■ BY VERN GRANER

VIRTUAL ROBOTICS:
Can you work with robotics if you don't have a robot?

DUE TO A LIFELONG LOVE AFFAIR WITH ALL THINGS ELECTRONIC, at any given moment I am within arm's reach of a number of robotic and electronic parts and tools. Servos and circuit boards decorate my desk, breadboards and batteries abound on my workbench, and the subtle bouquet of solder flux seems to linger in the air. Subsequently, when I want to experiment with electronics or try out a robotic idea, I can usually lay my hands on some parts in short order and just hook stuff up to see what happens. This, of course, isn't always the case. When I travel, I've discovered that it is not a good idea to stash tools, PC boards, and batteries in your carry-on luggage (especially big red LED displays that count backwards in seconds towards zero ... don't ask). So, the robots, parts, and tools are abandoned at home.

The Traveling Roboticist is not the only one faced with the issue of having no toy equipment on hand. I've received a number of emails from readers who have asked for information about getting started in robotics or ways to explore robotics on a low (read: zero) budget. Some have experience in associated technical areas like radio or analog circuitry and are interested in what it would take to cross over to robotics. Others have programming background but are attracted to the motion of robotics, but are not sure if they would have a sustained interest that would support an investment in parts, tools, and books. Still others have been eyeing the field from afar wondering how to "get there from here." In these situations where an investment of space, money, time, or interest is in question, there is usually one common solution: a personal computer.

VIRTUAL REALITY — THE GLOVES ARE OFF!

In the '80s, "Virtual Reality" (or VR) was a popular concept. Lots of companies came out with ultra geeky heads-up display helmets, actuator gloves, and other I/O devices to allow a user to immerse themselves in virtual worlds and simulations. After a while, developers discovered they could build virtual items using just the PC itself without the need for these cumbersome hardware I/O devices.

Using just a PC, it's possible to have entire virtual worlds, featuring simulated physics and even photo-realistic depictions of objects and environments. But before we jackrabbit ahead to Virtual Robots sporting Newtonian physics, let's slow down a bit and start with simple simulation using just your PC and a turtle.

LOCO FOR LOGO!

Created back in 1967 by Wally Feurzeig and Seymour Papert, LOGO is a programming language that is still

■ FIGURE 1. The LOGO Foundation.

alive and kicking today. Well supported by The LOGO foundation (Figure 1) and other vendors, LOGO is still used to teach the basics of programming around the world. Typically, the user writes commands in the language to control an on-screen avatar, affectionately known as the "turtle." On their website, The LOGO Foundation has many resources and downloadable implementations of the language, as well as tutorials and documentation, most of which is free to use.

I downloaded MSWLogo for Windows by George Mills and Brian Harvey and had my little turtle moving about the screen in no time (Figure 2). The best part about LOGO is that it's possible to graduate from virtual turtles, to real turtles (okay, real *robotic* turtles).
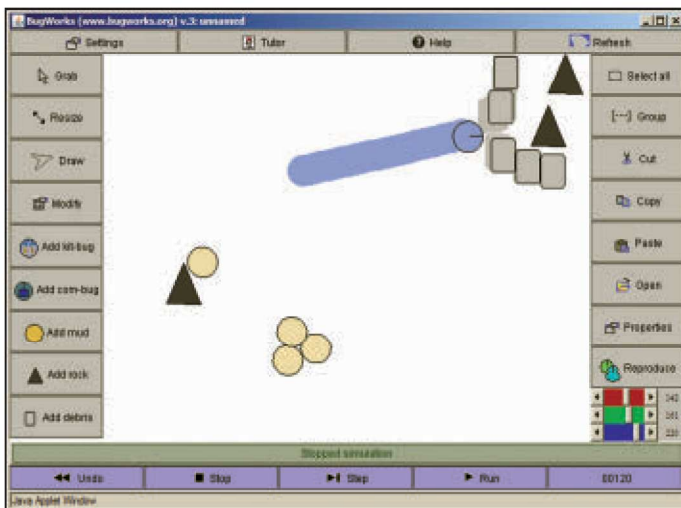
So, once you've learned how to make your virtual turtle turn some tricks, you can use your skills to program small, physical, battery-operated robots to do your bidding.

IT'S A BUGWORKS LIFE

In searching for robot simulators, I found "BugWorks" — a neat little 2D robotic simulator that is JAVA based. Simply point your browser to **www.bugworks.org** and select "Free Applet." A moment later, you'll have a fully interactive 2D robotic simulator on screen (Figure 3). The description from their website reads:

"BugWorks was originally developed

■ FIGURE 2. MSWLogo for Windows.

to enable students with no programming skills to experiment with 2D robots. More recently, it has acquired an 'eTutoring' dimension in the form of the built-in Mission Tutor. This sits on top of the main system suggesting missions to the user and giving feedback on any progress made. Credit is calculated internally and a log can be emailed to a named tutor at the student's instigation."

