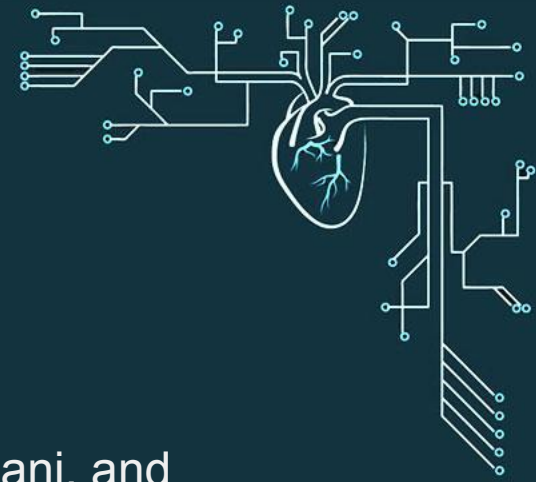
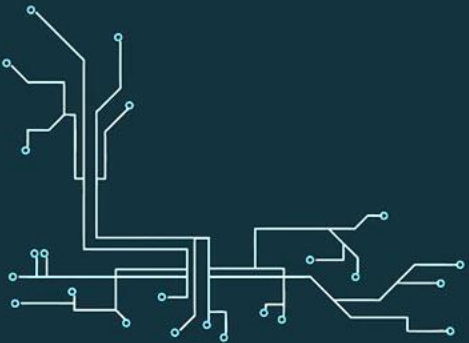


REGENERATIVE ELECTRIC DRIVEN POWER CART

ECE 480 SENIOR DESIGN TEAM 9

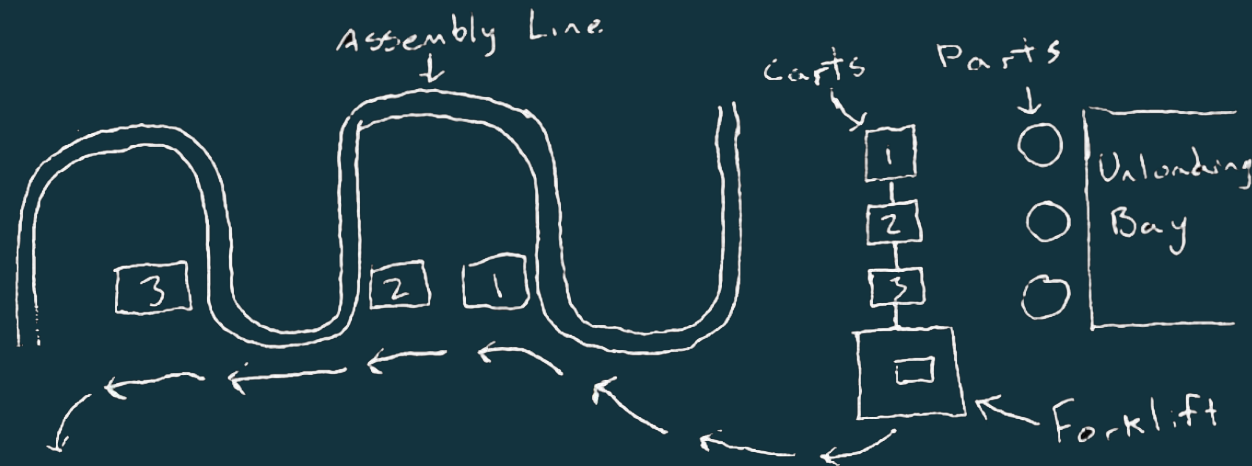


- **Team members:** Ning Zheng, Daniel Jarratt, Rui Zhang, Zhengze Zhu, Neil Damani, and Zhongyang Wang
- **Facilitator:** Bingsen Wang
- **Sponsors:**
 - Great Lakes Controls and Engineering
 - Conceptual Innovation



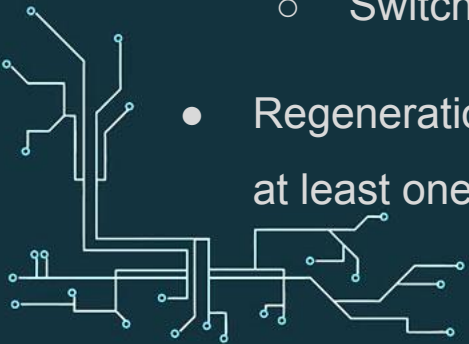
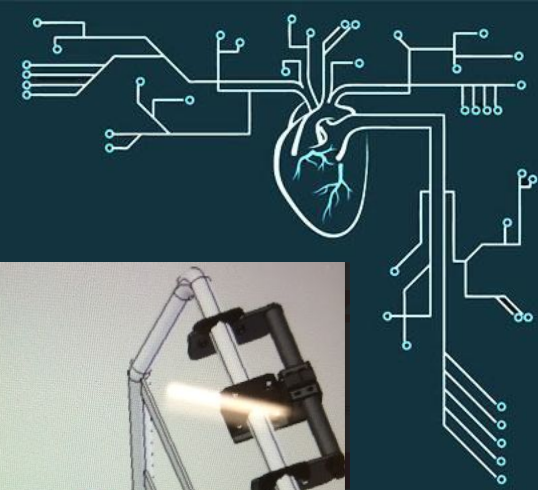
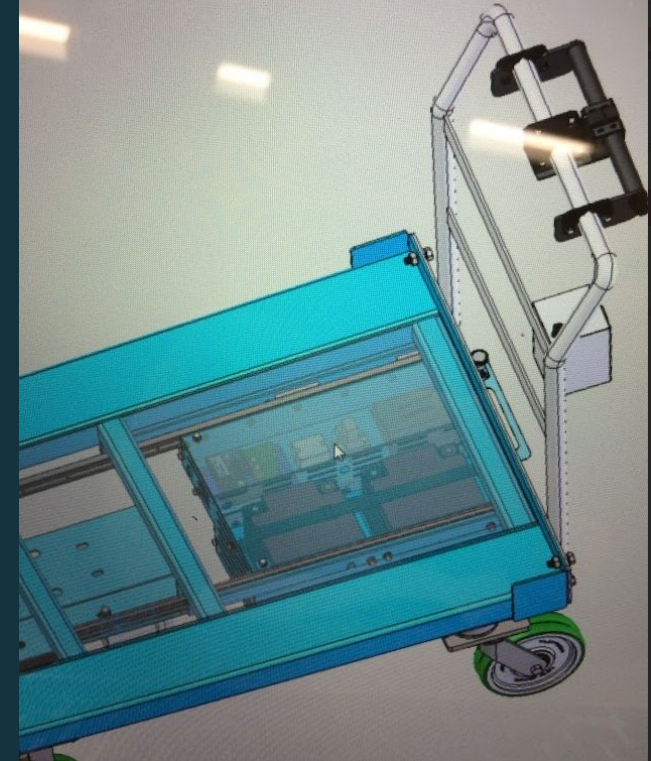
Introduction

Companies need to move their parts for production closer to the assembly line. The parts are very heavy (up to 8000 lbs) and cannot be moved manually but instead need a cart to be moved. A forklift picks the carts up and pulls them to their corresponding location. As the carts are being pulled the motor is being charged through a charge controller. When they are unhooked, they will have enough power to move the required distance (~15ft) to be closer to the assembly line. The forklift will then come back around and pick up the empty cart and then the process is repeated.

