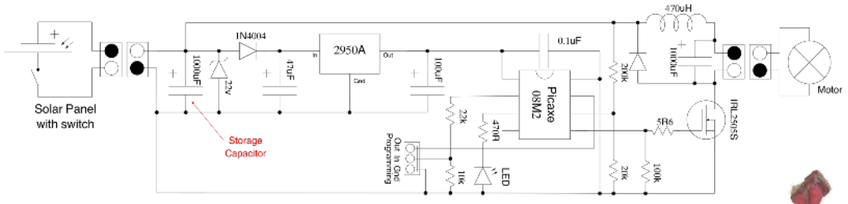
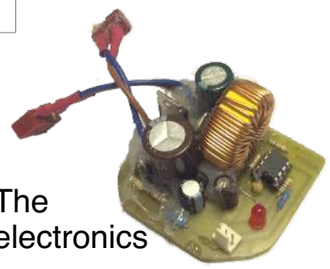
Humpty-04



The electronics circuit diagram

Design and Construction



The electronics

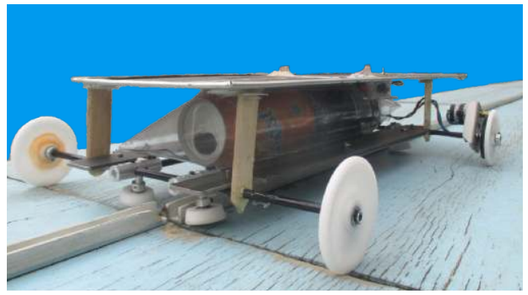
The car Humpty-04 is based on a thin plastic cylinder with a nosecone at each end and a strong, light and stable chassis. The car is designed to have a low frontal area and for quick and easy repairs if needed. Humpty-04 was designed using a CAD program along with a pencil and paper. To hold the chassis together, blocks of aluminium were machined on a lathe to clamp the chassis rods and axles together. The rods and axles are carbon fibre and aluminium arrow shafts glued together using epoxy resin. Prior to building the full sized car, a model of the chassis. was made using the construction toy "Meccano" to check the concept would work. The body was made from 0.5mm PVC sheet, cut to a template, folded and stuck with double sided tape The ballast, 3mm by 35mm steel bar shaped to fit the chassis, has been mounted as low as possible to ensure a low centre of gravity and good stability. It has been mounted using clamps and 4mm screws. To access the cargo of drink cans and the electronics, the rear nosecone is removable. Four balsa wood struts hold up the solar panel.

Electronics

The electronics used in Humpty-04 are a modified version of the Box Hill High School version 6 maximum power point tracker (BHHS v6). The electronics in Humpty-04 try to keep the solar panel voltage constant to maximise the amount of power available from the panel as the motor load varies from a near short circuit to a voltage determined by its speed. The electronics do this using pulse width modulation to control the average current to the motor. Everything is controlled by a Picaxe 08M2 micro-controller running my version of firmware. When first turned on, the electronics take a reading of the solar panel open circuit voltage and multiply it by 78%. This is the point that the electronics track to and is chosen to allow for panel warming during the race. Compared to the BHHS v6 electronics I tried removing the MOSFET that connected and disconnected the storage capacitor across the solar panel. The storage capacitor's role is to store energy to allow the peak current demands of the motor to be met, while holding panel voltage constant. Unfortunately a side effect of the capacitor being in circuit is that time, in the order of seconds, is required for the capacitor voltage to rise to the open circuit voltage of the panel when the MOSFET is turned off. Not including the second MOSFET was a mistake as Humpty-04's electronics can only check the panel's open circuit voltage when it is first turned on.

Testing

The model of the chassis

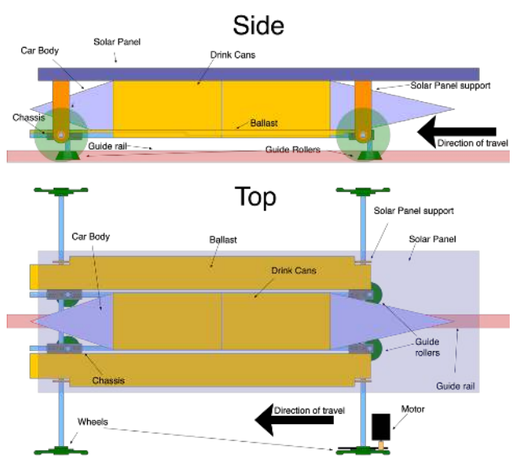


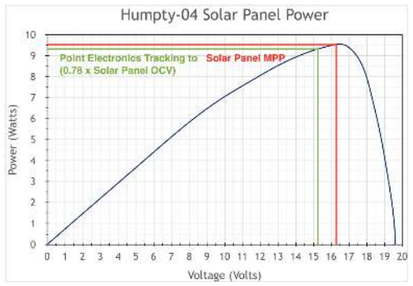
Humpty-04

Testing included
- Checking that the car went around the track reliably.
  - One of the wheels managed to fall off! This was fixed by using pins made from piano wire instead of copper wire to hold the wheels on. Surprisingly the car managed to keep going for a while before stopping. This proves that the canted guide rollers can help the car go over bumps somewhat.
- Checking that the electronics functioned as expected (they did not initially).
  - This was fixed by correcting bugs in the program and replacing the mosfet which was damaged and increasing the time allowed for the storage capacitor to charge.
- Trialling the best gear ratios - a small 9 tooth pinion with a 100 tooth gear worked best for low light.
- Measuring the solar panel performance to see how much ballast was required.
- Adding a tyre on the drive wheel to reduce wheel slip.
- Making the car lighter to reduce acceleration time. This included making new wheels with holes drilled in them to make them lighter.

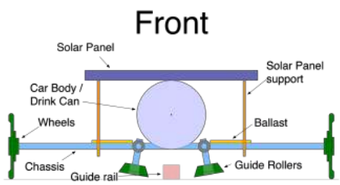
Greenhouse Relevence

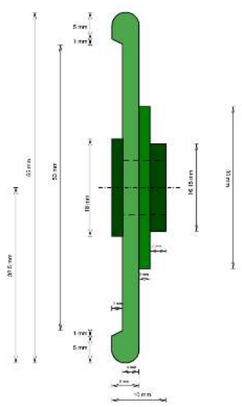
Solar Panels are a renewable source of energy and they do not produce any greenhouse gasses once they have been manufactured. However, even though they are a good source of energy, solar panels are only useful when the sun is shining on them. This means that there needs to be some way of storing some of the energy that they produce, for example a battery or as in model solar cars, kinetic energy.





Solar panel power graph





Plan for the wheels

References and Acknowledgments

- The Model Solar Car Design Guide
- Thank you to my parents for getting me to wherever I needed to be on time
- Thankyou to Mr Gardner for his helpful advice on making the electronics work
- Thankyou to Box Hill High School, for letting me test Humpty-04 on the track.

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