BugWorks is a cute little emulator and would be good for experimenting with basic robotic concepts. The BugWorks online applet is free to use, but if you want to run it off line, they ask for a $15 payment to download a copy for your personal use.

JUICING UP FOR 3D

One of the first 3D simulators I stumbled across in my quest for a virtual robotic world was JUICE. Created by Nate Waddoups of Redmond, WA, JUICE is a cross between a CAD program and a toy set. His own website couldn't even settle on a single description:

"It's a skeletal animation workshop, with realistic physics. It's like a virtual Erector set. It's sort of like a box of LEGO widgets. It could be a really cheesy CAD program. Mostly,

it's something fun to play with. You can use it to create robots that walk (if they fall down, you can call them kinetic sculptures)."

When I first started to play with this program, I was pretty amazed it was available for free. It allows you to experiment with virtual components in a virtual world and see some pretty amazing representations of how your device would function if you were to actually build it. (Figure 4). I was able to make a little hexapod robot and experiment with its walking gaits in just a matter of moments. Cool!

■ FIGURE 3. BugWorks JAVA-based simulator.

■ FIGURE 4. JUICE with simulated hexapod robot.
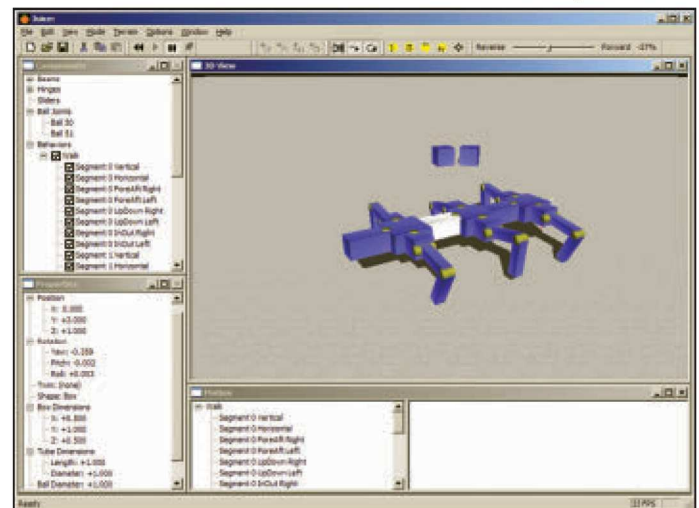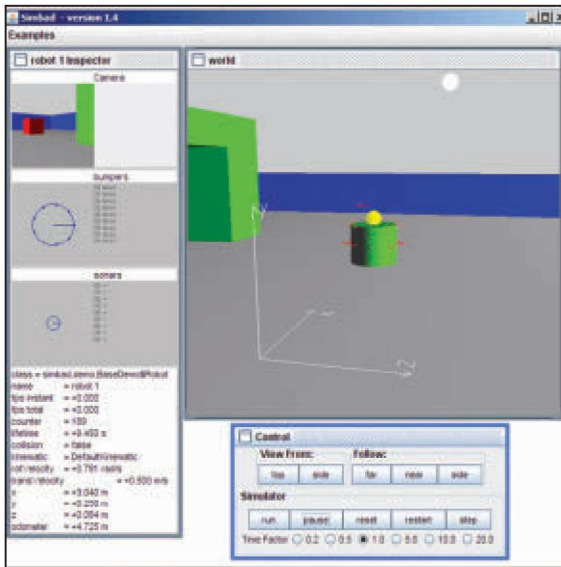
FIGURE 5. Simbad simulator.

Simbad is obviously designed with the professional researcher or programmer in mind. It's a definite must-have application for a long plane flight as it allows you to really experiment!