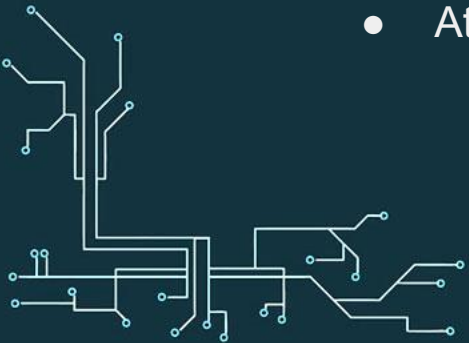
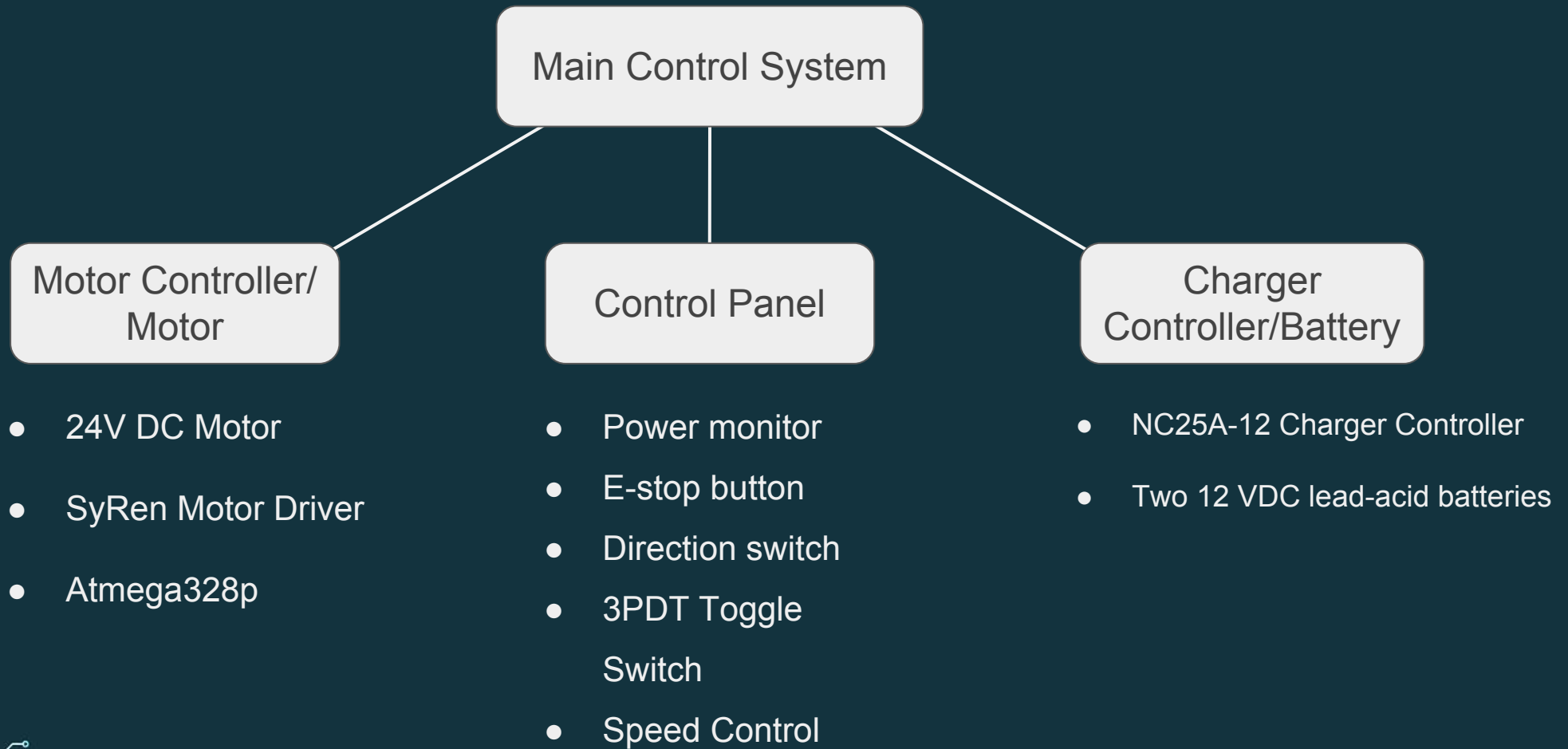
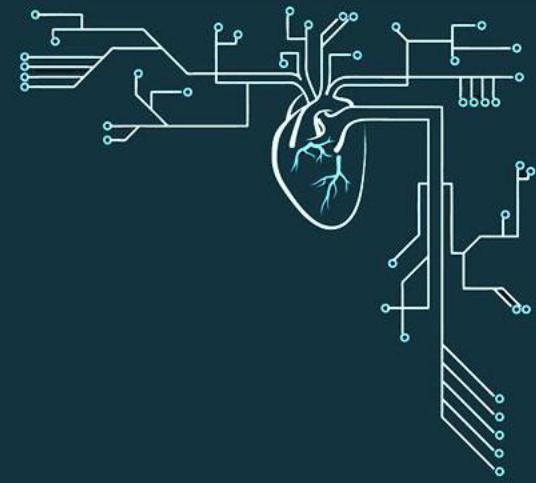


Project Goal

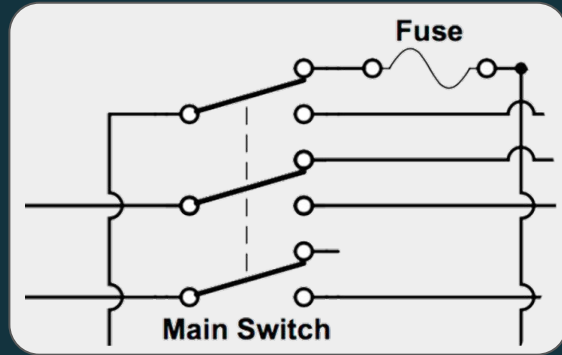
- Design a control system that will be enclosed in an industry tight vessel.
- Design customer-friendly outputs that will be displayed on a control panel.
- The functions of the control system:
 - Speed of the cart
 - Acceleration and deceleration of the cart
 - Emergency stop button
 - Control a sensor that can make the cart emergency stop
 - Switch that controls drive mode, system off mode, and regeneration mode
- Regeneration system must provide a high enough efficiency to supply power for at least one 8-hr shift.



