Signoff Request - September 16th - Motor Driv Microcontroller

Friday, September 16, 2(9:23 PM

"What it's gonna do"

The Mechanical Movement System requires Motor Drivers that will be used tc motors and act as an interface between them and the control circuitry. This is because motors operate at a high current and voltage, and the control circuit current signals. [1] Speaking of control circuitry, this signoff will also be for the that will be responsible for creating a closed feedback loop. This microcontrol movement instructions delivered by the Raspberry Pi from the Nav System, ar the speed of the robot by making use of the Hall Effect Encoders that come or

"Specs and Constraints"

Specifications:

Microcontroller

- Communicate with the Raspberry P
- PWM Capability to control motor spee
- Enough GPIO pins (to be calculated belo

Motor Driver

- Accept PWM input to control motor spee
- Bidirectional movement

Constraints

Microcontroller

- Vin must accept 12V. This constraint comes from the bus in the Powe
- At least 2 PWM pins and channels must exist to send signals to th
- SPI, I2C, or Serial Capabilities must exist to communicate with
- Read digital input of a maximum of 48 counts per revolution from the mc

Motor Driver

- The 5A stall current from the motors means that the driver must be able maximum of 5A
- Operate at 12V. This constraint also comes from the mc

"Analysis"

The first component to discuss is the selected motor driver from Cytron Tech MD20A [2].

"The MD20A enables bidirectional control of one high-power brushed DC mo 30V. With discrete NMOS H-Bridge design, this motor driver is able to suppor continuously without any heatsink" [2].

"This motor driver can be controlled with PWM and DIR inputs. With input lo from 1.8V to 12V, it's compatible with wide variety of host controller (e.g. Arc

Pi, PLC)" [2].

Since the MD20A can only support one motor, two motor drivers will be nece
this helps to increase the modularity of the design by having a separate drive
The driver can be seen in Figure 1.

Figure 1: MD20A Motor Driver [2]

The MD20A satisfies all the above specifications and constraints in the follow

- The driver accepts up to 20A and 30V, which fulfils the input constraints
- The driver accepts PWM input and a DIR input. This satisfies the speed co
  bidirectional movement specifications.

Figure 2 shows the connection interface as well as an input truth table. This h
everything will be built up, and it gives a good idea of how many pins the mic
need.

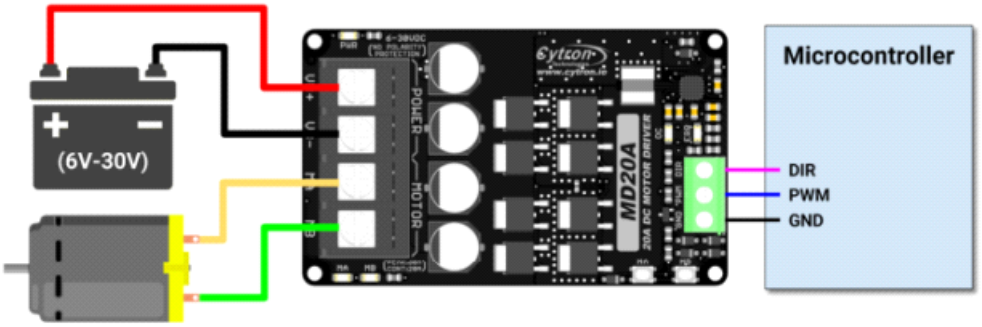

Figure 2: Motor Driver Connections and Input Truth Tab

General Analysis of Arduino Nano Ever

Now for the brains of the operation. The selected microcontroller is the Arduir
[4]. Figure 3 displays the Microcontroller, and Figure 4 shows some of the Tech
given information, the part can be analyzed to see if it meets some of easily id
and constraints that were laid out previously. Figure 4 clearly shows that the N
pins, which satisfies the requirement of the 2 that are necessary for controllin
motors. It is also stated that the board accepts a VIN of anywhere from 6-21 V
acceptable because the board can be connected to the 12V line. The Arduino c
communicate with the Pi by means of USB, SPI, I2C, or UARP. This allows for a
methods for communication, and this will be discussed more later on. Finally, t

