Assistant Eye

Team #9

Progress Report V

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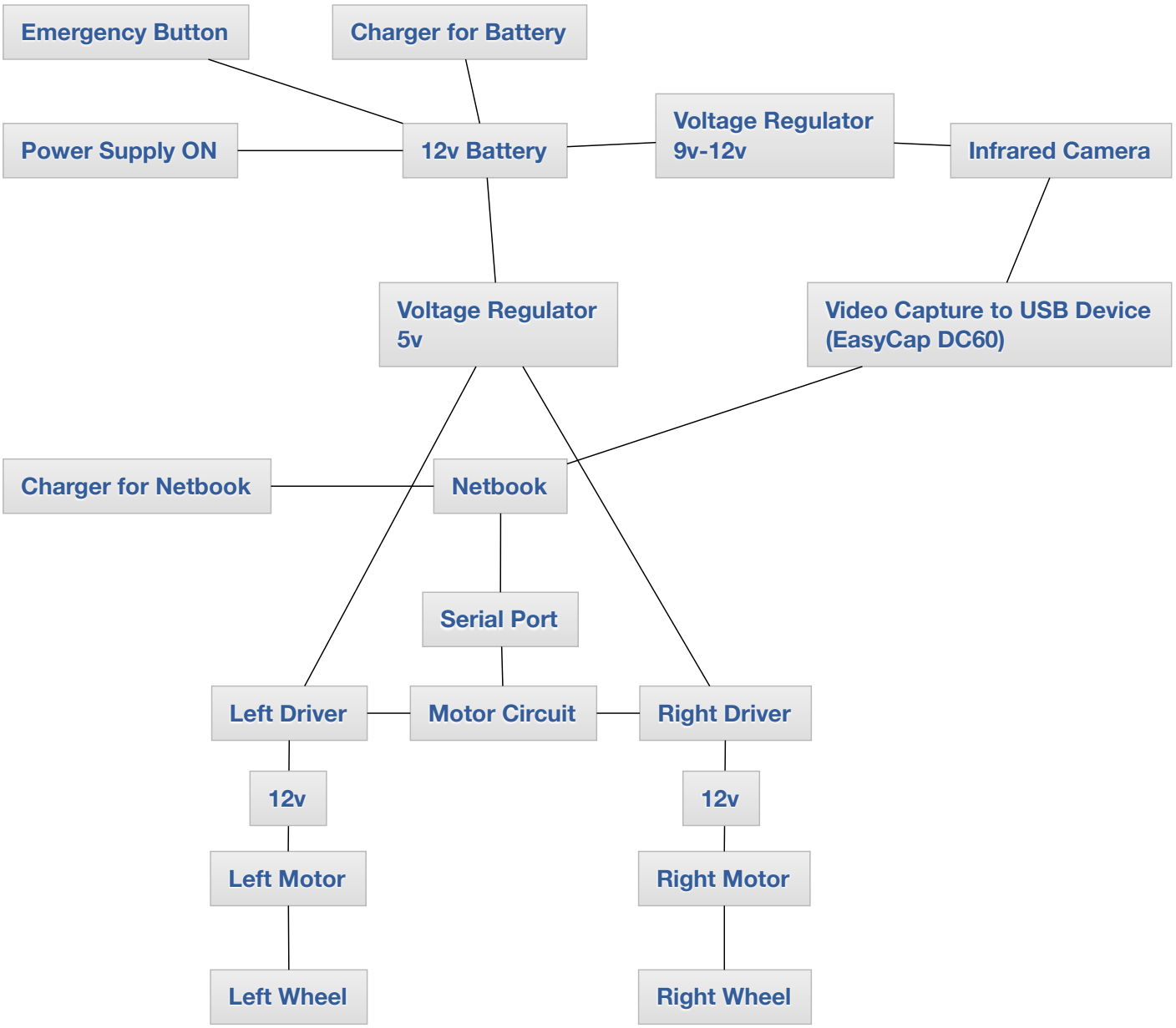
Introduction

This report is prepared to give an insight about the current progress of the Eye Cue Company's latest product Assistant Eye. The detailed system is explained in block diagrams and the connections between them. While preparing block diagram, we take our PCB into account. The interconnections between blocks are explained detailed such as, why and how do we connect them. The pictures of our PCBs are attached in this report with its own explanations. In addition to that, our test results are contained in this report as well as errors that we made.

Block Diagram

Assistant Eye



Relationship Between Blocks

Initially, the system should be turned on by the user. This will let 12V battery begin to supply voltage to the system. Directly afterwards, camera starts to take frames of the pupil of eye. Following to that part, the changes of the eye position that captured by camera will be calculated and accordingly, these calculated eye movement signals will be read by netbook. When the software on the netbook analyzes these signals, based on them, data will be sent to the motor drivers via serial port in order to make driver to move the DC motors. When the signal reaches to the DC motors, correspondingly the wheels are going to begin their movements. There will be 2 free little wheels on the front and these wheels will turn left and right according to the power that are provided from the back wheels. There exists an emergency button that directly cuts the voltage support to the system to prevent undesired situations. There are two outputs of the main block all of which are the DC motors, apart from this, there is just one input, which is detection of eye movements data. Additionally, chargers can be also considered as input while batteries and netbook computer are charging.

Interface Between Blocks

There exists a start system button that enables or disables the system complete the circuit and it will be connected to the system with a wire. When it is on, in the other words, it completes the circuit, 12V battery begins to provide voltage and current to the system. From now on, the system splits into three fields.

First of all is that since the camera needs 9-12V, initially one of the outputs of battery will be regulated to 9-12V to supply power to camera. The camera has composite output and the netbook computer driver has USB inputs, therefore composite output will be transferred to USB output by video capture to USB device which is EasyCapDC60. The pupil photos will be sent to driver via USB connection and its position will be calculated there.

At the second output of the battery, again a voltage regulator will be used in order to obtain 5V so that required voltage to both the motor drivers can be supplied. How the voltage will be provided to netbook is that its own battery is planned to be used for the power, so that there is no extra need to use another regulator for computer. When both drivers and netbook have the start up energy, the communication between camera and computer begins via USB cable and also interaction between computer and motor circuit will start via Serial port connection. When netbook gets the essential signals for motor drivers, after it analyses them, by its I/O pins it will send data to required motor driver in order to run required DC motor. As a result signal flow of motion process is almost completed.