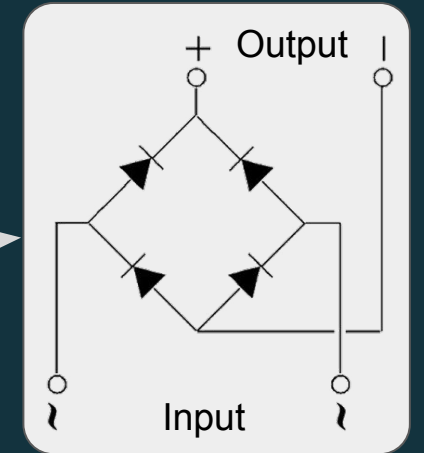
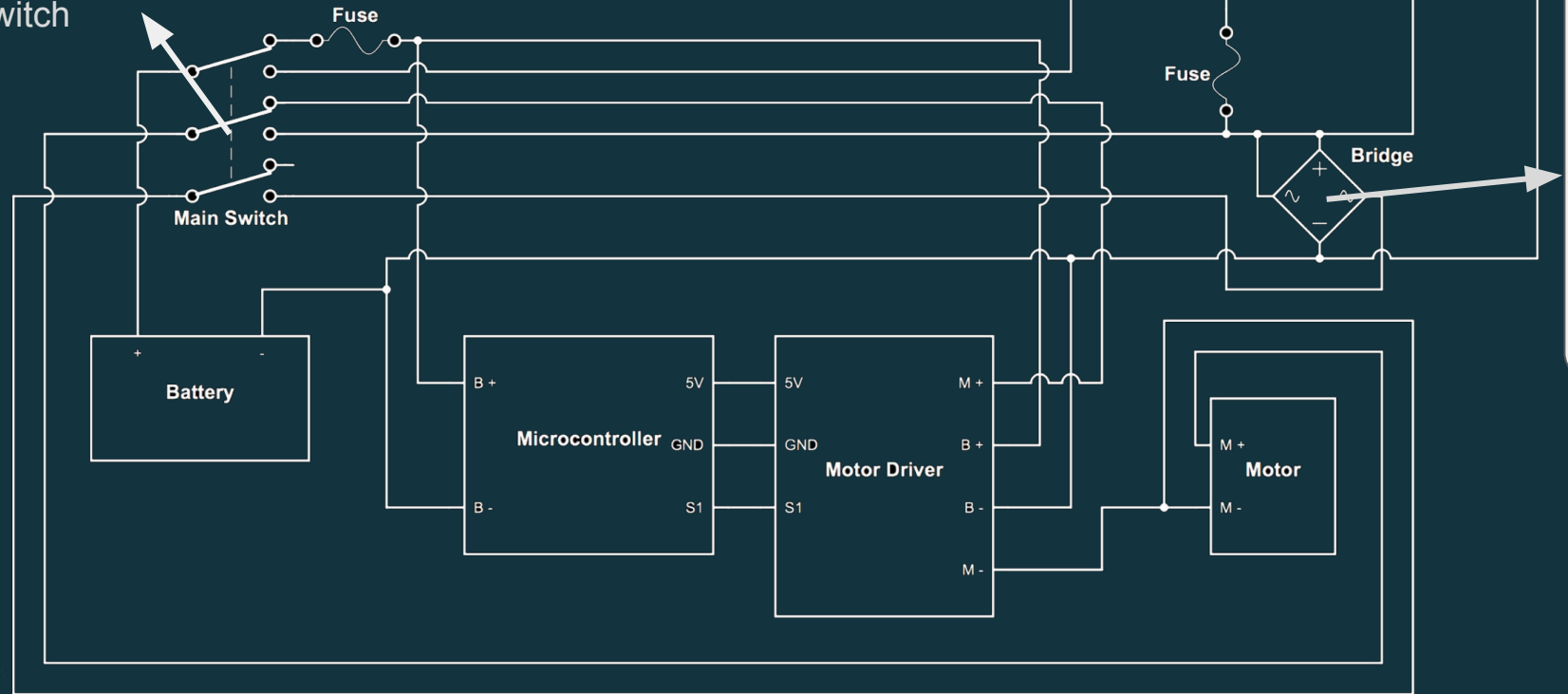
Review Design Specifications



