2015 Team Description Paper

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Abstract. This paper illustrates advances the RFC Cambridge team made in the 2014-2015 year and describes the changes all robots will undergo for the 2015 competition. Improvements were seen in both mechanical and electrical engineering portions. Mechanical engineering subteam made two major changes. Electrical engineering subteam redesigned big parts of the circuit and focused on goals such as reliability, robustness and transparency.

Mechanical Engineering

This year the mechanical team made two important advancements. First, in order to make the robots movements more exacting we decided to improve upon the encoders that are mounted on the robots motors. These encoders rotate as the motor rotates and are read by the robot and relayed back to the computer program to telling how far the robot has traveled and how fast it is moving. The problem with this system is that the encoders are not mounted on the motor exactly in the center or straight which causes inaccurate readings to be relayed to the computer.

In order to fix this we drilled a small hole into the motor shaft in which we inserted a dole pin. We used epoxy to fix its position exactly in the center of the shaft and straight as possible. We then mounted on top if the pin an aluminum shaft that we manufactured and again secured it with epoxy. To finish it off we just press fit the encoder onto the shaft and just like that we have more accurate readings from an encoder that is centered and straight.

The second advancement was the revision of the mechanism for retracting the kicker. Previously, the mechanism utilized a compression spring sandwiched between the solenoid body and a hard stop on the rear of the moving inner rod. However, the kicking force produced by our solenoids was strong enough to plastically deform the springs, causing them to gradually lose their ability to retract the kicker fully. Incompletely retracted kickers would in turn lead to reduced kicking force, or even prevented the robots from dribbling and/or detecting the ball.

To address this issue, we switched the retraction from compression to extension, using elastic bands instead of compression springs. The bands are connected to the rear of the inner solenoid rod, via a laser-cut and thermoformed plastic mounting piece. The bands are then braced against a rigid post fixed to the

base plate of the robot in the back. When the solenoid kicks, the bands stretch, but then pull the inner rod back. Because the kicker's travel length is limited, the bands are never overextended and therefore maintain their performance over time.

Electrical Engineering

This year the electronics team has done a full redesign of our electronics system. Our design goals for the new system are:

1. Reliability and Robustness
2. Transparency and Communication
3. Improved Control

We are addressing point 1 by adding overvoltage and overcurrent protection to many parts of the circuit, in particular the motor system. In addition to hardware limits, we added sensing capabilities so that we can measure our current draw for each motor and use software to identify problems. We measure current by passing it through a very small sense resistor and amplifying the voltage drop.

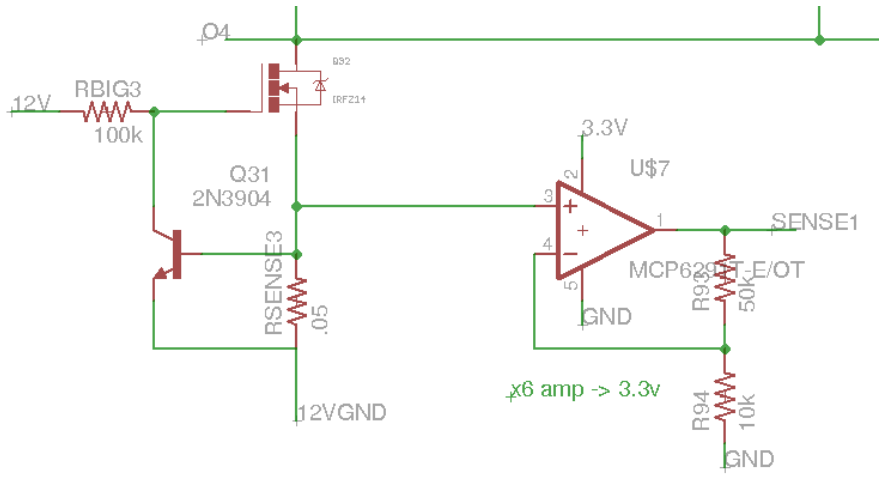

Fig. 1. Diagram for limiting and measuring motor current.

Point 2 is addressed by using a Xbee wireless transmitter that is capable of two way communication. Now that we will be able to send messages back from the robots to our central computer, we will be able to quickly identify and respond to hardware malfunctions or firmware errors.

To take advantage of this capability, we aim to make the electronics able to identify and diagnose problems themselves. For instance, we can identify a