The last but not least part after the battery is motors, which each one are 12V being directly supplied by 12V battery, are attached to the wheels so as to provide motion to wheels according to the eye movements that are detected by infrared camera and afterwards executed by computer and then it gives the necessary information to both motor drivers that give orders to motors. Now, motors get the order and move respectively to the coming signal of motor drivers.

Finally there exists an emergency button that is linked with battery and is used for directly cutting the voltage support to the system to prevent undesired situations.

Progress of Assistant Eye's Structures

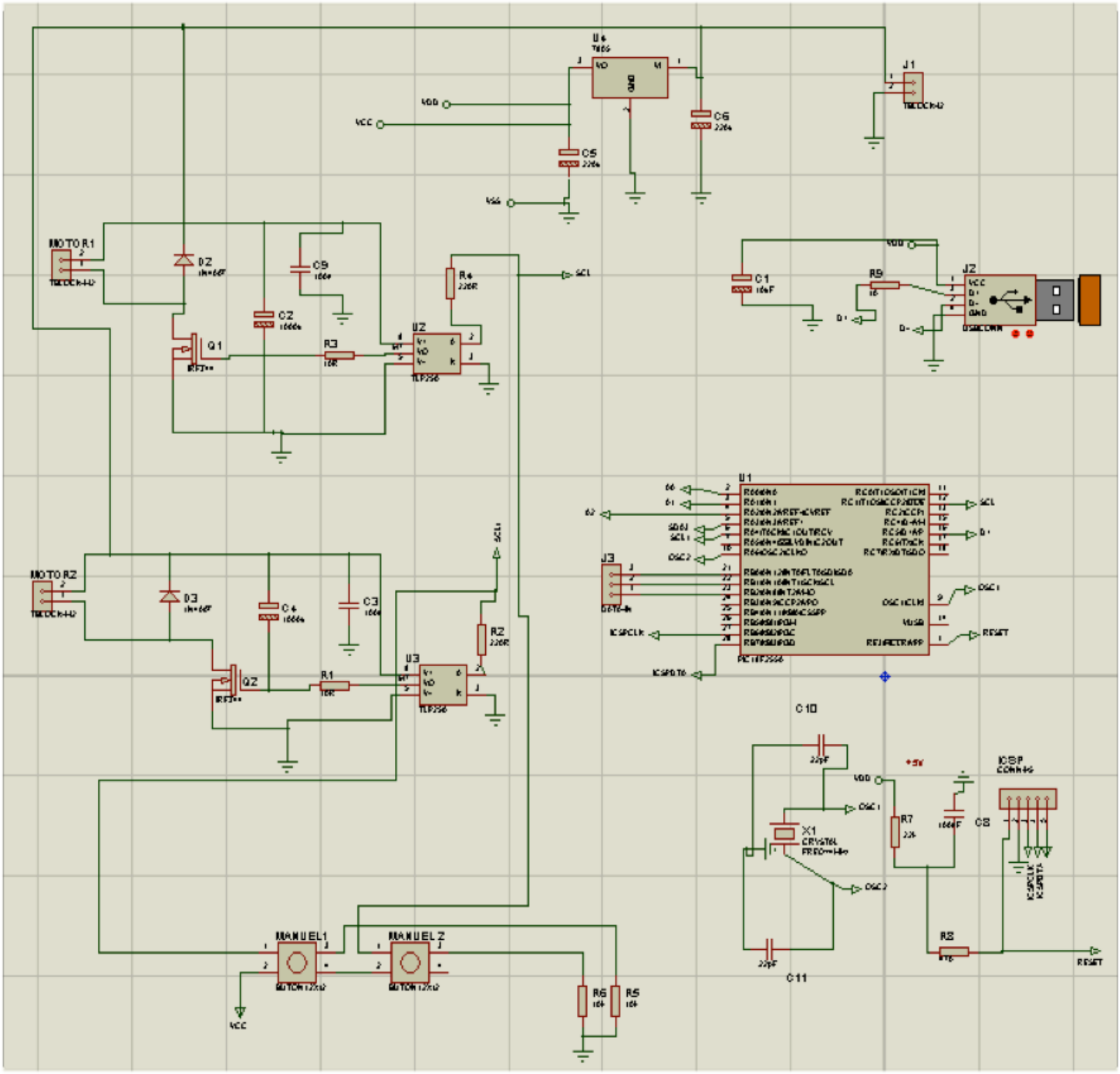
The motor that we are planning to use while driving the wheelchair. It is working on 12v voltage and it draws 1,5 A current.

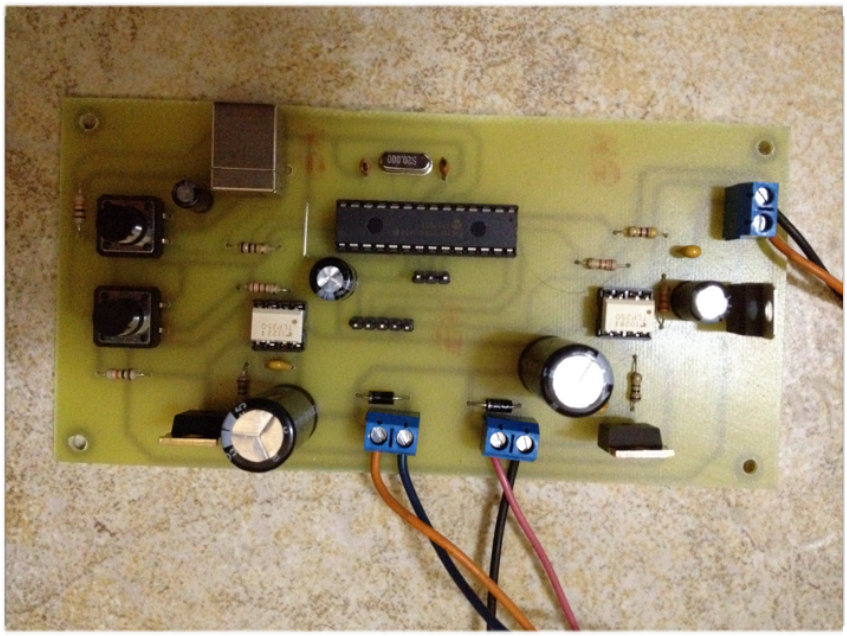
That is one of the wheels with an attached DC motor on it. There will be two different DC motors attached on two separate wheels. The movement will be provided by these motors power.