Schematic



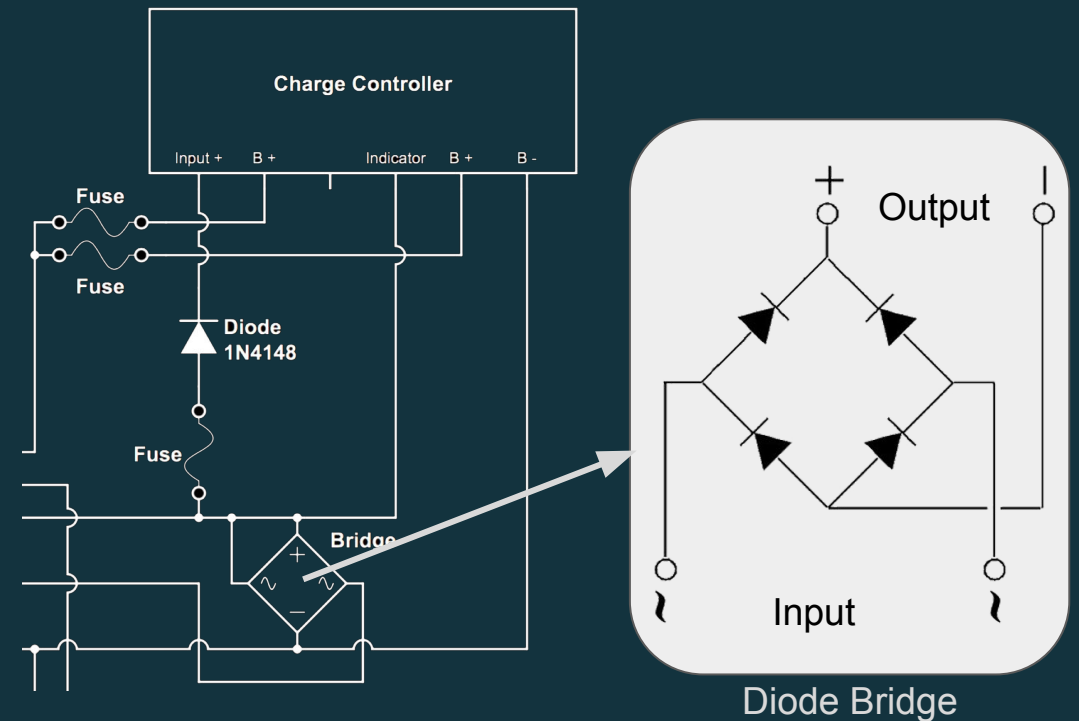
3PDT Switch



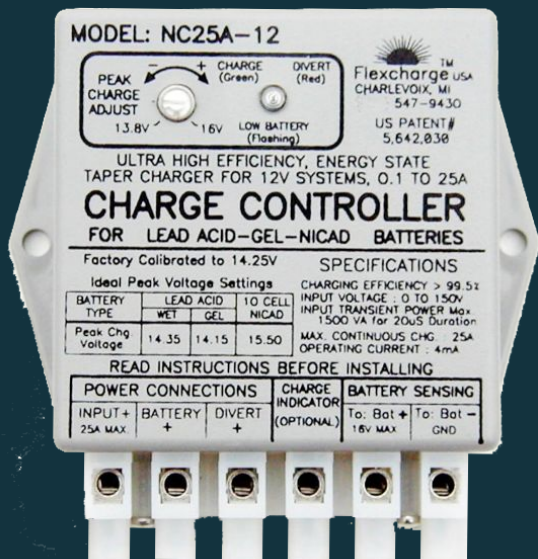
Diode Bridge

Charging System

- Diode: The 1N4148 diode makes sure that the current always flows to the battery.
- Diode Bridge: Keeps input voltage generated by the motor to be positive.
- Fuses
 - Fuses to B+ are 2A fuses
 - Fuses to Input+ is 3A fuses



Charge Controller

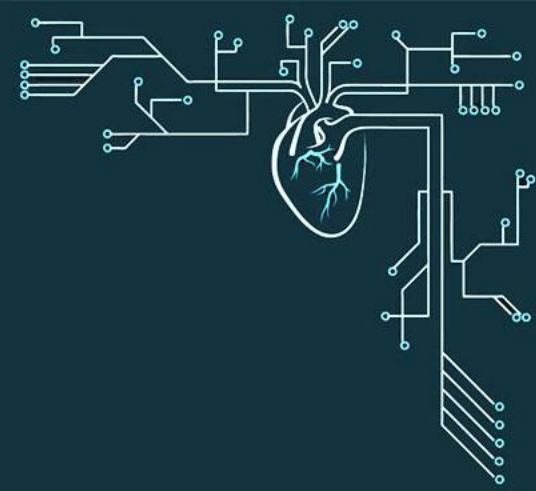


- We used four out of the six pins on the charge controller.
- When charging, the charging indicator in the top-middle flashes red. The indicator is off when the battery is fully charged (above 11V).

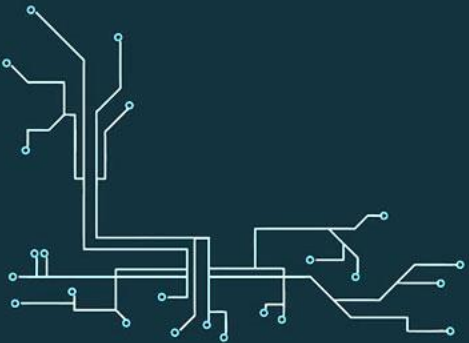
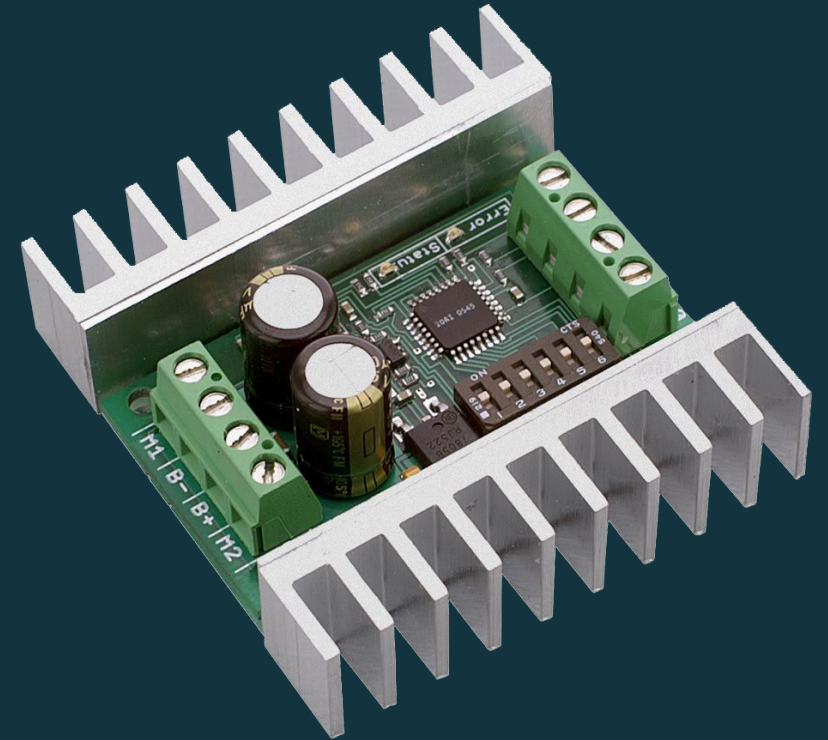
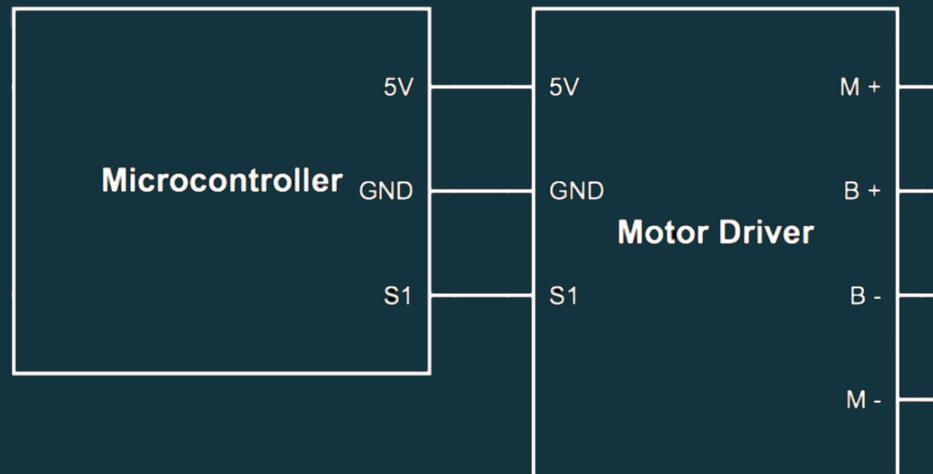
Charge Controller Pin Layout