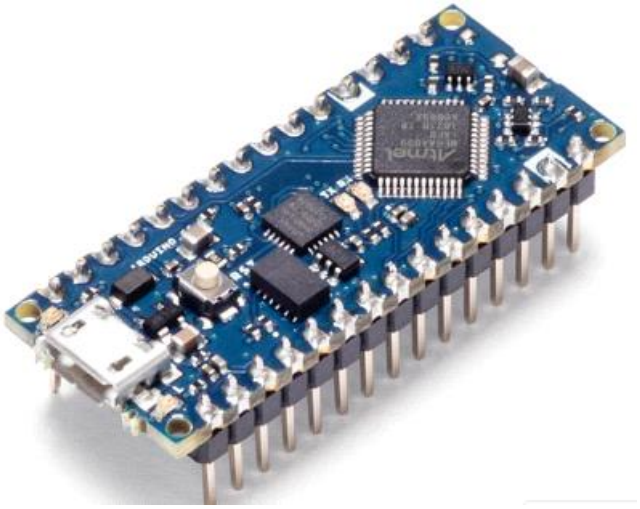

Figure 3: Arduino Nano Every Image [4

Figure 4: Arduino Nano Specs [4]

GPIO Pins:

2 of the digital pins will be used for the PWM signals to the motor drivers resp
2 pins will be used as the DIR signals to the drivers respectively. This takes care

used on the motor drivers. Figure 2 shows those GND wires going from the dri
microcontroller, but connecting to the robots main ground line will do. Additic
need to be connected to the Hall Effect Encoders on the motors. This will allov
microcontroller to monitor the speed at which the robot is moving. Figure 5 sh
connections. The Yellow and White wires from each motor need to be connect
microcontroller. This results in another 4 pins being used. It is also important t
the Arduino will communicate with the Raspberry Pi. Using UART, an additiona
and RX capability will be required. The Arduino Nano Every has 14 digital pins a
ready to go. That number is enough to satisfy the 10 pin requirement with 2 of
PWM and another 2 for TX and RX. Figure 6 shows the pinout of the Arduino N
In Figure 6, the PWM compatible digital pins are denoted with a "~" in the pinc

25D mm metal gearmotor with 48 CPR encoder (with end cap removed).

Color	Function
Red	motor power (connects to one motor terminal)
Black	motor power (connects to the other motor terminal)
Green	encoder GND
Blue	encoder Vcc (3.5 V to 20 V)
Yellow	encoder A output
White	encoder B output

Figure 5: Motor Connections Explanation [.