Plastic gear was inefficient in usage thus, we are planning to use a fiber gear instead of plastic one. We are also planning to use an extra gear in order to increase the torque on wheel.

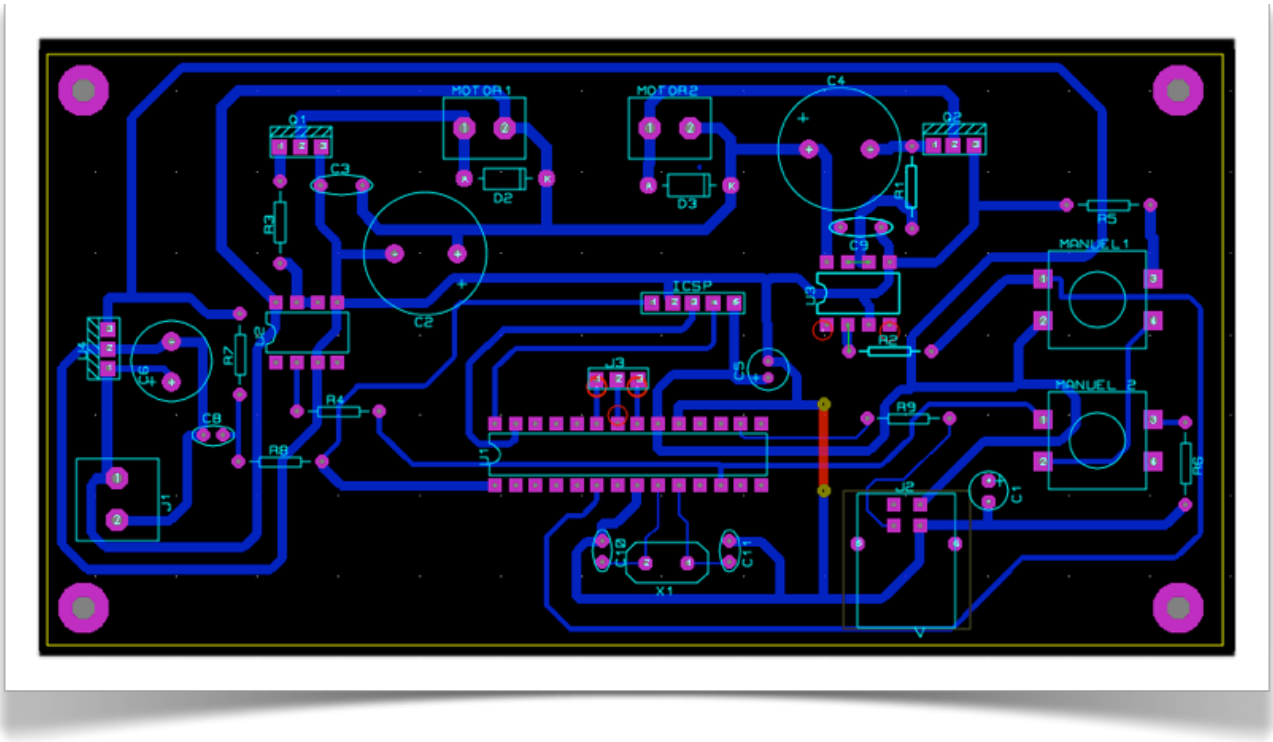
Motor Circuit

Our entire circuit schematic is as shown in figure below. When it is deeply taken into account, it can be observed that it consists of 5 major parts as we had designed in our previous block diagrams. The detailed examination is in the following.





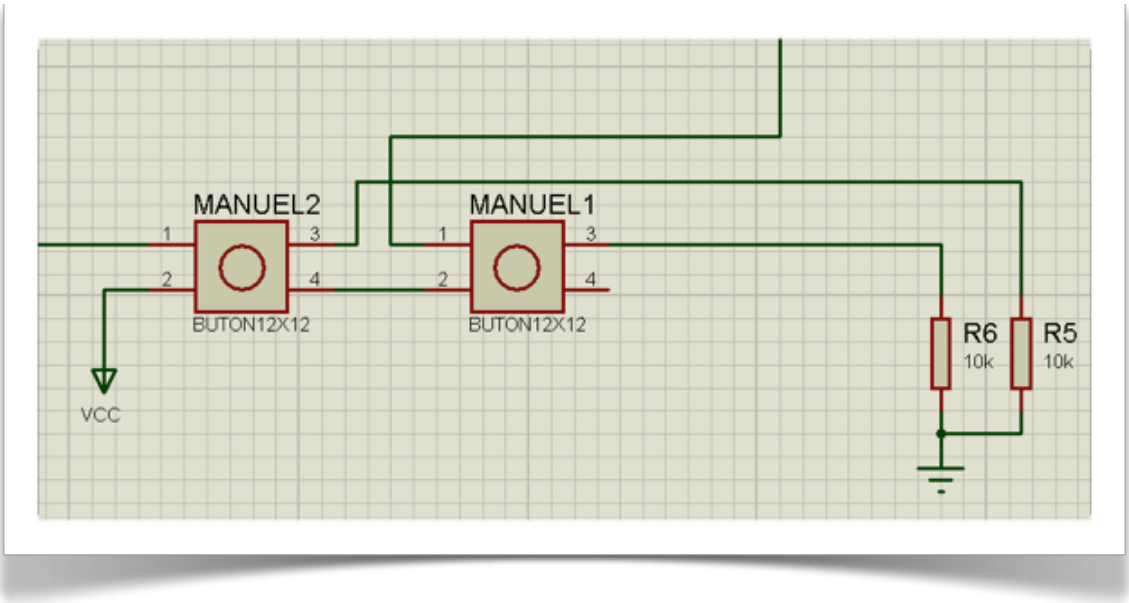
PCB Design



Here PCB design of our latest motor circuit can be found.