Pin On Controller	Input +	Battery +	To: Bat +	To: Bat -
Input to Controller	Motor + (with fuse)	Battery + (with fuse)	Battery + (with fuse)	Battery - and Motor -

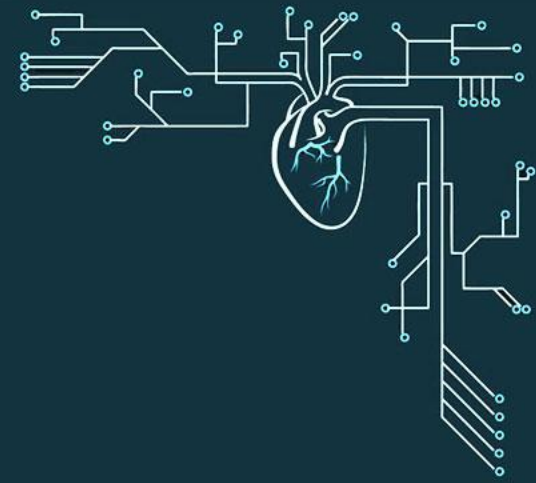
SyRen 50A Motor Driver



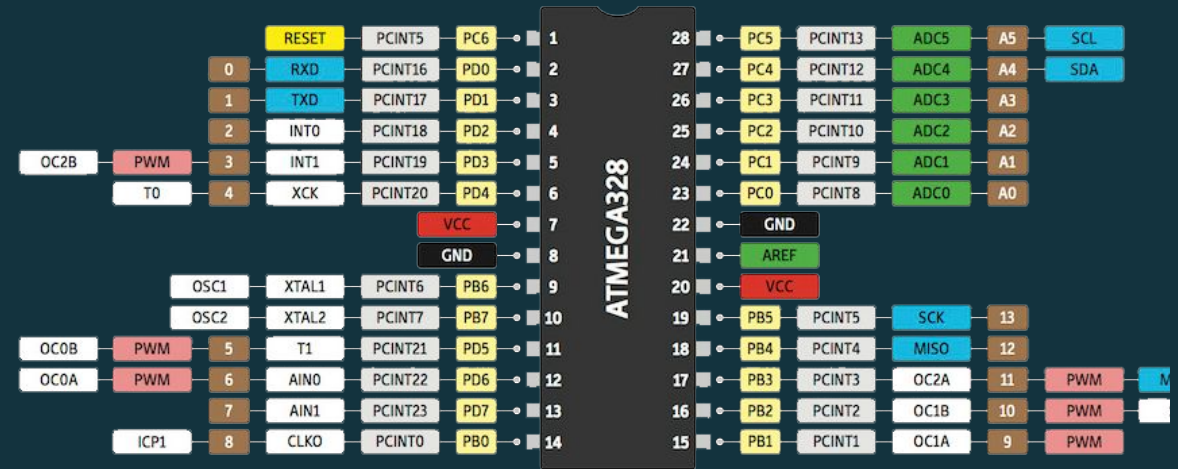
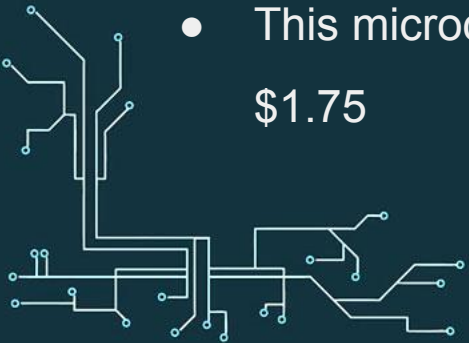
- Input voltage 6V-30V, suitable for the 24V battery we use.
- It can provide 5V output to the microcontroller.
- Pin S1 is connected to the microcontroller (Atmega328p) to receive serial data.



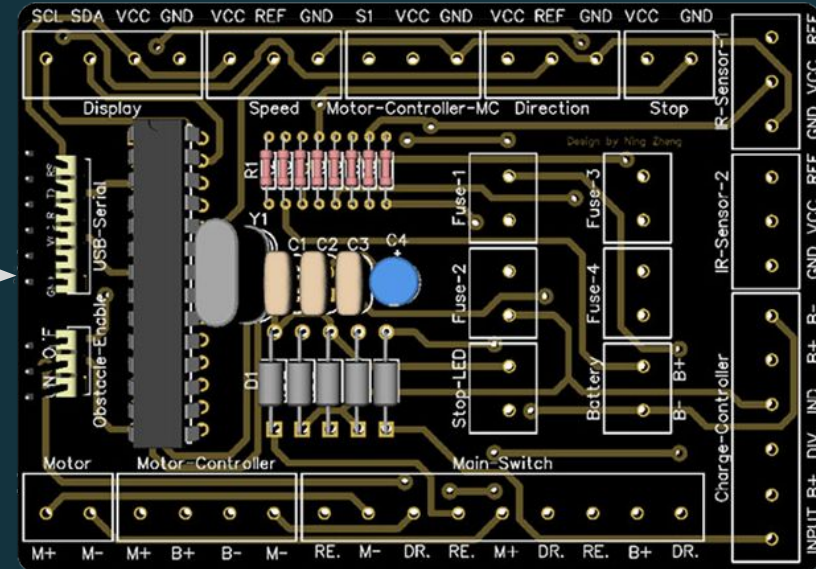
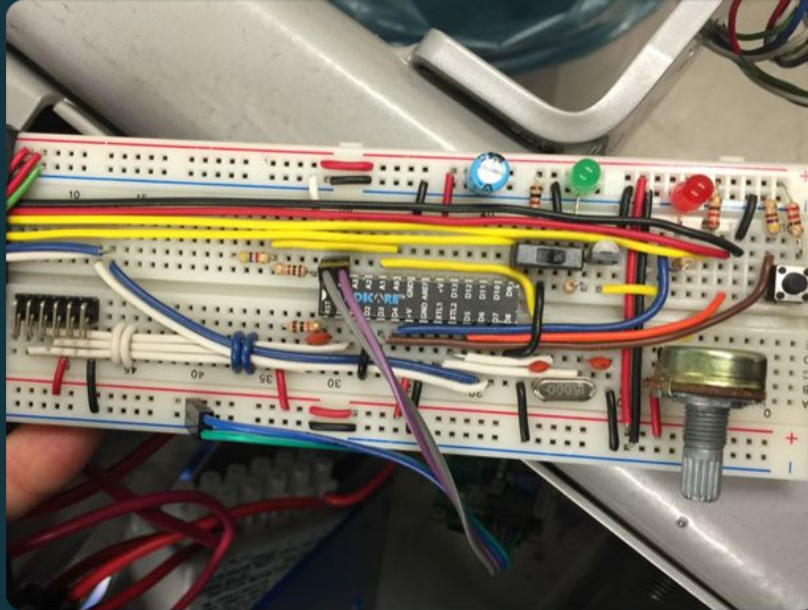
Microcontroller - Atmega328p



