Electronics on Chipping Sodbury School's

The “Fly By Computer” Rotary Racer 7

The Chipping Sodbury School's Rotary Racer team has been involved in Greenpower for a large number of years supported enthusiastically by Brendan McMorrow at the school. Although team members have come and gone, throughout the years the team has used a simple covered aluminum tube space frame design with simple fixed gear chain drive employing a simple on/off switch and no instrumentation. This has allowed the car to be relatively easily built by the pupils and parents involved. Good team spirit together with the cars reliability, reasonable aerodynamics and light weight has allowed the team to do well in races. However, it was always a bit hit and miss if the batteries would last the race or conversely would have lots of power left in them. It was also difficult to measure any improvements in the cars performance in order to improve it. Also we needed to look at controlling the power output somehow to try and gain a few percent extra performance.

With Rotary Racer 7 we decided to try and employ electronics in the cars design in order to provide information to the driver, to log data for later analysis and to use a computer controlled motor speed controller instead of gearing to manage the motors power. We started out with a simple prototype system based on a PICAXE AXE020 microcomputer board, as used for teaching at the school and a home designed and built motor speed controller. After experimenting with this for a while, we decided to go the whole hog and produce our own computer board and motor speed controller board. This was mainly due to reliability issues and the fact that the speed controller's MOSFET's had blown up in spectacular style during testing with bangs and flames !

Illustration 1: Car Computer

We designed a simple PIC micro based Car Computer board that could be easily built by the pupils and would perform all of the data gathering and logging functions we desired. The PCB was tracked by a parent with some pupil input using the kicad free PCB package. In order to improve reliability, (and make it easier for ourselves to build !), we had 6 PCB's manufactured professionally on double sided boards.

We also designed and built a motor speed controller output stage using, high current, 80 Amp, MOSFETS. This is driven and managed directly by the Car Computer. The simple double sided PCB was made in the DT labs by the pupils and parents. Due to the large currents involved the PCB tracks had to be beefed up with the copper wire from 30 Amp ring mains cable. A simple driver display panel consisting of a 2 x 20 character LCD display with 3 LED's and 4 push buttons for control functions is connected through a cable to the Car Computer.

The boards were designed so that there would be minimal extra wiring in the car to help with reliability. We have programmed the computer using the 'C' programming language using the free SDCC compiler under the Linux operating system. The system performs the following functions:

- Battery backed up real-time clock for date and time. This keeps the date and time for the data logging so that all information has a date and time attached.
- Measure, calculate and display the cars current and average speed. A small magnetic cycle computer wheel sensor is used as a sensor for this.
- Calculate and display the distance traveled.
- Measure and display the battery voltage. This system alarms and automatically reduces power when

battery voltage goes below a certain level to protect the batteries.

- Measure and display motor current. A hall effect sensor on the speed controller board is used for this.
- Measure and display the motors temperature.
- Calculate and display the battery charge in % for each battery set. An extra pin on the battery plug is used to detect which battery pack is installed.
- Log all of the data to non-volatile SDCARD memory for later recall (over a years worth of data at 1 sample per second).

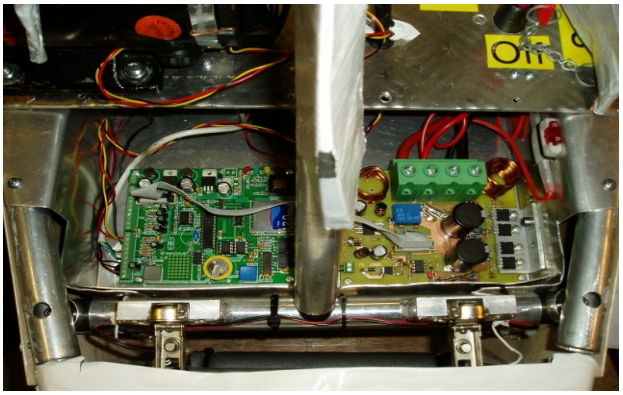

Illustration 2: Electronics in Rotary Racer

- Switched mode regulated power supply: Runs off car's 24Volt power supply. The boards have filters to reduce glitches on the power affecting its operation.
- Low power, approx 20mA at 24Volts (0.48 Watts, 0.08% of cars power) for computer, speed controller and display.
- High efficiency speed controller between 97.0% and 98.88%. Note that the solenoid we used previously used 0.4 Amp and so was only 98.4% efficient !
- Serial RS232 communication to Laptop computer for data download or program upload.
- Soft start and limits peak current to 60Amp to protect the motor and the batteries.
- Control motor speed through the attached speed controller board. An algorithm manages the motors power based on the throttle position, the charge present in the batteries and the race duration. This is a “fly by computer” car !
- Controls the speed of a cooling fan for the motor to save power on this device.
- Watchdog timer to reset the computer in the case of failure.