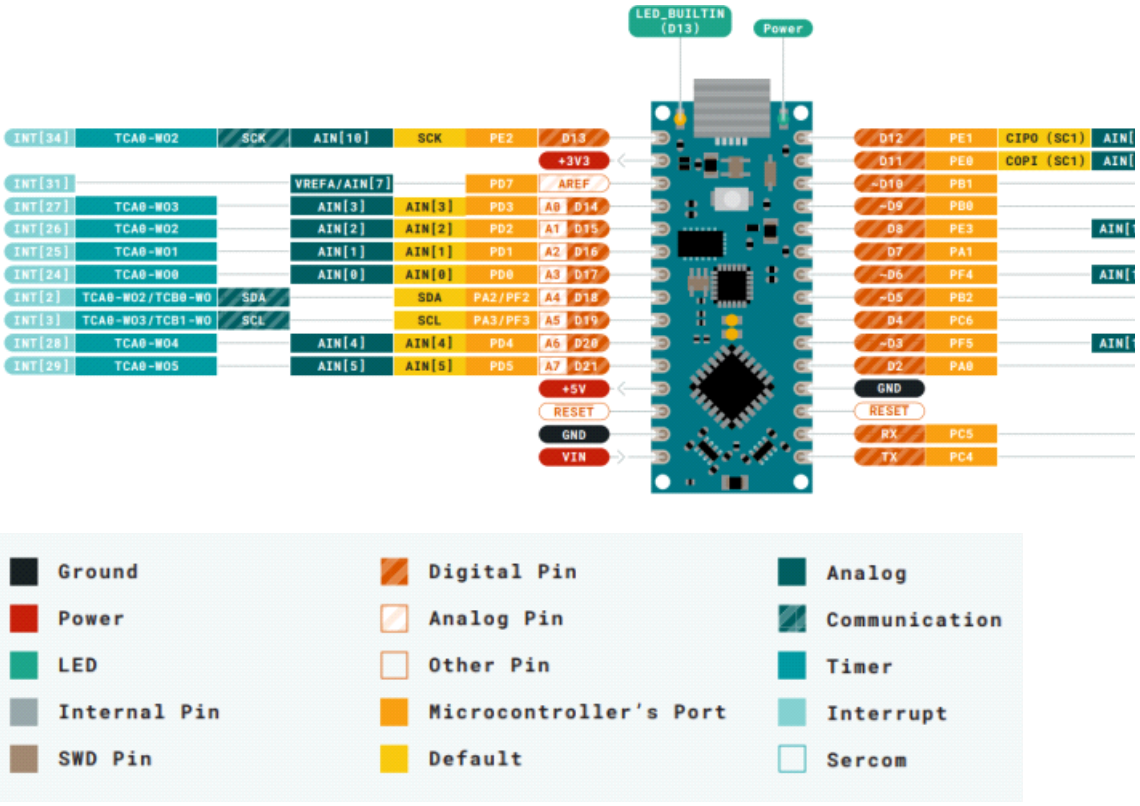

Figure 6: Arduino Nano Every Pinout [4

Communication Protocol:

Next up is the analysis for how the Arduino will communicate with the Raspbe
selected protocol of UART allows for full duplex communication so that the Ar
Raspberry Pi can communicate with one another at the same time. UART has r
such as only using two wires (TX and RX) and it does not require a clock. The T
1) will connect to the Pi's GPIO pin 10 which is RX 1. The Arduino's RX pin (digi
connected to the Pi's GPIO pin 8 which is TX1. This allows the two devices to ta
simultaneously. Figure 7 depicts the connections, and Figure 8 shows the othe
connected to the pi. This proves that there are enough pins and other connect
around. BIG NOTE!!! Figure 8 shows the INCORRECT CONNECTIONS for the Arc

