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Introduction

Aims and Objectives

The challenge was to harvest energy from three different energy sources and deliver to an electrochemical device (i.e. the flag) to measure the amount of energy transmitted. The robot needed to capture energy from at least two of three sources (either wind, light, or electric) and transfer the energy to a flag mechanism. All sources and the flag mechanism were at various corners of the playing field. The light source was a 50 Watt Halogen MR16 GU10 Base Flood Light Bulb powered by a 115 V, 60 Hz outlet. The electric source was a 5 V Thevenin source with 24 Ohm Thevenin resistance. The wind source was a Style by Revlon 1875 Watt Dryer set to high and cold shot. Once the robot harvested the energy from the sources, it would power a gear motor (Part No. 1094, Pololu Robotics) to raise and lower the flag.

Robot Hardware

Robot Software

We used Keil uVision IDE to develop the software for the micro controller.

Modules

Printed Circuit Board

The Stellaris Arm LM 35811 served as the main processing unit for the system. Communication components include a USB to JTAG, a Serial Peripheral Interface Bus, and an Inter-Integrated Circuit bus. There are also ports for Analog Input and Digital I/O. A 8.4 V battery supplies voltage to the circuit board.

IR Sensor/Wall following

In this robot there are 6 Infrared Sensors (Sharp 2D120X) around the peripheral of the robot base. They produce an analog output between 3.1 V at 4 cm and 0.3 V at 30 cm. The sensors are used in conjunction with wall-following code to help determine the direction the robot should be moving.

Charging and Discharging

There are three 1 F capacitors to store energy from the various sources. When charging, the capacitors will be placed in parallel and when discharging, will be placed in series. Each capacitor will be charged to 2 V for a total of 6 V when in series. There are also four relays (Aromat/Panasonic HC4-HL-DC24V) that operate at 12 V. Mosfets are used to switch the relays with 4 V. When the mosfets are not conducting, there is an open circuit and the relays are off. When the mosfets are conducting, the circuit is complete, and the relays turn on. The first relay is a multiplexer to select between the three input sources (charging) and the output (discharging). The second relay guarantees that only source is going into the capacitors. The third relay serves as a disconnector and backup to the charging device. A digital zero corresponds to normal mode and a digital one corresponds to disconnecting the output to the capacitor. The fourth relay changes the three capacitors from series to parallel. Off corresponds to a parallel configuration and On corresponds to a series configuration.There will be two relays for each subsequent capacitor (capacitor no. 2 and capacitor no. 3). The relays can be either on or off (different connections). See Figure 1.

Motors and Movement

We used two motors, one on the left end and the other on the right end of the robot. The two motors use a servomechanism with two quadrature encoders (incremental rotary encoders) to provide feedback about the direction of the rotating shaft. The motors have built in optical encoders separated by optical ticks that count the number of ticks between when light is sensed and when it is not sensed.The potentiometer in the servo determines what angle the robot is moving, what angle it will be moving at, and also corrects the power to the motor. A pulse (50 Hz) to the servo controls the angle of the servo (0 -90, 90 -180) and motor-speed through a h-bridge circuit. The duty cycle (percentage on/ percentage off) is around 0.5 ms - 2.5 ms. A caster is attached to the middle of the robot to support the robot frame and to help maneuver.

Solar Panels

To maximize the current, we placed six panels in parallel in two rows. We expect the voltage across each panel to be approximately 4 V and the resultant maximum voltage to be 8 V. In addition, there are two servos (Hitec HS-300) to rotate it into the optimal position to obtain solar energy. When the solar panels are not being used, they will be positioned in parallel with the robot base so that the other modules may be used. See Figure 2.

Fans

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Electrical Source

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Body/Chassis

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Program

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References

[1]. Sharp 2D120X http://www.phidgets.com/documentation/Phidgets/3520Datasheet.pdf (accessed April 20, 2012)
[2]. Panasonic HC4 HL DC24V http://datasheet.octopart.com/HC4-HL-DC24V-Panasonic-datasheet-109869.pdf(accessed April 20, 2012)

