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Roller-Bot® III

A flashlight activated miniature robot built on a paint roller.

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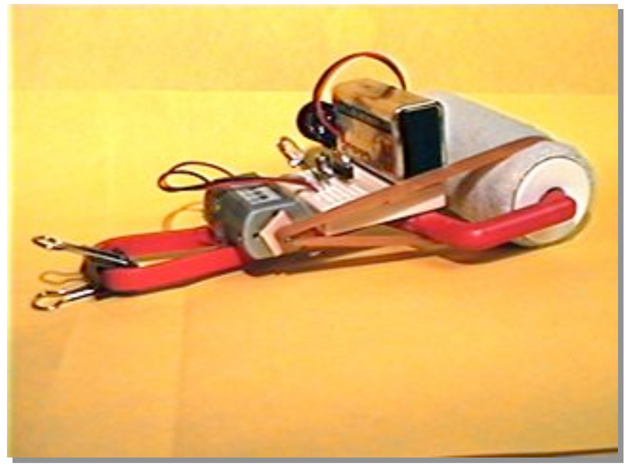

The Roller-Bot is a project that evolved from my fascination with the concept of "minimal engineering". It is a "dumb" micro - robot fabricated on an unlikely platform, a small paint roller. The first experimental Roller-Bot was assembled as a proof of concept for introduction into my EE151 Introductory Electronic Projects class January 2000. but was deployed initially as a promotional give-away item for student and departmental events at Washington University in 1999. *(EE151 was cancelled by EE department administrators after the Fall 1999 offering)*

The original Roller-Bot I was frist deployed by the Washington University student chapters of Engineers-Council and IEEE as a promotion for Engineers Week 1999. The promotion offered a "give-away" project to a limited number of first showing students at the student Union. (Washington University RECORD photo, March 25, 1999)

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Guided by the light Aspiring robo-creators John Fahrner from Urbana, Ill., and Melissa Egner from Burlington, Wis., both freshmen, build dumb robots called "Roller-Bots" with three-inch paint rollers, transistors, binder clips, rubber bands and a handful of other parts at an Engineers Week event March 16 in the Gargoyle. The build-and-take project was one of several slated for the 1999 EN-Week. Paul L. Discher, technical services supervisor in the Department of Electrical Engineering, developed the Roller-Bot, which is activated by a flashlight and moves in a 10-foot radius.

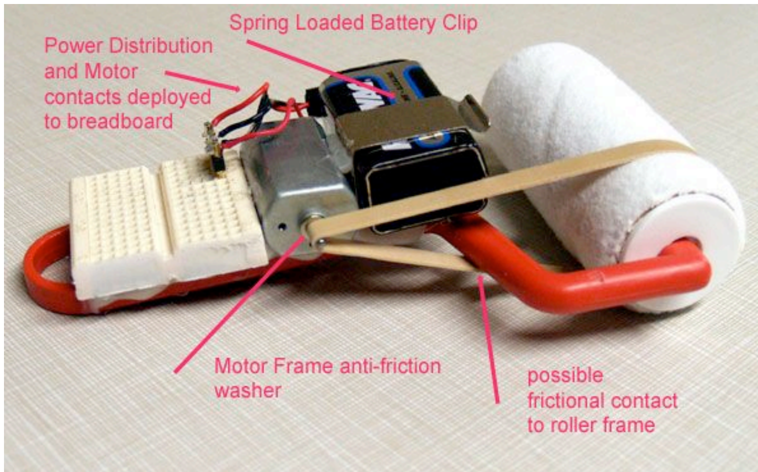
Roller-Bot II was later featured as a promotional item for student's attendees of the Electrical Engineering Department Open House, August 20, 1999.

"Make-and-Take" projects are inspired by my affiliation with the St. Louis Area Physics Teachers (http://www.slapt.org/) and the legacy of similar "make-and-take projects" contributed by member teachers.

The Roller-Bot project was designed to employ very few parts and few tools for final assembly. This objective did however require pre-fabrication of the roller chassis, and soldering wires to the motor. About 55 Roller-Bots were built and given away in 1999. In the photo below, WU engineering student, Dougal Cullen, and member of IEEE is show fabrication 25 of the Roller-Bot roller frames in 1999.

The Roller-Bot is an unusually simple project that can be used to introduce students to engineering and robots. The project offers an imperfect solution and plenty of latitude for expansion and experimentation providing a metaphor for student exploration, motivation, and enrichment. Students can explore simple alternative control systems, such as IR or RF, or alternative propulsion systems or using arrays of paint rollers. The result is a project of unique prospective that can get students motivated and makes them think.