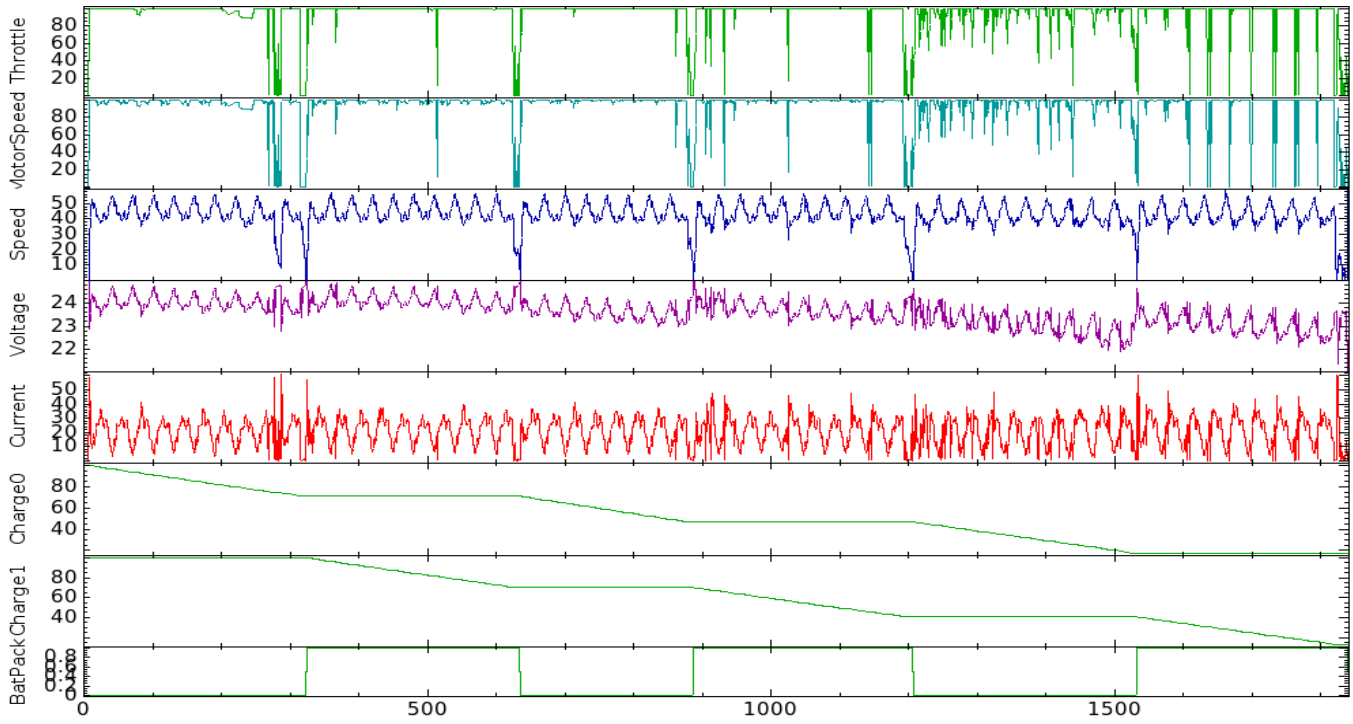

Illustration 3: Some data from Castle Combe race

So far the system has worked reliably well. It has helped us improve the performance of the car and the computer controlled motor speed helped our batteries last for us to win the Castle Combe race. The pupils have been exposed to electronics and a bit of scientific measurements along the way. Future reliability may be an issue, we shall see. We hope to add telemetry and possibly a GPS module next year.
More information is at: http://www.greenpower.beamweb.co.uk/

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