SKETCH IT UP, I'LL TAKE IT!
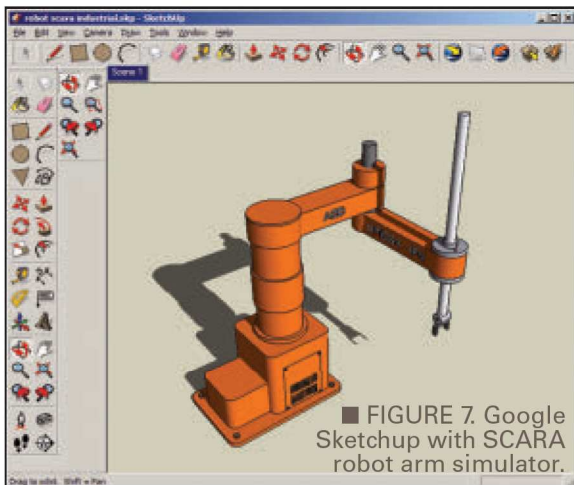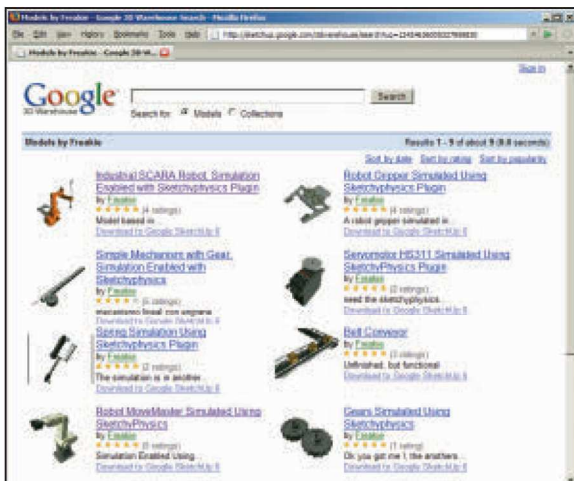
SAILING ON WITH SIMBAD

For fans of open FOSS, Simbad is the way to go for robotics simulation.

FIGURE 7. Google Sketchup with SCARA robot arm simulator.

FIGURE 8. Google 3D Warehouse with pre-made robotic parts.

Hosted on Source Forge and distributed under the GNU public license, Simbad's JAVA roots make it compatible with a plethora of platforms. I used the JAVA version under Windows XP with no trouble at all and was delighted with the capabilities of this product (Figure 5). This is serious simulation software for doing advanced robotics research. From their website:

"Simbad is a Java 3D robot simulator for scientific and educational purposes. It is mainly dedicated to researchers/programmers who want a simple basis for studying Situated Artificial Intelligence, Machine Learning, and more generally AI algorithms, in the context of Autonomous Robotics and Autonomous Agents. It is not intended to provide a real world simulation and is kept voluntarily readable and simple. Simbad enables programmers to write their own robot controller, modify the environment, and use the available sensors. Don't think of it as a finite product but merely as an opened framework to test your own ideas."

If serious three dimensional drawing is what you're after, Google has made available an amazing CAD tool called Google Sketchup that can be used to model all kinds of objects. Though available as a free download (Figure 6), they also offer a pro version for $500. Since Google has such a vast presence on the Internet, the user base for this program is huge, and the libraries of free models is simply stunning. Sketchup can support plug-ins that expand its functionality. One such is the "Google Sketchy Physics" module. This plug-in allows you to apply Newtonian physics to your models in real time.

One of the first models I found in searching for robotics was a complete SCARA (Selective Compliant Assembly Robot Arm) model with real physics (Figure 7)! And this was just the beginning. If you go to the Google Sketchup 3D Warehouse, you can search through tons of models (Figure 8) so you don't have to re-invent the wheel. (Literally! you can download models of wheels!) Lots of other robotic parts and even complete robotic systems have also already been modeled and are ready to be downloaded and assembled into your own virtual bot (Figure 9).

THIS IS THE DROIDQUEST YOU ARE LOOKING FOR!

For those of you who remember the Apple][computer, you may be

FIGURE 9. Google 3D warehouse complete robotic arm model.
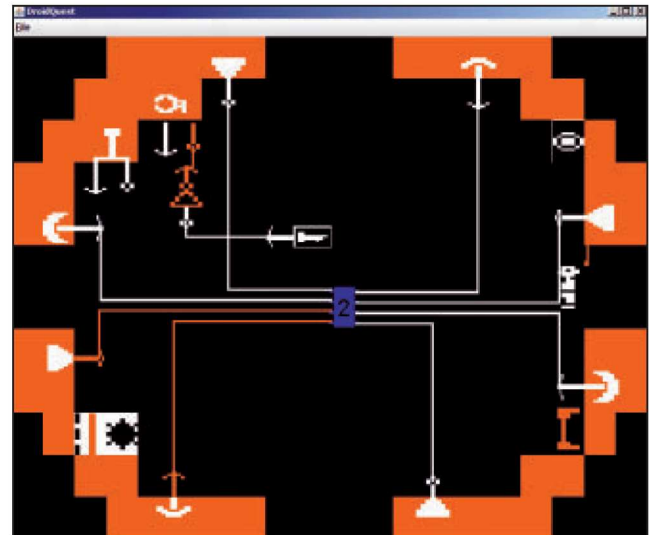
FIGURE 10. DroidQuest educational game.

delighted to find that a very popular educational game is still alive and doing fine on the Internet. Robot Odyssey, developed back in 1984 by The Learning Company, taught the basics of programming by presenting challenges that were solved by wiring together logic gates. Rescued from the digital garbage heap by Thomas Foote, this game has been reborn and dubbed "Droid Quest."

