ROBOT HANDS - ARDUINO BOT - LEGOBOT

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CIRQUE DU ROBOT

The SmartSensor Lite from CATCAN Creative gets put through its paces

Arduino-like results from the Arduino-compatible PIC-based *Pinguino*

Combat Zone

- Identifying unknown brushed DC motors
- Affordable 2.4 GHz
- Using Li-poly or Li-ion batteries safely
- Brushed DC Motor Tutorial

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COMBAT ZONE

Featured This Month:

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PARTS IS PARTS

Identifying Unknown Brushed DC Motors

● by Kevin M. Berry

This month's column is blatantly stolen (Editor's note: "researched," not stolen!) from Professor Marco Antonio Meggiolaro's popular book, the *RioBotz Combot Tutorial*. Marco's book is available free for download at **www.riobotz.com.br/en/tutorial.html**.

If you bought your motor from a junkyard or found it forgotten somewhere in your laboratory and you don't have any clue about its characteristics, you can follow these steps:

- Seek any identification on the motor, and look for its datasheet over the Internet.
- Make sure it is a DC motor. If there are only two wires connecting it, there is a good chance it is DC. Otherwise, it could be an AC, brushless, or step motor.
- Measure the electrical resistance between the terminals, obtaining Rmotor.
- Apply increasingly higher voltages, such as 6V, 9V, 12V, 18V, and 24V. Wait for a few minutes at each level while checking if the motor warms up significantly. If it gets very hot even without loads, you're probably over the nominal voltage, so reduce its value.
- Most high quality motors can work without problems during a three minute match with twice their nominal voltage; this is a technique used in combat (such as the 48V Etek powered at 96V). The 24V Magmotors are exceptions. They are already optimized for this voltage, tolerating at most 36V. Even so, the current should be limited in this case.
- Once you've chosen the

FIGURE 1

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working voltage V_{input}, connect the motor (without loads on its shaft) to the appropriate battery — the same that will be used in combat — and measure I_{no_load}. Note that the value of I_{no_load} does not depend much on V_{input}. However, it is always a good idea to measure it at the working voltage. If you have an optical tachometer (which uses strobe lights, such as the one in **Figure 1**), you can also measure the maximum no-load motor speed ω_{no_load}. A cheaper option is to attach a small spool to the motor shaft, and to count how long it takes for it to roll up. For instance, take 0 meters or 30 feet of nylon thread. The angular speed in rad/s will be the length of the thread divided by the radius of the spool; all this is divided by the measured time (the thread needs to be thin, so that when it's rolled up around the spool the effective radius doesn't vary significantly).

- Attach the motor shaft to a vise grip, hold both the motor and the vise grip well, and connect the battery. Be careful because the torque can be large. The measured current will be I_{stall}, associated with the circuit resistance $R_{system} = R_{battery} + R_{motor}$, so $I_{stall} = V_{input} / R_{system}$; then, calculate $R_{battery} = (V_{input}/I_{stall}) - R_{motor}$. Do not leave the motor stalled for a long time; it will overheat and possibly get damaged. Also, take care not to dent the motor body while holding it (for instance, with a C-clamp) as shown in **Figure 2**.

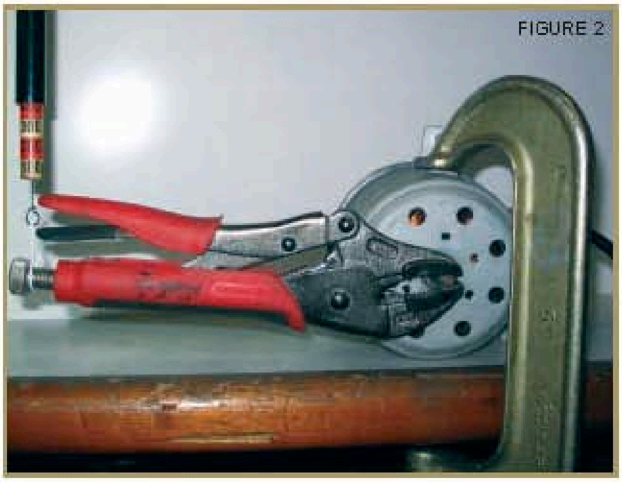
FIGURE 2

- Repeat the procedure above, but supporting one end of the vise grip by a scale or spring dynamometer (with the vise grip in the horizontal position; see **Figure 2**). Then, measure the difference between the weights with the motor stalled and with it turned off, and multiply this value by the lever arm of the vise grip to obtain the maximum torque of the motor, τ_{stall}. For instance, if the scale reads 0.1 kg with the motor turned off (because of the vise grip weight) and 0.8 kg when it is stalled, and the lever arm (distance between the axis of the motor shaft and the point in the vise grip attached to the scale) is 150 mm, then $\tau_{stall} = (0.8kg - 0.1kg) \times 9.81m/s^2 \times 0.150m = 1.03 N \times m$.
- Because $\tau_{stall} = K_t \times (I_{stall} - I_{no\_load})$, you can obtain the motor torque constant by calculating $K_t = \tau_{stall} / (I_{stall} - I_{no\_load})$.
- Alternatively, if you were able to measure ω_{no_load} with a tachometer or spool, then you can calculate the motor speed constant using $K_v = \omega_{no\_load} / (V_{input} - R_{system} \times I_{no\_load})$. Check if the product $K_t \times K_v$ is indeed equal to 1, representing K_t in N×m/A and K_v in (rad/s)/V. This is a redundancy check that reduces the measurement errors. If you weren't able to measure ω_{no_load}, there is no problem. Simply calculate $K_v = 1 / K_t$, taking care with the physical units.
- Finally, once you have the values of V_{input}, K_t (and/or K_v), R_{system}, and I_{no_load}, you can obtain all other parameters associated with your motor + battery system using the previously presented equations (don't forget to later add the resistance of the electronics, as well). **SV**

Affordable 2.4 GHz

● by Pete Smith

The principal radio frequency for many years in USA combat robotics was 75 MHz PCM. This worked well enough, but the transmitters (TX) and receivers (RX) for PCM were both expensive, and the receivers were both bulky and not particularly reliable under combat conditions. The main problem, however, was the limited number of channels available and controlling the use of those channels in a major event.

The arrival of the Spektrum DX6 changed all that. It uses 2.4 GHz and each radio "binds" to and can control only one RX at a time without any possibility that it can interfere with (or be interfered by) another transmitter. This removed — in a stroke — many of the radio concerns at events. Organizers no longer had to worry about competitors interfering with each other or with other RC sets being used nearby, affecting safe control of the robots.

Competitors also no longer had to be concerned about being on the same channel as their opponent and perhaps being forced to make last