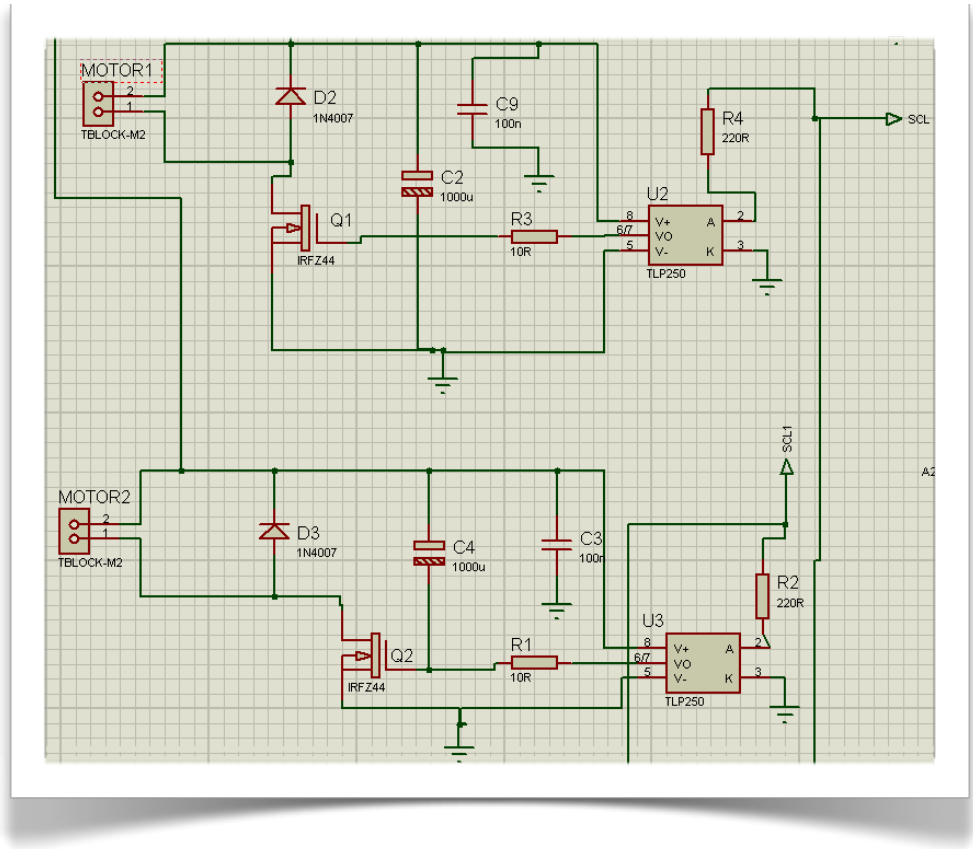
Buttons

Buttons are used for enabling motor movements. If button1 is pressed the right motor will take action, if button 2 is pressed left motor will take action. Additionally if both of them are pressed, both left and right motors will work together. Our intention is to use 3 buttons that the 3rd one is for move the motors at the same time, nevertheless we encountered with unexpected problem that explained in the Problems part.



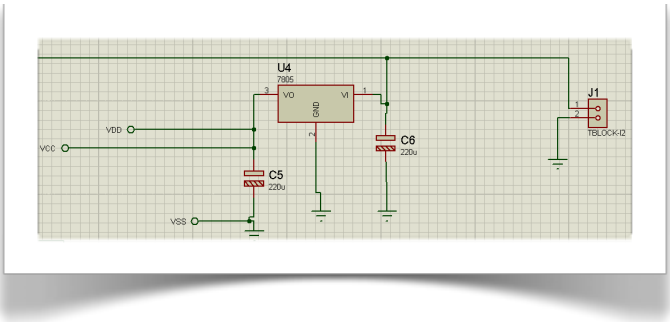
Motor Driver

Motor driver part is the core of the system since it enables the user to control motors as desired. There exists two motors, therefore two different motor driver parts are needed as one for left and the other for right motor. These motors are driven by power MOSFETs due to several experiments. The detailed faced problems are explained in Problems part. Capacitors are used for the protection of the power MOSFETs due to risk of instant voltage drops. We also added two diodes to have much more smooth and stable signal on the motors. With this way, we are protecting the motors from ripples that can occur on the incoming voltage. Besides this, if the probes are connected in the reverse direction, it can cause the motors or the driver circuit to be damaged and they may not work properly or don't work at all. However, in this design, even if probes are connected in the reverse direction, diodes will prevent voltage to pass through. As it can be seen on the schematic circuit, our supply voltage is 12 V. When this voltage flows through the circuit, because of the capacitor's effect, it is transmitted to TLP 250 (MOSFET gate drive) as 5 V. This component's function is to provide a stable and reliable supply voltage for power MOSFET, because otherwise power MOSFET will not work properly. Thanks to the TLP 250, power MOSFETs drive the motors with 12 V.



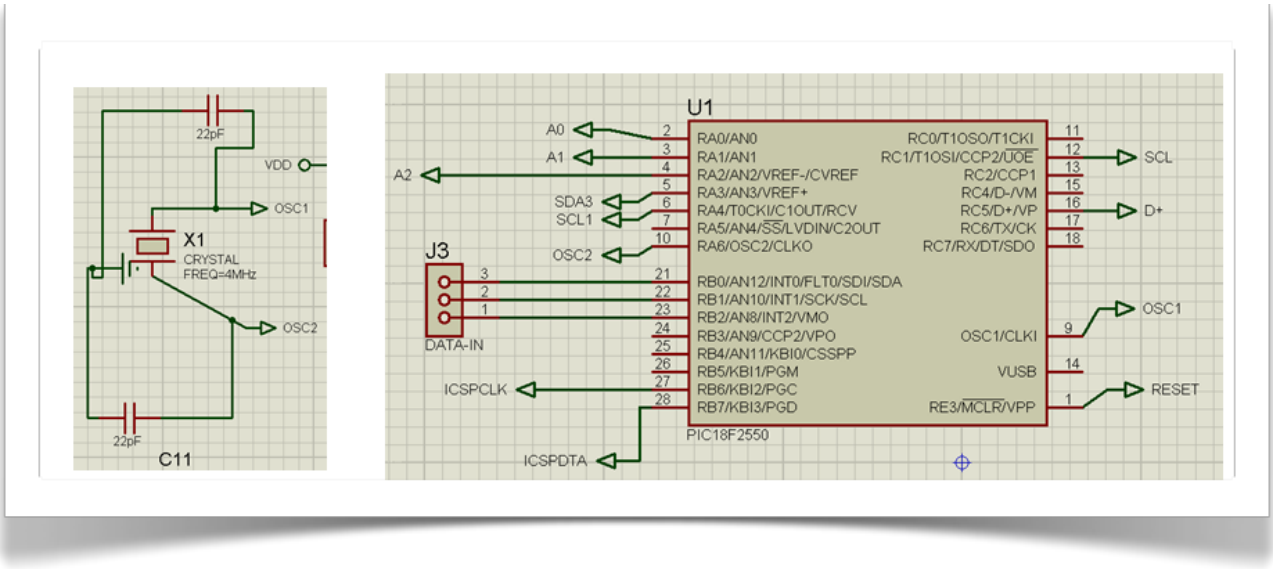
Voltage Regulator (12V to 5V)

