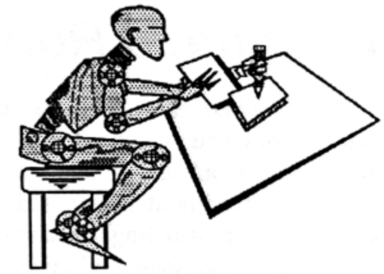
# DPRG

DALLAS PERSONAL ROBOTICS GROUP



December 1993 — A Newsletter for Personal Robot Enthusiasts

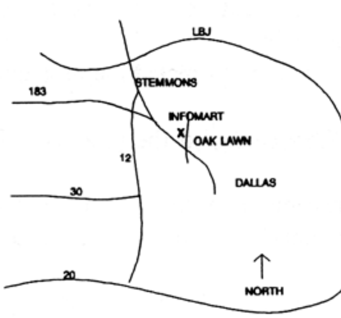
11th

## Contest Draws Crowd but not Robots

After several months of preparation, some robot builders were simply not ready to have their machines run the contest course at the November DPRG meeting. A crowd did show up to watch the event at which 3 units did complete the course. The first one to run was a simple 3-wheeled device made with a 2 by 4, DC gear motor, battery pack and a toggle switch. The switch was connected to a long lever that was used to reverse the robot as it came in contact with the wall. Even though this low-tech approach did not move in a straight line, proper positioning allowed it to complete the course after only three tries. The second entry was constructed using parts from a motorized toy along with some special mechanics created with Erector Set components. Traction was a problem on the carpet but the unit was able to complete a substitute course on a table top. The unit went all the way to the end, stopped and returned to the starting point as the rules require. The third entry was a 6-wheeled robot which used a PC-based control system that was "taught" by its operator then simply repeated what it learned to complete the course. Wheel slippage was a problem with this robot which had no sensors on the wheels but wasn't enough of a problem to prevent it from completing the course.

Because so many robots are on the brink of being completed, the contest will be run again in February or March.

## DPRG Meetings




Each month the DPRG meets at the Infomart in Dallas, Texas along with many other computer clubs and special interest groups. There is no charge to check things out including a vendor area that contains the latest in computer and electronic hardware and software at great prices. Just walk in the front door and you'll see several overhead projectors that list each meeting with the time and room number. The next DPRG meeting is Dec. 11, 1993 at 1:30 in room 1059 - See you there!

## December ~~20th~~ Meeting Agenda

At the December meeting, we'll be trying to get our robots to complete the contest course and talk about the latest additions and changes to our creations. We'll also do the normal distribution of data books from Motorola, Signetics, and CDI and swap sources for parts.

For those of you building a robot, see Roger for information on the DC-DC converters that were donated by CDI. These units are free to DPRG members who will use them. The supply is limited so be reasonable.

## AI/Robotics BBS (214) 258-1832

## President's Note

Welcome to another issue of the DPRG newsletter. This month features an article by Steve Rainwater who is building a robot using R/C (remote control) components. His experience is typical of robot builders. If you're building a robot for the first time you may be encountering some of the same obstacles he speaks of in this article. Steve also runs the INTEROCITOR BBS (214-258-1832) which is a great source of information on robotics and AI. He also publishes the AI CD-ROM advertised in AI Magazine.

Those of you interested in the wireless data link (and there are many of you) may have noticed that last month's article included a phone number which is a fax number to the sales rep. For voice, please use (713) 589-6828.

There are many new faces at the meetings lately and we enjoy the interest. If you are building a robot but haven't yet completed it, I encourage you to bring it to the meeting. You will be able to ask questions that may solve problems you're having and you may be able to answer questions for those who are only thinking about building a robot.

See you at the meeting.

Roger Arrick

# *Building a Robot, Part 2*

***By Steve Rainwater***

***THE PLATFORM*** -- This document, part two of my experiences in building a robot, will describe the trials and tribulations of a software-oriented person attempting to build hardware that somewhat resembles a robot. I must add a disclaimer here: Don't take any of this as advice. I went into this part of the project with virtually no experience and, as a result, have run into numerous problems, arriving at the desired destination in a very round about way. Several other members of the Dallas Personal Robotics Group were constructing the hardware portions of various projects at the same time and, judging from the results, any of them would be a much better source of advice than what you're about to read. Even so, perhaps something of my experience will be of use to someone, if only as an example of how not to do something.

***DESIGN GOALS*** -- As described in the first part of this series, the hardware portion of this project is the part of least personal interest, its sole purpose being to provide the means by which I can develop and test interesting software. The goals I've chosen for the platform are these:

**GOAL 1**: The platform must be small and light enough to be transported by one person without a dolly (or a fork lift!). Ideally, this would mean less than one cubic foot and less than 40 pounds. At a minimum it means small enough to fit through the average doorway and less than 100 pounds.