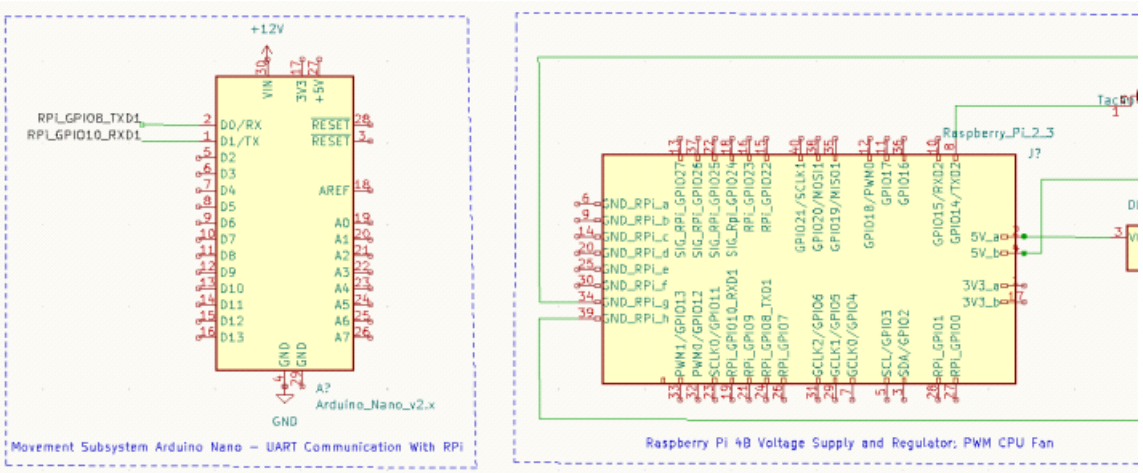

Figure 7: Serial Communication Connectio

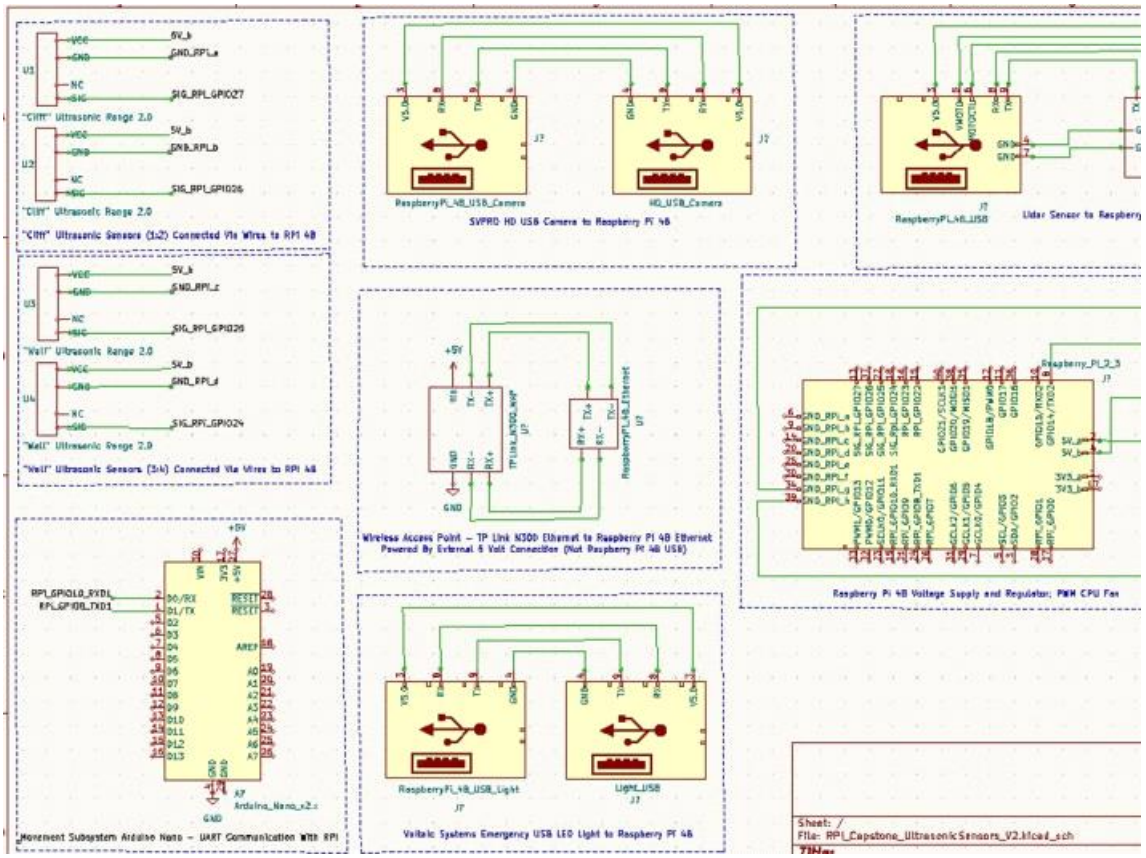

Figure 8: Total Raspberry Pi Connectior

Hall Effect Encoder Signal Reception

The selected motors come with integrated Hall Effect Encoders; the connectio shown in Figure 9. "A two-channel Hall effect encoder is used to sense the rota magnetic disk on a rear protrusion of the motor shaft. The quadrature encode resolution of 48 counts per revolution of the motor shaft when counting both channels. The Hall sensor requires an input voltage, Vcc, between 3.5 and 20 V maximum of 10 mA. The A and B outputs are square waves from 0 V to Vcc ap out of phase. The frequency of the transitions tells you the speed of the motor of the transitions tells you the direction" [5]. Those output square waves are d will be inputted to and interpreted by the Arduino Nano Every in order to mon

command takes about 48 clock cycles [6]. The total amount of clock cycles nee
176 counts in one second is 48*176 = 8448 cycles per second. The Arduino's cl

25D mm metal gearmotor with 48 CPR encoder (with end cap removed).