This part is the input part of the circuit. When the block diagram taken into consideration, we need to transfer 12V to 5V for so that 12V input is given to the circuit and it will be regulated to 5V for the remaining parts of the circuit.



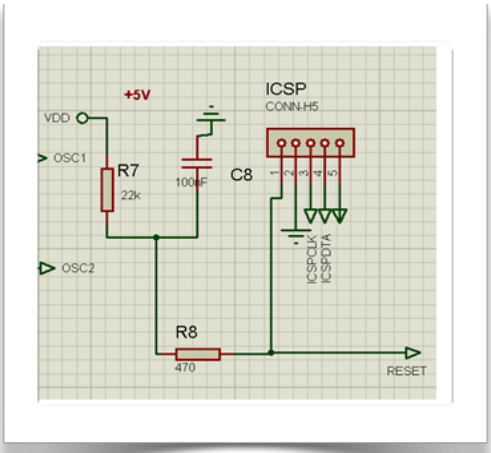
Microcontroller

In order to enable the protocol between USB and Motor driver circuits, we use PIC18F2550 so that the written code in this chip will lead a connection and motors will move according to USB port where it is connected to PC. In our design, we used an oscillator with 20 MHz. This component is used to get information from USB and transmit it to the motors . However, we need this process to be really fast, so there won't be any unnecessary delays between USB and motors.



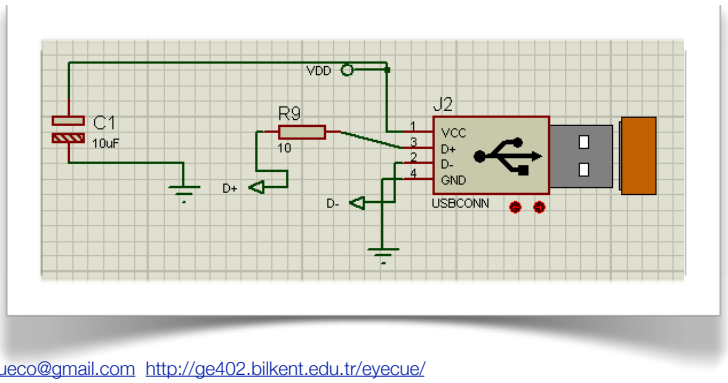
ICSP

We always need to reprogram microchip and this causes our microcontroller's pins to be broken frequently. Later, we have found out that we can program the chip on the layout without problem by adding ICSP part to next to the microcontroller. Therefore we add additional part for reprogramming our controller.



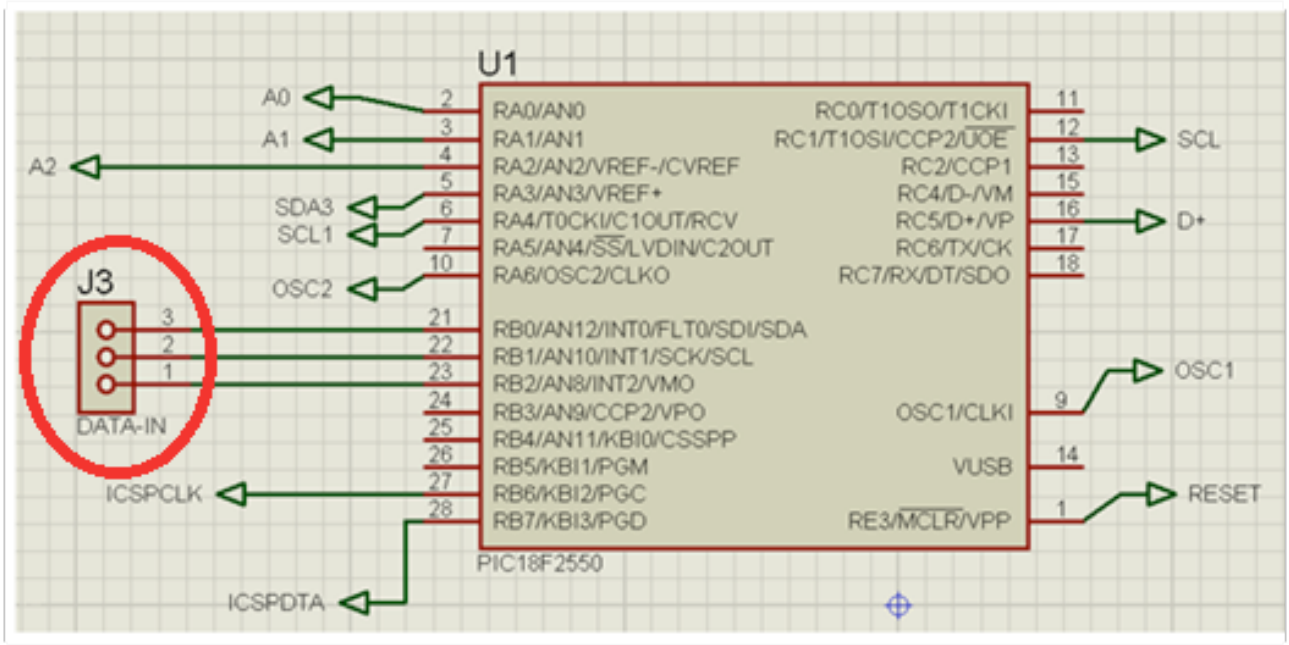
USB Part

The objective is to move motors based on the detection of eye pupil movements so that these taken movement signals need to be sent to the motor circuit. By the USB connection between computer and circuit, we achieved to combine two parts.