**GOAL 2**: The platform must be able to move at a reasonable speed and be self sustaining for a reasonable amount of time. Ideally, speeds equal to or exceeding those of a running human and a run time of greater than an hour. At a minimum, the speed of a walking human and a run time of 15 minutes would be acceptable.

***WHEEL OR LEGS?*** -- The first painful decision I had to make was whether to use a wheeled platform or a multi-legged platform. Anything with legs is almost certainly going to be very complicated, heavy, and expensive. Anything with wheels, as anyone with the slightest familiarity with science fiction literature can tell, is poorly equipped to deal with the common obstacles found in human environments (how many times has Dr. Who, for example, escaped death at the hands of the Daleks merely by climbing a flight of stairs). On the other hand, a platform with wheels is cheap and easy to build. Not surprisingly, I chose a wheeled platform. The problem was to find one that I could be assemble without the need for expensive tools or a degree in mechanical engineering. I finally settled on using components designed for a radio-controlled vehicle.

**FROM MONSTER TRUCK TO MINI-ROBOT** -- Among the advantages of using a radio-controlled vehicle chassis are (or so it seemed at the time...) ease and speed of assembly, low cost, an integral drive system with appropriate gears and motors, and availability of replacement parts. As it turned out, I was right about the availability of replacement parts. Only the high-end radio controlled vehicles turned out to meet the requirements presented by my goals. I eventually purchased a Kyosho USA-1 Monster Truck to use as a starting point. The only parts not used were the plastic truck body and a mechanical speed control. The USA-1 chassis included two motors and provided for front and rear wheel drive. Each drive system has a transmission with a working differential gear set. It also provided a four wheel steering system that allowed much tighter turns that would normally be possible for a vehicle of this size. Along the way I learned some R/C terms used to rate motors. "Cells" is a terms used to describe the maximum voltage of a motor. A 10 cell motor is a 12 volt motor. The term comes from the common use of 1.2v ni-cad cells (10 x 1.2v = 12v). The term "turns" refers literally to the number of turns of wire around the armature of the motor. I don't know exactly what electrical characteristics this affects beyond the motor's resistance and the current it draws when operating. Another term, "hotness" is inversely proportional to "turns" and appears to mean more-or-less the same thing. A "hot" motor would be one with a small number of "turns". I was able to discover the term "hotness" came from the higher temperatures caused by a running with fewer turns or perhaps from slang for "faster".

**PROBLEMS ABOUND** -- As I begin to assemble the chassis, I discovered a series of minor deficiencies due to the difference in weight between what the chassis was designed to support, and the weight of the components to be used in robot. The major contributors to the overall weight were three Panasonic sealed, lead-calcium batteries. Two 6v, 10ah batteries for the drive system and a 12v, 6ah battery for the electronics. The chassis and suspension could only support a load of about 8 pounds. Following this discovery about the suspension, I undertook a lengthy series of corrective measures which I will attempt to summarize:

**1**. I replaced the eight stock suspension springs with much stiffer steel springs from a local hardware store. This supported the expected load of 30-40 pounds but created two more problems: The plastic spring retainers were too weak to retain the stronger springs and the turnbuckles that connected the suspension components were now bending under the strain.

**2**. I then had to replaced the plastic spring retainers with steel washers of approximately the same size. This corrected the problem of the springs overextending themselves.

**3**. Then I replaced the small diameter steel turnbuckle rods with larger rods made of titanium. This corrected the problem. The titanium rods came from a company that makes aftermarket parts specifically for R/C vehicles.

**4**. The rubber tires supplied with the chassis were air filled but not airtight, resulting in easy compression under the load (i.e. it had 4 flat tires). I found dense, foam rubber inserts to fill the tires and act as inner-tubes. This fixed the "flats". The inserts were made by an aftermarket R/C parts supplier.

**5**. With both the large payload and fairly good traction provided by the tires, the steering mechanism had a hard time moving the wheels. The stock four-wheel steering system was controlled by a single small servo and plastic linkages. I split the steering into separate front and rear sections, each now controlled by a high-powered Futaba servo. The linkages were replaced with a combination of steel bell cranks and titanium push rods. This not only corrected the problem but added the possibility of independent control of front and rear steering. The source of titatium rods was mentioned previously and the bell cranks are commonly found at R/C hobby stores.