The Roller-Bot Mechanical Overview:



The Roller-Bot mechanical Overview:
The Roller-Bot employs a number 64 postal rubber band for the transmission of rotational power from the motor to the main drive roller. An unusual feature of the roller nap material is the ability to “lock” the rubber band into a “virtual track” on the roller and thereby keeping the drive band in place. The “wide track” of the roller nap tracks well on carpeting and the exposed rubber band in the driveline grips well on smooth surfaces.

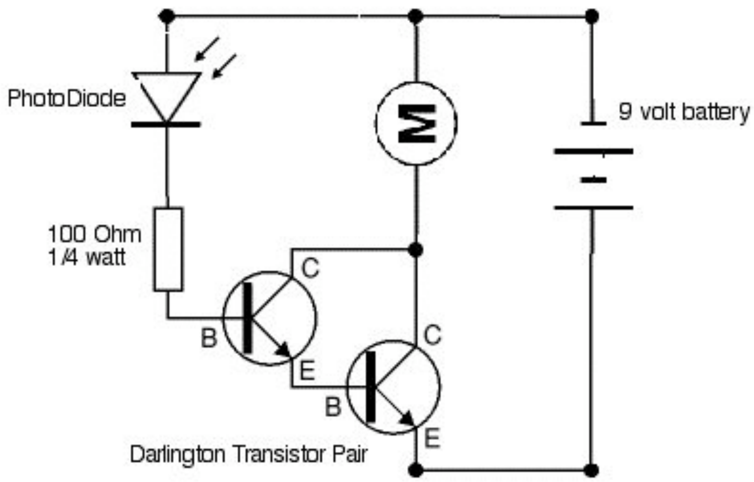
The selected DC motor has a bare shaft diameter of 2mm while paint roller measures 32mm in diameter. This offers a 16:1 drive ratio for minimum motor loading and excellent torque all achieved without the need for gears or pulleys. A multi-function “tail hook assembly” consists of a small binder clip, which originally intended to reduce the drag of the tail assembly. Adjusting the angle of presentation on this clip will also introduce directional control of the roller-bot acting like a boat rudder. The tail hook also offers a method of vertical display of the roller-bot on a corkboard. The motor / rubber band driveline was relocated on the Roller-Bot II variation in order to reduce roller deformation caused by static rubber band tension. Roller-Bot III designs also sought to redeploy the location of the battery and the application of a 9-volt battery spring clip. As alternative battery holder, a strong magnet can also be glued to the roller frame to secure the 9v battery. The solderless breadboard section was also relocated to the aft section of the handle for better prototyping access.

The Roller-Bot Electrical Overview:
In the original “proof of concept” Roller-Bot a small solderless breadboard was employed for wiring, such that I could experiment with several motor trigger and control circuits. I was striving for a design that was extraordinarily simple and that could be achieved with low cost easily to find components. I immediately realized the value of a prototyping platform on the Roller-Bot and decided to incorporate that wiring system as a standard feature.

A 9-volt battery source was selected because it offered the best power to weight ratio and did not require a costly battery holder. I tested a variety of light sensing semiconductors and settled on an inexpensive IR photodiode. This diode easily saturates when illuminated by the “spot” of an ordinary flashlight but it also is sensitive to presence of IR content ambient light. The Roller-Bot performs better in subdued light, and this "imperfect design" is a natural springboard for student experimentation and improvements.

The Roller-Bot uses a simple 2N2222 transistor and a photo diode to drive the DC motor. The photodiode limited the saturation current to the transistor, but in Roller-Bot III variant, a series resistor is added in the transistor base circuit for transistor protection. The principal changes in Roller-Bot III were to harden the design for more future student experiments. Roller-Bot III also has an improved application for electrical motor drive by employing two transistors in a Darlington Pair configuration. This parallel transistor arrangement is more agile in handling higher current loads, such as may be experienced when using other types of surplus dc motors.

The Roller-Bot SCHEMATIC DIAGRAM



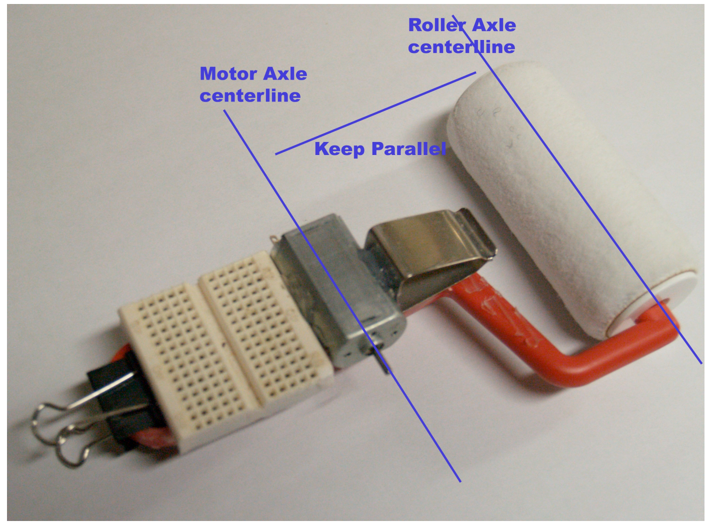
Roller-Bot III Parts List

Shur-Line 3" touch up paint roller
#64 Postal rubber band
solderless breadboard section about 1.5" x 1.25"
spring battery holder or magnet for holding battery
3/4" binder clip for tail hook (optional)
2-each 2N2222 NPN transistors
1-each IR Photodiode
1- 150~200 ohm 1/4 watt resistor
DC motor 6v – 9v opeation
9v- battery
9v- battery electrical snap
fragments of 22 ga wire
Flashlight with a tight beam spot