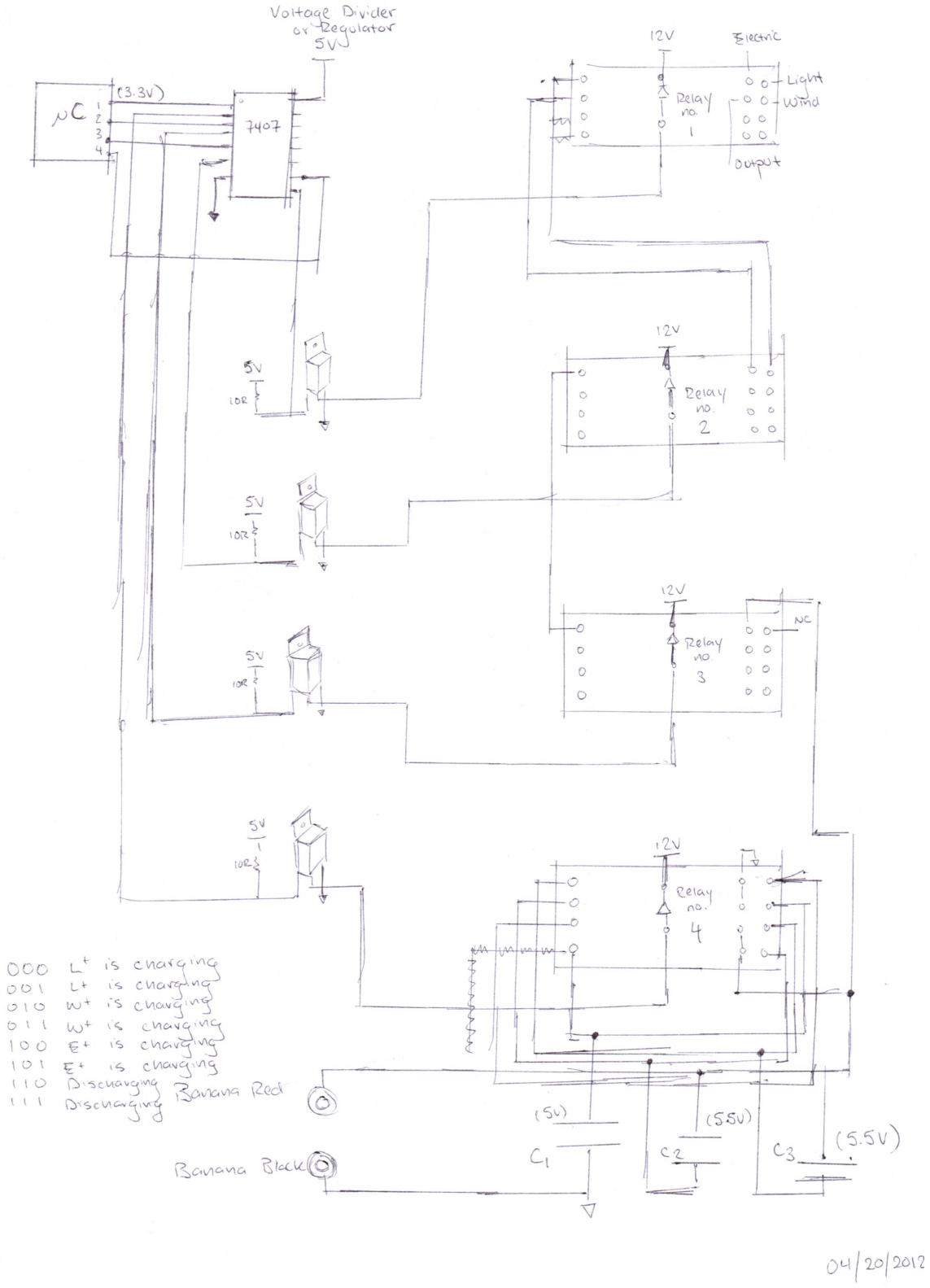

Figure 1: Charging and Discharging Module

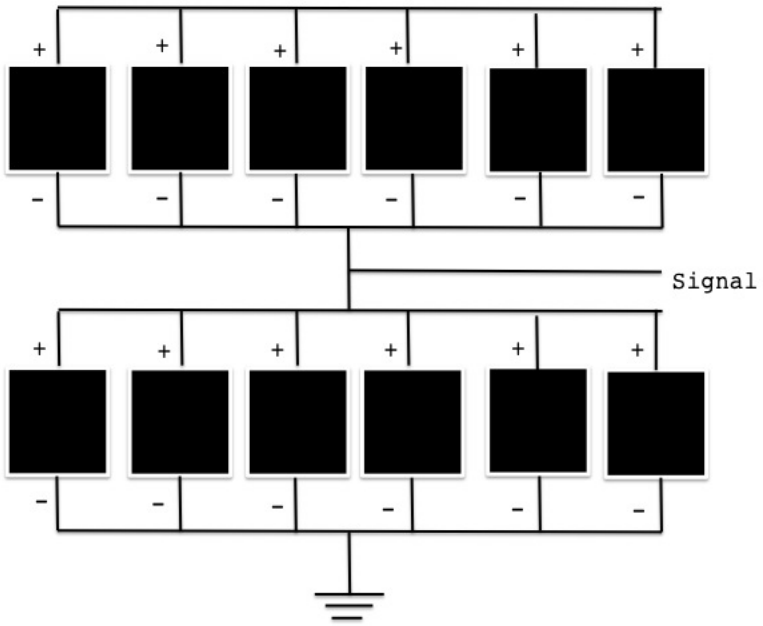

Figure 2: Solar Panels