- 8-bit single chip microcontroller.
- 23 GPIO lines.
- Programmed by Arduino IDE.
- Supports the motor driver's library.
- We programmed the controller to control the speed of the motor, the acceleration and deceleration, the battery monitor and the IR sensor.
- This microcontroller is very cheap, only costing \$1.75

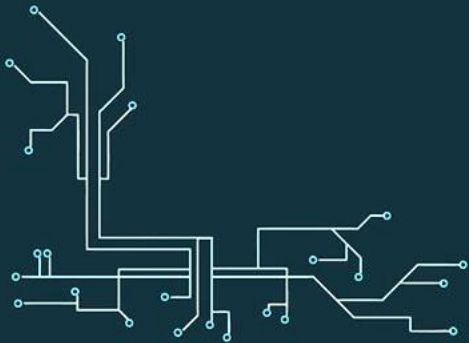
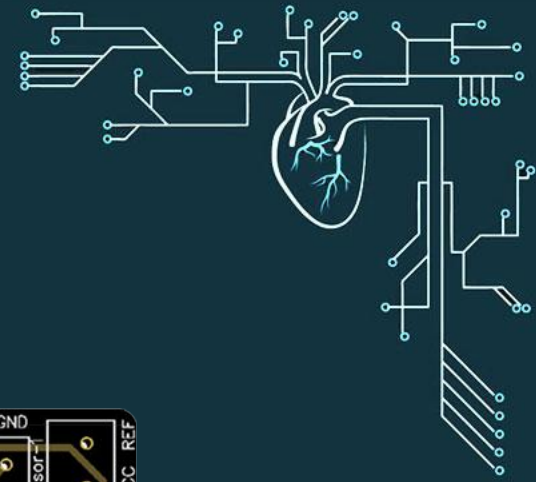


PCB Design

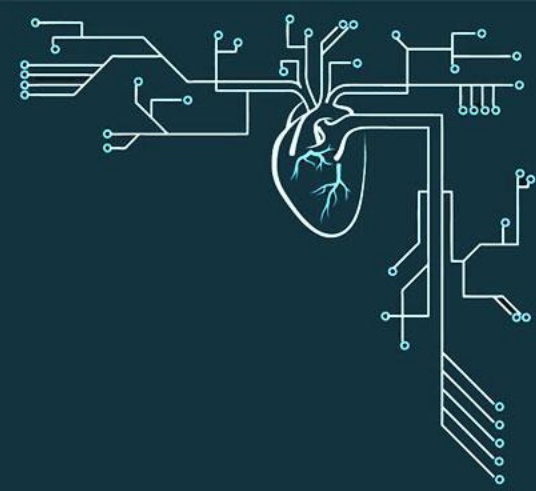


3.5 in

2.5 in



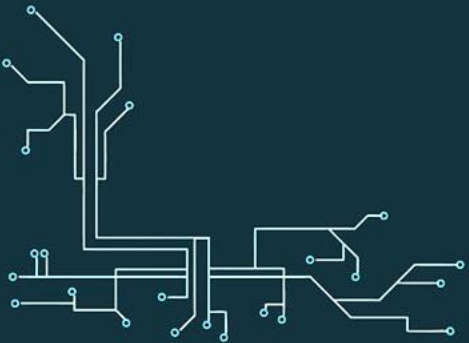
Control Panel



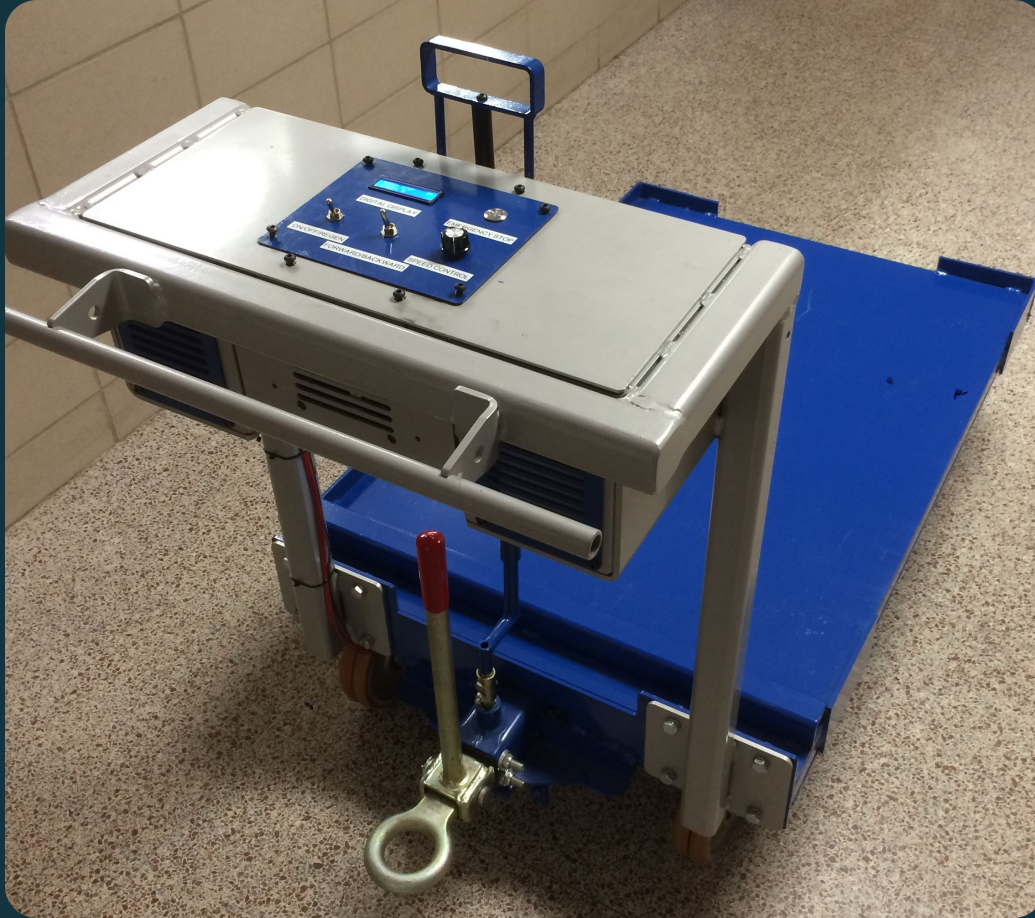
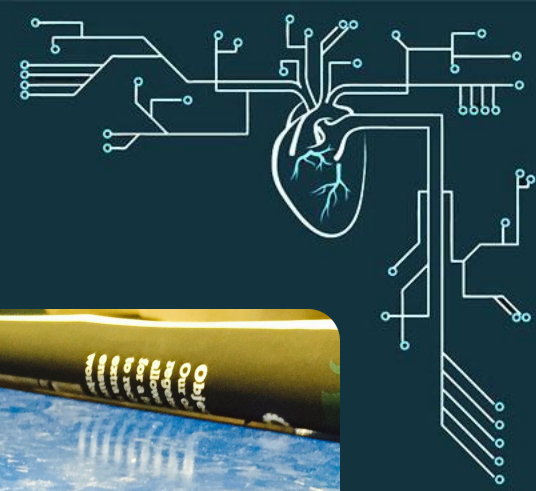
The visual panel that customers will see while using the cart.

