly. Inadequate frame, proposed funds increase to purchase new frame.
Week 6: Became part of Paragon team. Brought up to speed with this team's progress.
Week 7: Inspected motor controller to determine its functionality and configure it.
Week 8: Designed circuits and compiled a parts list.
Week 9: Updated motor controller configuration with less-expensive and potentially more reliable parts.
Week 10: Updated configuration further due to undesired power consumption.
Week 11: Ordered parts and assembled test rig.
Week 12: Assembled parts to the car. (where the team is now)
Week 13: Light system design implementation.
Next Semester: To be determined at beginning of the semester.

Resource Requirements

Parts ordered:

- Contactor relay
- Wires and connectors
- Buzzer
- Switches: mode-select, direction-select, ignition key

Parts to be ordered:

- Fuse box and fuses.

Risks

- Bad collaboration: Team's designs don't properly match up and work together.
- Bodily injury due to parts failing or violation of safety rules.
- Parts failing or breaking during testing.
- Not finding adequate storage space for the car, damage due to negligence during storage.
- Failing to meet deadlines.
- Losing support for the project from Paragon if they decide they aren't satisfied with our design.

Plan Review

This project will design and build an electric vehicle that meets all functional and non-functional requirements listed. It will have a 30 mile per hour top speed and an operating endurance of about an hour to an hour and a half in testing configuration conditions, but will be able to have its performance increased by the use of different batteries. When finished it will be fun little vehicle that meets Paragon's reputation as being a manufacturer of fun products for amusement parks and carnivals.