**6**. The central portion of the plastic truck chassis twisted and distorted, under the terrific stresses being generated by the powerful steering servos trying to overcome the traction of the tires. To correct this, the chassis was replaced with one made of machined aluminum. This component was, again, from an R/C specialty company. Now that the suspension was fully functional, I assumed (incorrectly) that my problems were solved. I moved on to the power train where I made an interesting discovery: applying power to the fully-loaded platform resulted not in forward movement, but in the connecting wires between the battery and motors emitting a large amount of smoke and becoming quite shiny as their plastic insulation began to melt. As it turned out, the problem was due to a gearing ratio in the transmission that was no longer able to pull the entire chassis. This caused the front and rear motors to stall, presumably then pulling their stall current of over 100 amps each (or as much two 20 amp hour batteries could provide, anyway). The solution turned out to be fairly simple. I ordered new pinion gears for the motors with 9, rather than 11, teeth. This was the smallest pinion gear available and gave greater torque but slower speed. Installing the gears turned out to be more complicated than I had imagined. The plastic transmission housing to which the motors mount had precise mounting holes that assumed a particular pinion gear diameter. With the new pinion gears in place on the motors, no contact was made between the pinion gears and the transmission gears. Several hours with a dremel tool finally solved this problem and the new gears have so far proved satisfactory.

Now that I finally had a reasonably functional platform, the next step was to build some sort of structure on the chassis to serve as a "body" for the robot; housing its electronics. The robot's body would be affixed to an aluminum framework I had already constructed and attached to the chassis for the purpose of retaining the batteries. This framework was built of U-shaped aluminum stock that was easily cut with a hacksaw and inaccurately drilled with my dremel tool. The design of the framework gave me an approximate size for the body and I had some idea of what would be going inside. I decided on a housing about a foot long, at least 6 inches wide, and several inches high. A trip to The Container Store provided a number of interesting possibilities. I ended up purchasing a strangely shaped, elongated housing with several holes in one side and an open, mouth-like apparition at one end. It bore some resemblance to a white mail box with no door. I had no idea what the original purpose was and it had no label to indicate it - though I have since been told it's probably for storing and dispensing plastic grocery store bags.

Inside the robot's new body, I mounted U-shaped aluminum rails by means of double-stick tape. I then fashioned a rectangular tray from foam core panels that would slide into the rails through the mouth of the body. This tray will be used to mount various controllers and a 6811 cpu.

The final product can deal with quite a range of obstacles and should provide stable performance on fairly steep inclines. It may not be able to handle stairs, but should at least be able to deal with other common obstacles such as speed-bumps and curbs. I won't know if all my platform design goals have been met until I do more extensive testing, which will have to wait until the cpu is installed and working. What brief testing I have done indicates that it will meet most of the goals. It appears to be fairly fast. The batteries give the drive system a reasonable run time and allow more than enough time for the cpu and electronics. The robot weighs quite a bit but can be handled by one person. While a bit larger than a cubic foot (17w x 18l x 14h), it is still small enough to fit into cars and through door ways. In spite of the numerous obstacles (and cost overruns worthy of any government project) using an R/C chassis has resulted in a fairly successful robot so far.

In the part three I will talk about the sensors and the electronics used to control the motors and servos in the robot.

## *Submit your Brain*

Yes, your brain. Are you experiencing guilt for hoarding all that great information in your brain without letting others benefit from it? If so, we have the answer - write an article for the DPRG newsletter. Where do you start? With your brain, of course. First, find something in there that you did and others can learn from. Second, write it down on a piece of paper. Third, send it to:

DPRG, C/O Roger Arrick
P.O. Box 1626
Hurst, TX 76053

Your guilt will be immediately removed as thousands of readers are enlightened and the world becomes a better place! ahhh . . . . .

## Mobil Robots

Inspiration to Implementation

This is one of the latest books about the construction of personal robots by Anita Flynn and Joseph Jones. The contents include a description of TuteBot (tutorial Robot), Computational Hardware, Sensors, Motors, Programming and more. The publisher is offering this book to DPRG members at 10% off of the retail price of $39.95. Phone: 617-235-2210, Fax: 617-235-2404.

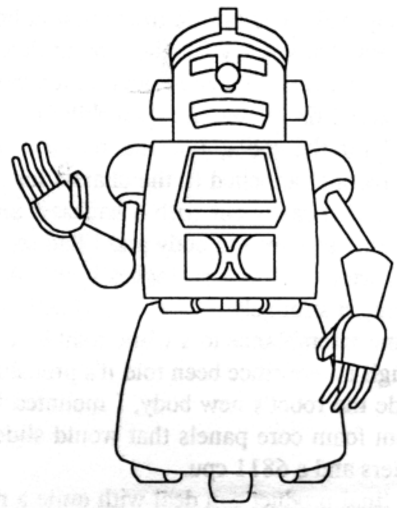
DPRG DALLAS PERSONAL ROBOTICS GROUP

# December 1993 NEWSLETTER

**December Meeting:**
Saturday the 11th, 1:30 PM
At the Dallas INFOMART

# Inside -

- ***Contest Draws Crowd, Not Robots***
- ***Building a Robot, Part 2***
- ***Mobil Robots Book***
- ***Submit Your Brain!***



---

Dallas Personal Robotics Group
C/O Roger Arrick
P.O. Box 1626
Hurst, TX 76053

FORT WORTH TX 761
07 DEC
1993