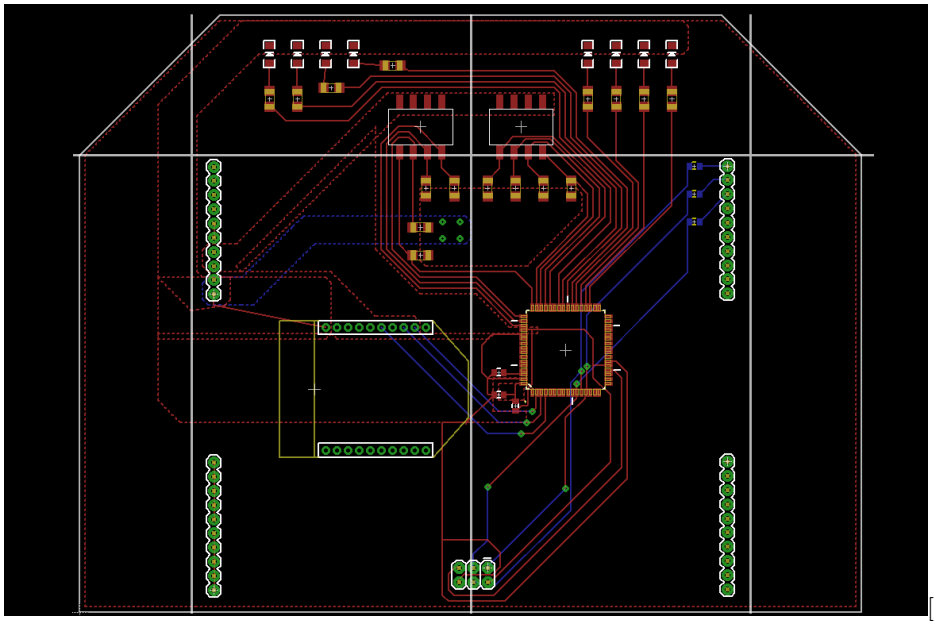 [h!]

Fig. 2. Board layout to interface with an Xbee radio.

burned motor or driver by comparing our commanded rotation speed with the actual speed as measured by our sensors. We can also measure our battery voltage. Burned motor or low battery notifications can be sent to the computer to allow us to call a timeout and fix the problem.

A primary goal of Point 3 is better controlling our motion. We will use specialized ICs to drive our wheel motors, and use a single microcontroller to set the speed for all 4 wheels. This will allow us to balance and compensate between different wheels. Another part of control is in our ball handling. We are designing new circuitry to let us carefully select our kicking force at the moment we kick, in order to have both fast shots, and slow passes.

Computer Science

For computer science we are working on fixing bugs we encountered in our previous competitions to make our robots run more effectively and efficiently. In addition to our general bug fixing and ensuring reliability in our robots, we have split the computer science team into three subteams; a team that is working on the offense, a team that is working on the defense, and a team that is working on implementing the changes to the rules. The offensive team has been ensuring our robots choose better paths for path-planning, and we are programming plays for our robots to set up picks to clear shooting lanes. In addition, we are implementing code to more effectively use our dribbler for novel plays that put

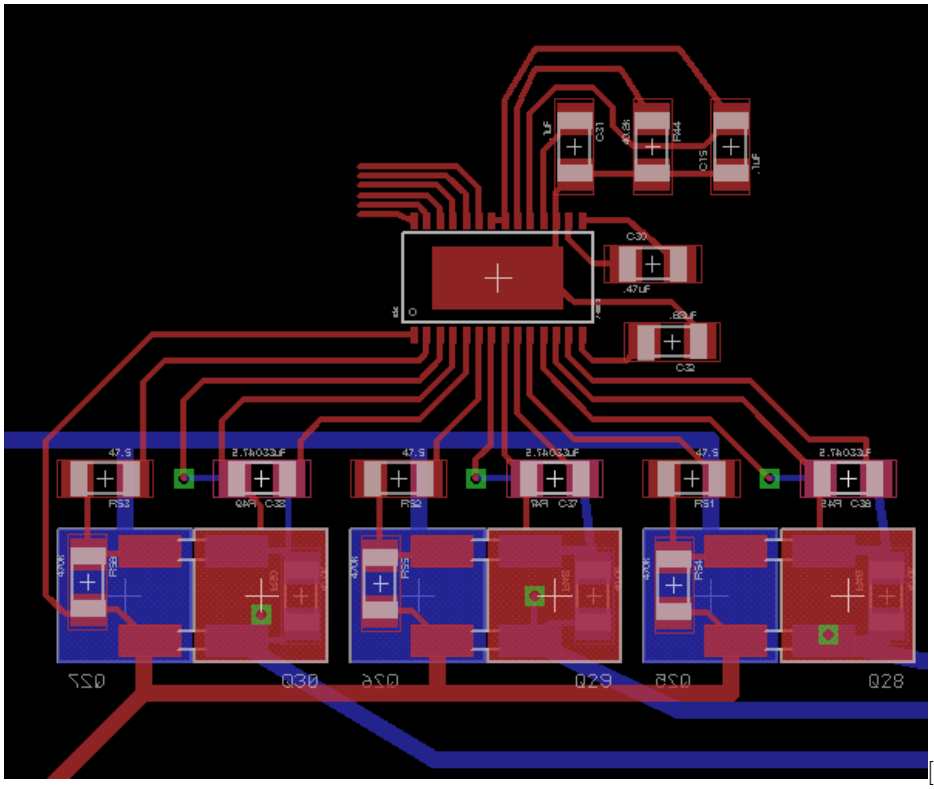

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Fig. 3. Board layout for a single wheels motor driver.

our robots in better positions to shoot. On defense, we've been improving our defensive matching algorithm, making sure our robots are being assigned to the closest robots on the opposing team that present the largest threats. In addition, we are implementing code that allows us to find any of our robots that potentially are broken, and flag them as improper to use on defense so we can take them off of the field to repair them. Finally, our new-rule team is ensuring our code complies with the larger field constraints and the new icing rules, making sure we are able to compete effectively in the new season.