Additional Data Pins

In our design, besides the USB connection, we also have three input-data connection pins. These input data can be used for serial port communication. The reason why we have implemented such a component to the design is that if we can't provide the connection between USB and motors, RS232 can be used for communication.

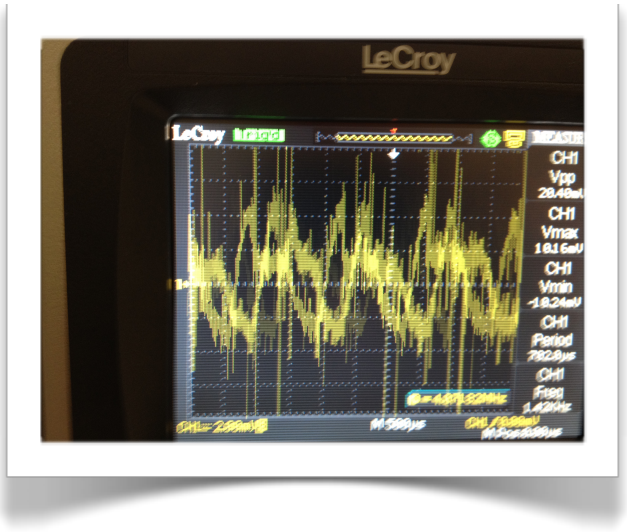


Hardware Check

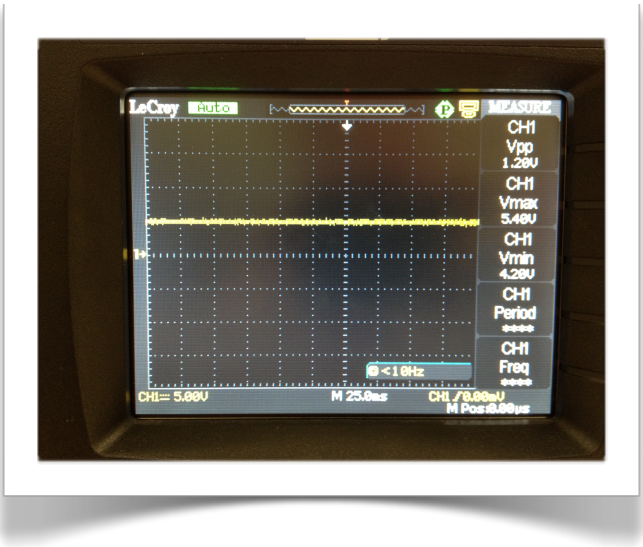
When our latest hardware is taken into consideration, we can proudly say that everything works well according to components performances.

- ✓ 12V input voltage regulated to 5V by the regulator.
- ✓ When any of buttons are pressed the related motors start their action.
- ✓ The output of the power MOSFETs supply 12V to motors.
- ✓ Failed to implement USB data connection, therefore we cannot check whether our USB circuit part works properly or not.