The panel will have the following components:

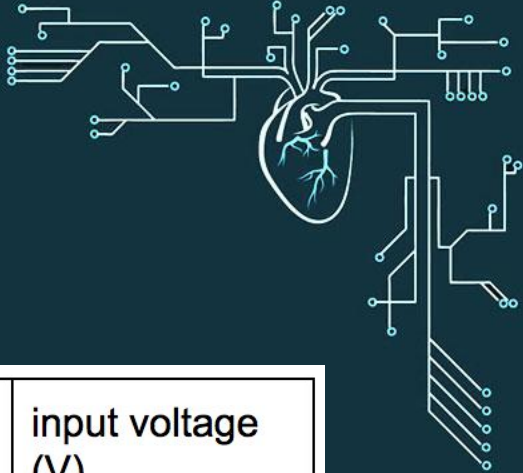
1. Drive/Off/Regeneration Mode Switch
2. Forward/Reverse Switch
3. Emergency Stop Button
4. Speed Control Knob
5. A display to show the operation information



The Final Design

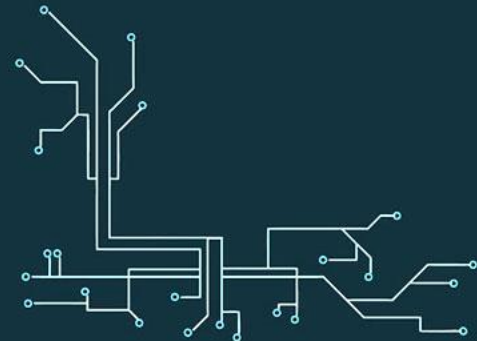


Data of Regeneration System

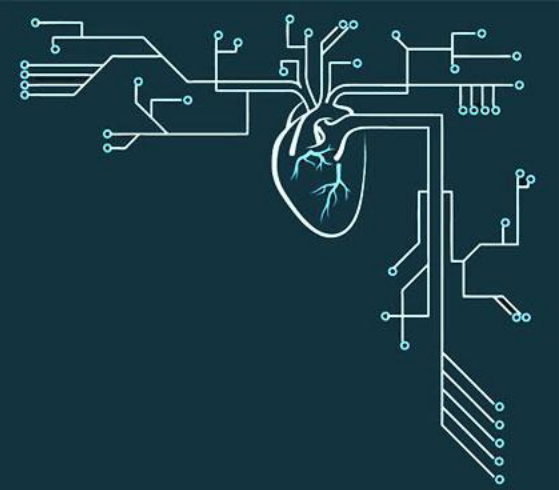


The average voltage change is about 0.034V (about 2% to 3% of the battery capacity).

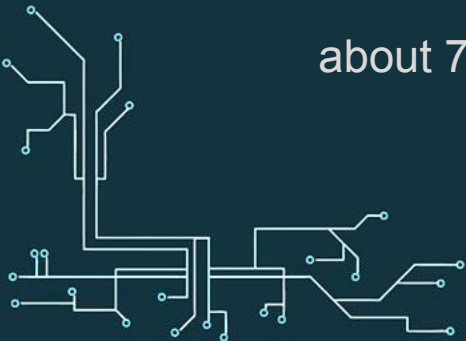
Time duration (minutes)	before charge (V)	after charge (V)	volt change (V)	input voltage (V)
10	10.45	10.50	0.05	4.5
10	11.90	11.92	0.02	4.5
10	11.00	11.03	0.03	4.5
10	12.40	12.41	0.01	4.5
10	10.30	10.34	0.04	4.5
10	11.01	11.04	0.03	4.5
10	10.04	10.09	0.05	4.5
10	11.13	11.16	0.03	4.5
10	11.99	12.01	0.02	4.5
10	10.05	10.11	0.06	4.5



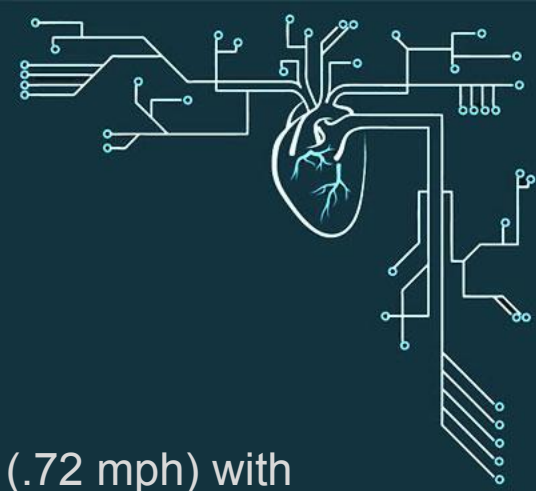
Evaluation of the Regeneration System



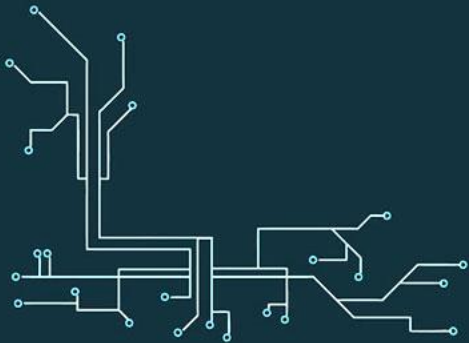
- The diameter of the wheels of the cart is 0.204 meters.
- The diameter of the wheel on the 1/16 hp motor is 0.08 meters.
- When the cart was moving at 1.1 m/s, the rotation speed of the small motor was about 4.383 rotations/s.
- When the motor was rotated at this speed, it was measured that the direct output voltage was from 5.4 V to 7.5 V.
- The output voltage of the charge controller came to be about 4.5 V.
- The current outputs measured were very close from the motor and the charge controller.
- From the above data we can conclude that the actual charge efficiency of this charge system is about 70%.