Roller-Bot Pre-Assembly Guide

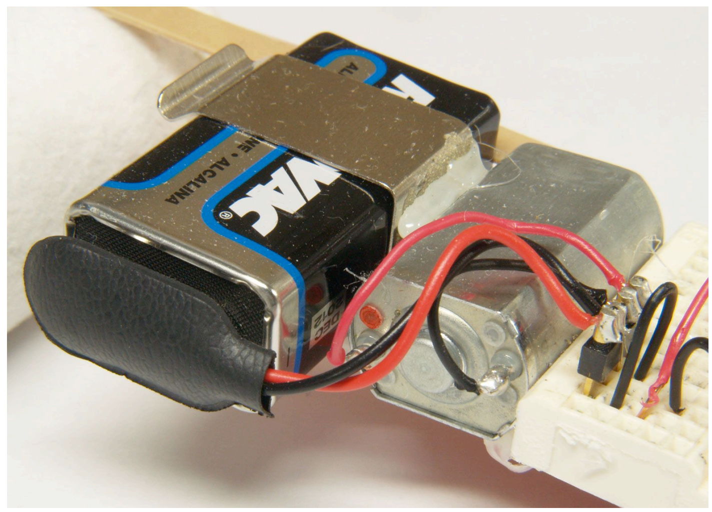
STEP 1:
Gluing Mechanical Parts

Small Solderless breadboards can be purchased or larger units can be sliced for a custom fit. I have always used defective solderless breadboards that were "fall-out" from the electronics class. Reusing discarded materials like this can keep the cost down. Hot melt glue is used to secure all components to the paint roller. The motor is glued and positioned by installing the rubber band and finding a location that gives adequate but not excessive tension. Keep the motor axle centerline parallel with the paint roller. A small anti-friction washer can be placed on the motor axel to prevent rubber band contact.



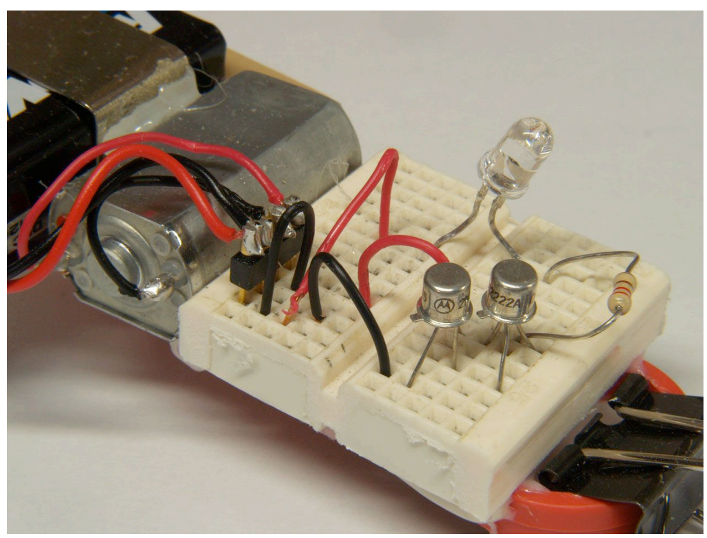
STEP 2:
Soldering leads to motor & header pins

The 9-volt battery connector is wired using stranded wire, and sometimes adds difficulty-making insertion into the breadboards. These wires can be tinned with solder, or optionally attached to square header pins for insertion into the breadboard. Normal polarity color-coding convention has + (plus) 9-volts on Red wire, and - (minus) is on the black wire. The orientation of the motor can create an issue with rotation direction of the motor and can easily be remedied by reversing polarity on the motor.



STEP 3:
Student Deployment

At this point the Roller-Bot frame is ready for student deployment. The actual layout and use of solder-less breadboard interconnecting topologies can view as a skill and an art. The Roller-Bot layout is not critical. Placement of parts and wires is subjective. Mastering "tricks" in using minimal amounts of wire and placing components near one another make for a compact and semi-durable package.



General Considerations:
DISCONNECT THE BATTERY WHEN NOT IN USE TO AVOID DISCHARGE OF THE BATTERY

ALWAYS DISCONNECTED THE BATTERY, while making electrical connections.