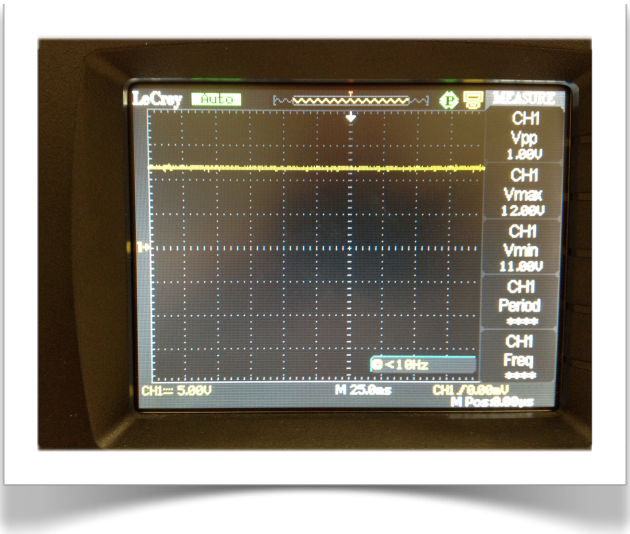
Test results



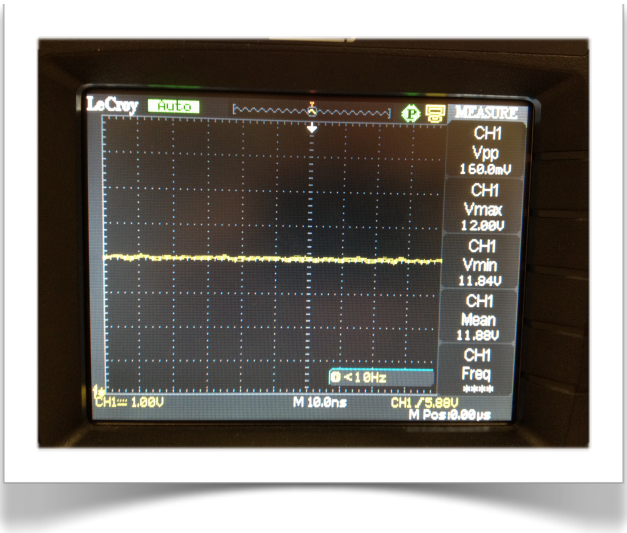
12v to MOSFET's Drain



Voltage Regulator Output

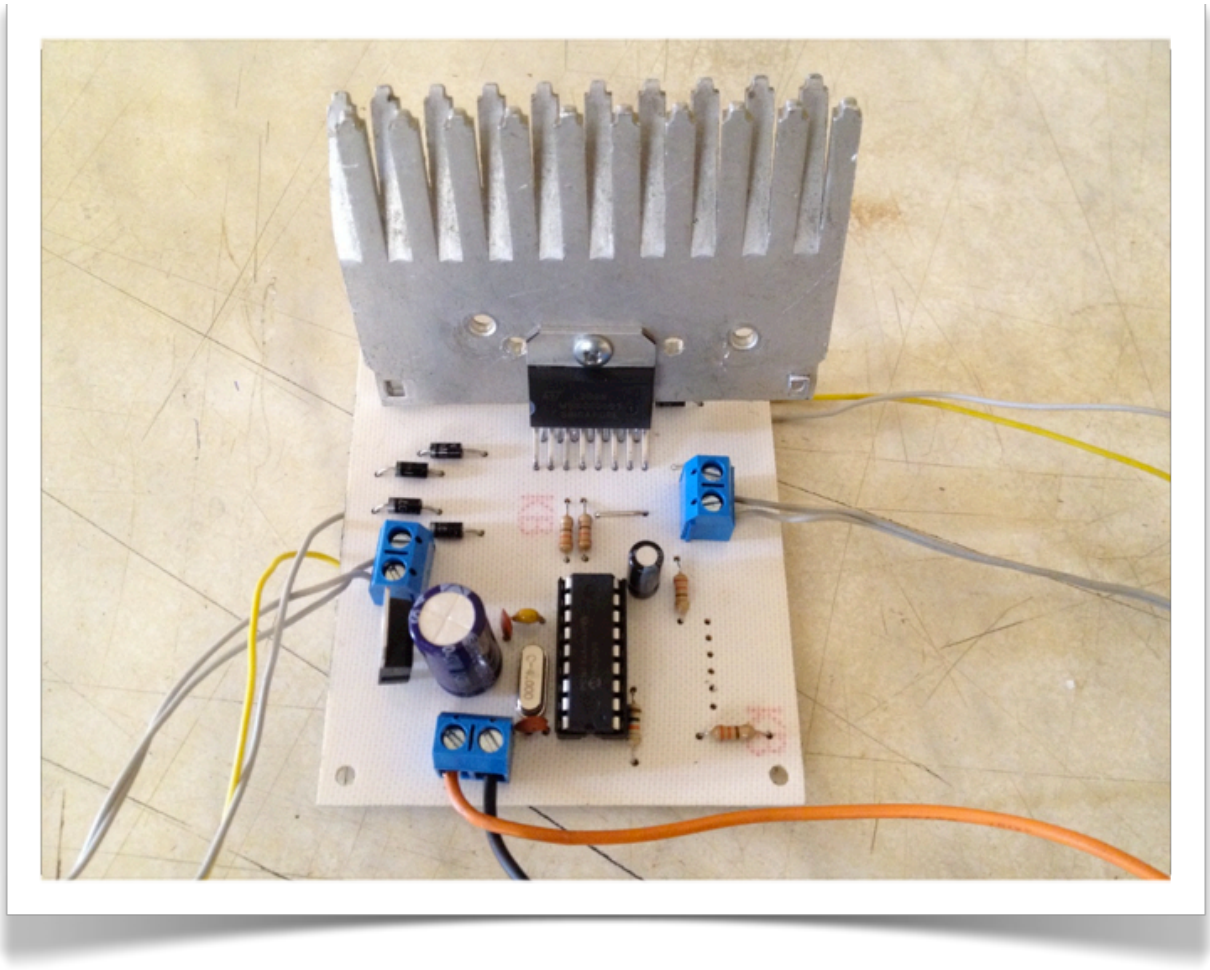


MOSFET to Motor Input 12v

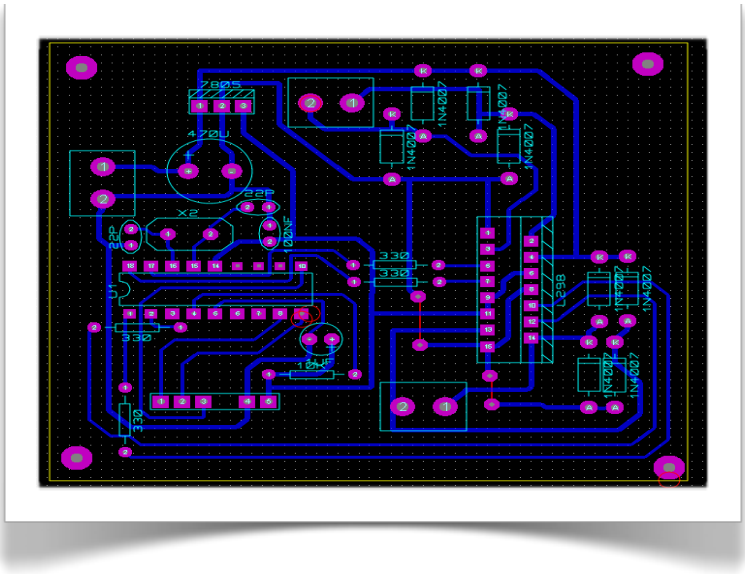


Vcc 12v TLP250 Input

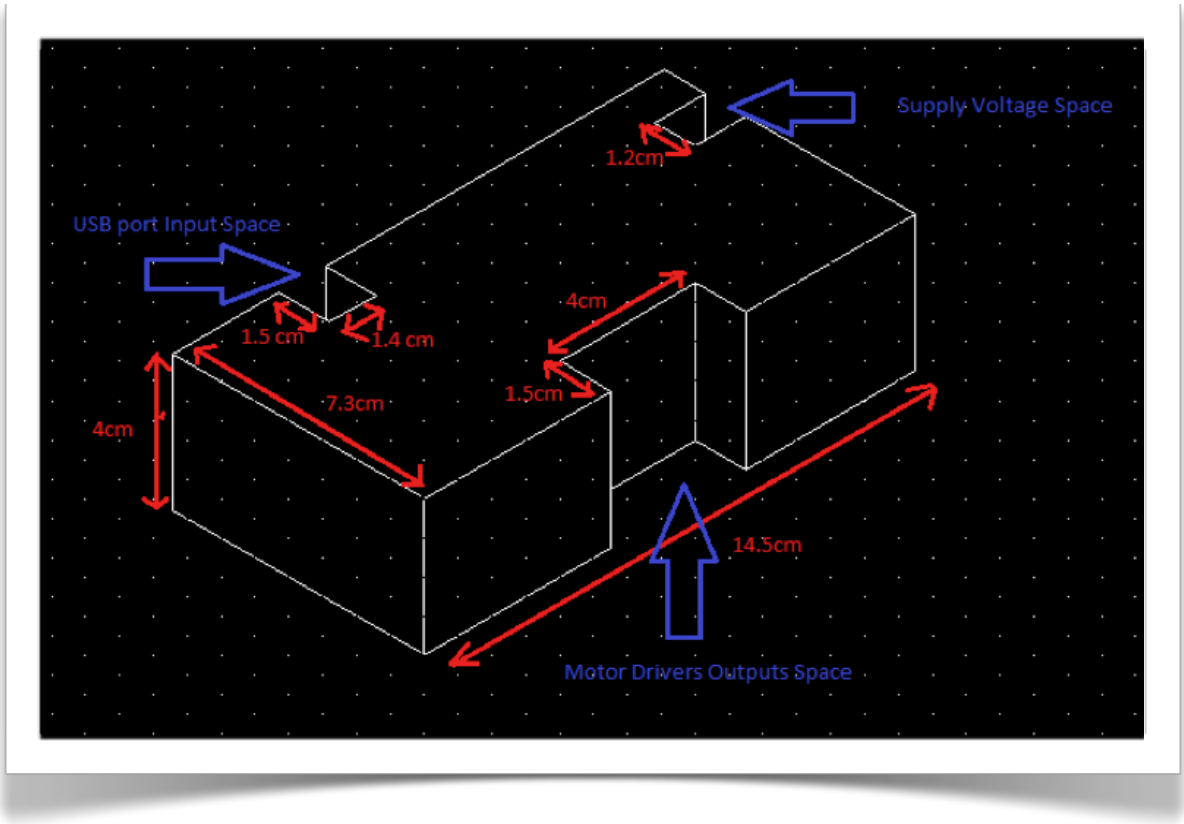
First Circuit Trial



At the beginning of this term we came up with this circuit that again a PIC microcontroller, 12V to 5V regulator, some components for the required circuit adjustments and a dual motor driver are used with two buttons for left and right motors. What the most important point is that per motor requires at least 1.5Amp and that makes 3 Amp in total, nevertheless, although the dual motor driver seems to supply such ampere, it heats a lot in short time. For that reason we added a cooler behind it but while we are on the process of enhancing the circuit we heated it so much that it won't work anymore. Therefore we have decided to implement the circuit in other ways since the dual motor driver fail to support our needs.



Designed Box



The latest designed box is given below. The collapsed parts are for inputs and outputs of the related connectors.

Problems

- Our first intention about the buttons was to run our motors with 3 buttons that have different functions such that two of them were going to be used to run two different motors and the other was going to control both of the motors. We implemented this idea into our design by using Proteus. We were able to control both of the motors seperately by pressing the buttons. Then, we added another button whose function was supposed to be running both of the motors at the same time. However, when we implemented the third button, we observed that neither first nor the second motor was moving at all. At first, we thought it might be caused by a short circuit between the two buttons, thus we removed the third button to observe what happens when both of the buttons are pressed. After testing this, we observed that both of the motors were running with no errors. Therefore, we couldn't figure out what caused the third button not functioning correctly and designed our PCB with two buttons.

- After making researches and talking with expert people about the topic regarding to motor driver circuit, we came to the conclusion that using a power MOSFET will be the best choice which serves to our purpose. In our researches, we found out some examples about motor driver circuits which contain a certain MOSFET type, IRFZ 44N n-channel MOSFET. We wanted to test this MOSFET in our design, however we found out that normally it doesn't exist in Proteus' library, therefore we had to check its datasheet and implement the required properties manually.