Color	Function
Red	motor power (connects to one motor terminal)

Figure 9: Hall Effect Encoder Connections Explanatior

Lastly, to ensure complete third party buildability, a full electrical schematic h
to provide instruction on how all the pieces of the Mechanical Movement Syst
with each other. Figure 10 shows those connections.

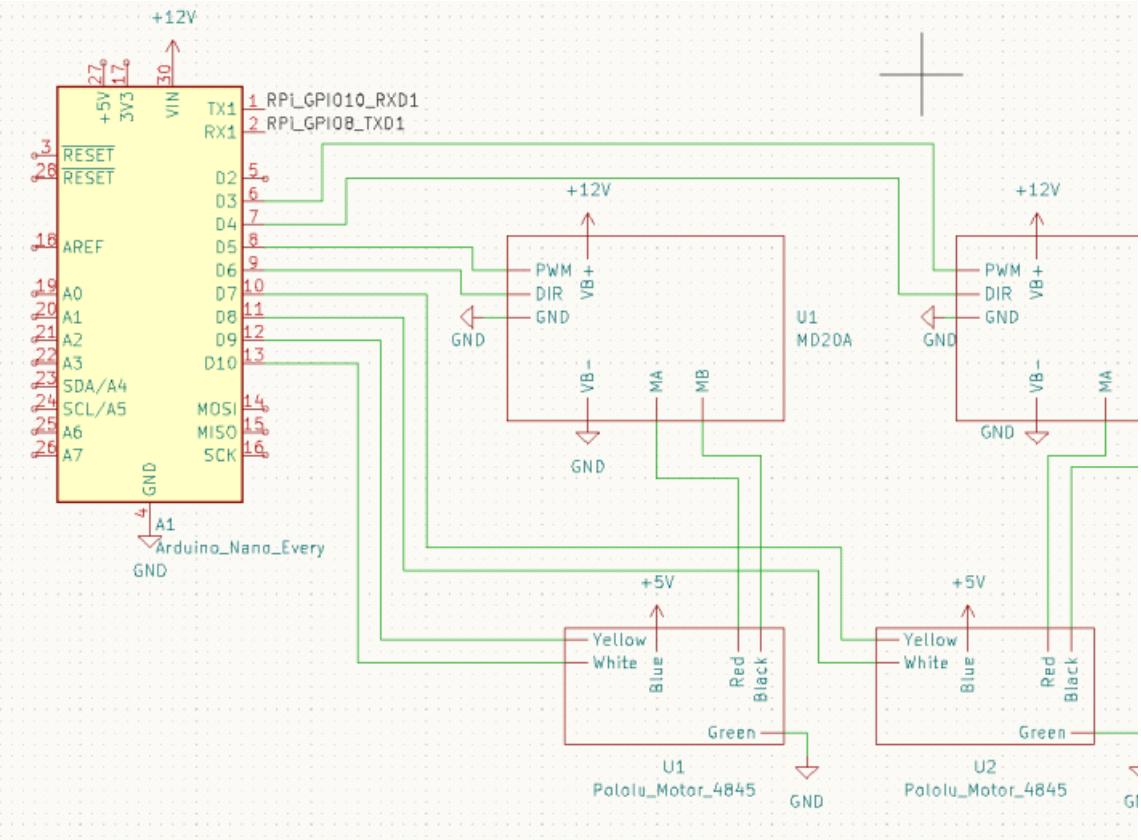

Figure 10: Electrical build for Mechanical Movement Sy

MD20A Motor Driver: $21.00 each (2 neede
Arduino Nano Every: $15.00

Sources

[1] Motor Drivers are Important
[2] MD20A from Cytron
[3] MD20A Datasheet
[4] Arduino Nano Every
[5] Pololu Motor 4845
[6] DigitalRead Time