Evaluation of the Driving System

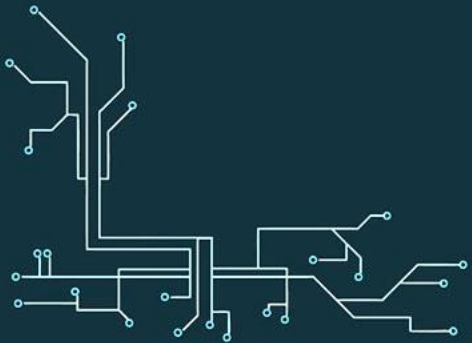
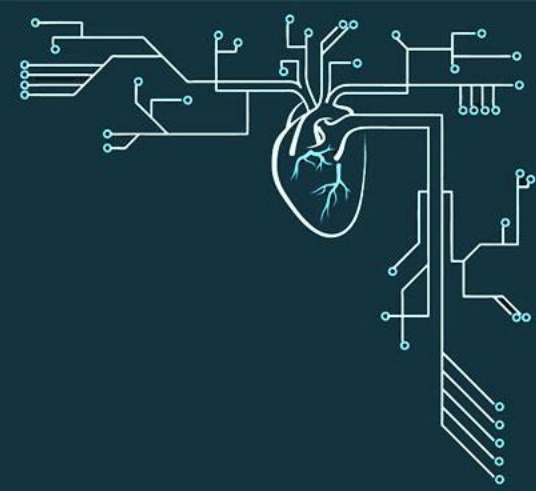


- Speed of the cart (no loads) can be controlled from 0.08 m/s (.18 mph) to 0.322 m/s (.72 mph) with 1/2 hp motor with one 12V battery.
- Acceleration time and deceleration time is approximately 1 second. When the movement direction is switched, the speed will decelerate to zero then accelerate to a certain speed set by the potentiometer.
- Cart will be stopped when the IR sensors detects an obstacle within a .5 meters.

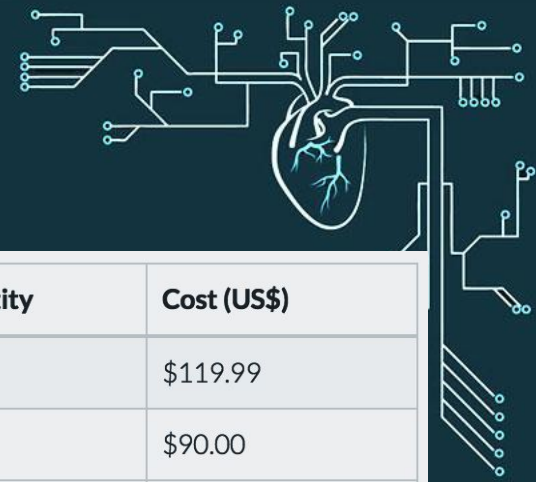


Suggestions for Future Improvements

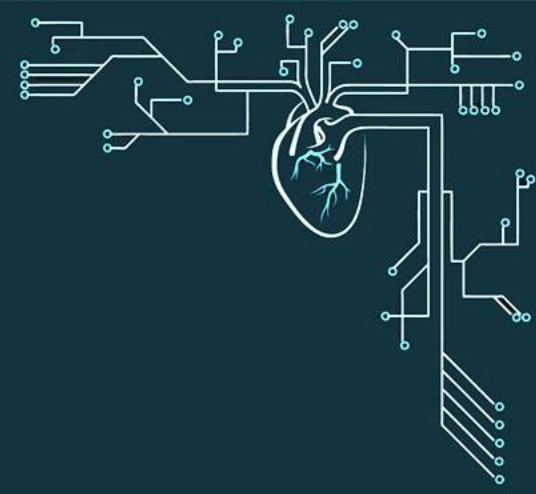
- Redesign the motor driver to make it more suitable for the cart.
- Combine the new designed motor driver and the control board on a single board.
- Use proper motors which have regeneration mode and enough power to drive the cart.



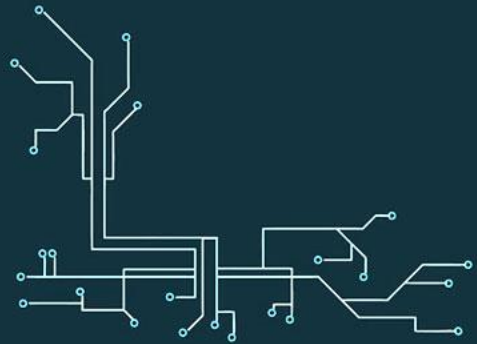
Budget Breakdown

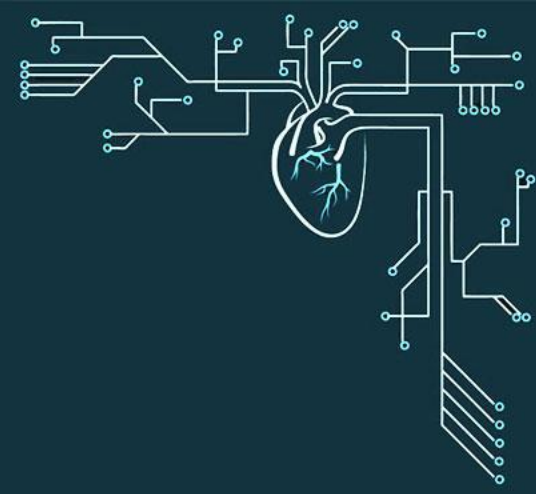


Number	Manufacturer	Item Name	Quantity	Cost (US\$)
1	SyRen®	50A Regenerative Motor Driver	1	\$119.99
2	Flexcharge®	Charge Controller (NC25A-12)	1	\$90.00
3	Qiorange®	Fuse holder in-line AWG	4	\$2.79
4	Foxnovo®	assorted auto car mini flade fuses.	4	\$0.53
5	Geeetech®	Infrared proximity switch module	2	\$15.98
6	Atmel®	ATmega328P-PU DIP-28 Chip	1	\$4.50
7	UlincoS®	Momentary Push Button Switch U19D1	1	\$8.99
8	Uxcell®	AC ON-OFF-ON 3 Positions Toggle Switch 3PDT	2	\$17.98
9	Uxcell®	PCB Mount Screw Terminal Blocks	20	\$3.98
10	Bay Area Circuits®	PCB Manufacture	1	\$52.50
11	Uxcell®	22pF 50V Low Voltage Radial Ceramic Disc Capacitors	3	\$0.17
12	Uxcell®	Quartz Crystal Oscillator 16MHz	1	\$0.58
13	Arduino®	USB 2 Serial Converter Micro	1	\$19.95
Total				\$337.94



Demonstration





Questions?