- As it can be seen on the schematic of the driver circuit, we used two power MOSFETs to control the motors. The reason why we selected power MOSFET for this purpose is that while other integrated circuits don't support the range of current value that motors work properly, power MOSFET can support high current values. In addition to this, even if motors are overloaded and draw more current compared to the average value, which is shown in the datasheet of the motors, there won't be any problems on the motor driver side, since the battery we used in the design supports less current than MOSFET does.

- At first, according to Tarık Reyhan's advice, we tried to desing our circuit by using relays to provide the necessary current for motors. We already had a schematic that contains an integrated circuit. Thus, we integrated the relays into the previous existent circuit to check if we can use them in our design. However, when we consruct the circuit and run it, after a while because of the current, relays started to overheat and they adhered to each other. We are not sure if the relays themselves or the way we used them were improper for our purpose. We just wanted to give it a shot with trial and error method. After failing on this attempt, we didn't want to waste time by discussing about it and tried to find out some other ways to complete our design.

- Since we have wasted too much time with implementation part, we couldn't spare enough time for programming a USB data connection protocol. We just made some research about it in our limited time and found out that it is much more complicated than we have been thinking. Therefore, in the future, we may need some assistance from our software designer.

Referances

IRF Z44N Data Sheet

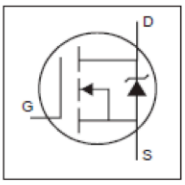
International
IOR Rectifier

PD - 94053

IRFZ44N

HEXFET® Power MOSFET

- Advanced Process Technology
- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated



V_{DSS} = 55V

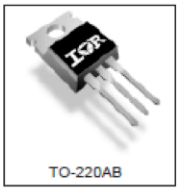
$R_{DS(on)}$ = 17.5mΩ

I_D = 49A

Description

Advanced HEXFET® Power MOSFETs from International Rectifier utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that HEXFET power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in a wide variety of applications.

The TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 watts. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.



TO-220AB

Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V	49	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V	35	
I_{DM}	Pulsed Drain Current ①	160	
P_D @T_C = 25°C	Power Dissipation	94	W
	Linear Derating Factor	0.63	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
I_{AR}	Avalanche Current①	25	A
E_{AR}	Repetitive Avalanche Energy①	9.4	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	Soldering Temperature, for 10 seconds	300 (1.6mm from case)	
	Mounting torque, 6-32 or M3 srew	10 lbf-in (1.1N-m)	

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	1.5	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient	—	62	

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DC Motor Data Specifications

Characteristics

Voltage: 12 V

Working Voltage: 9 - 16 V

Max Torque: 36Nm

Reduction Ratio: 1/67 ve 1/63

Engine speed interval: 45±5 rpm to 65±5 rpm

Current interval: 2.5A - 4A