Implemented in JAVA (thereby making it compatible with Linux, Mac, and the Windows world), this game is a wonderful way to approach the otherwise somewhat dry and confusing world of logic circuits and how they interact. Though the graphics are quite faithful to the original eight-bit Apple program (Figure 10), it only takes a little playing time to see through the clunky, blocky figures to the underlying exciting challenges.

Originally designed for kids, the game also works well for adults and has the ability to provide a good foundation in the basic building blocks of robotics to anyone who plays it. It's a free download from **www.droidquest.com**.

LOSE SCOPE? WINSCOPE!

So now that we've looked over some simulators, let's have a look at some virtual tools you can get just by downloading them to your hard drive!

One of the more common tools used in robotics is the venerable oscilloscope. If you'd like to have one for experimentation, you can get a free software-based scope that uses your sound card to sample events and display the traces on your computer screen. WinScope (Figure 11) by Konstantin Zeldovich is available for free and does a pretty good job of showing frequencies and waveforms in the 20 kHz and less range. Though not as advanced as a real scope or even some of the hybrid hardware/software scope offerings, if you just need to see a pulse train or want to experiment with a scope before buying one, this little utility is perfect.

Though still available on the Internet from various sources (see the resource section for links) for free, an updated commercial version has become available from the original author for $20.

THE TOOL THAT NAMES ITSELF!

The aptly named "Frequency Analyzer" is a nice little spectrum analyzer that offers a visual glimpse into the

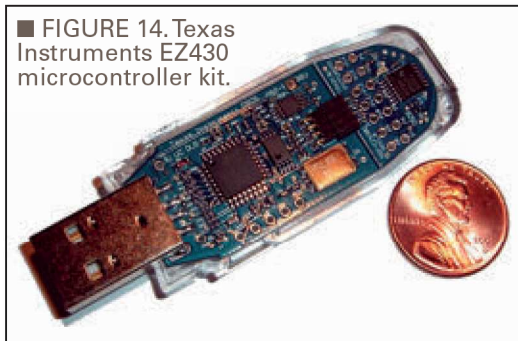FIGURE 12. Software based frequency analyzer.

audible world (Figure 12). Sporting both a waveform display like an oscilloscope and a color graphic FFT (Fast Fourier Transform) display, you can use this virtual tool to see how frequencies are concentrated across the spectrum in real time! This program is not only available as a free download; Reliable Software has the source code available, as well. This makes it possible for you to examine and learn how to write software tools

FIGURE 11. WinScope software oscilloscope.
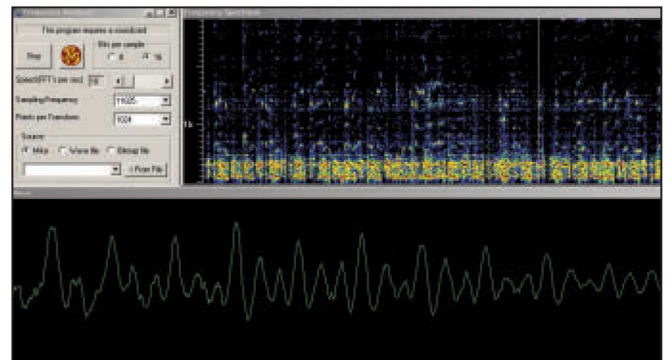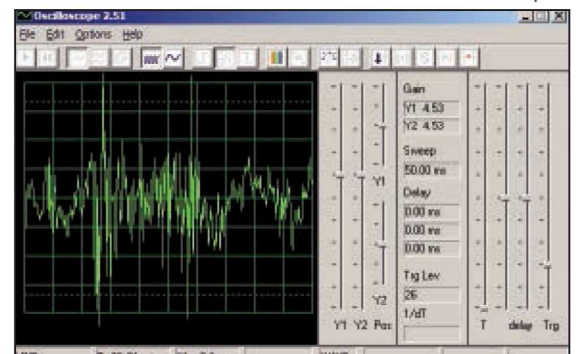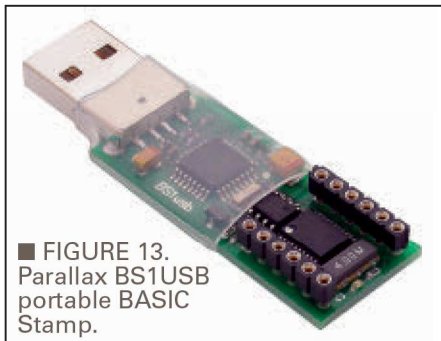
■ FIGURE 13. Parallax BS1USB portable BASIC Stamp.

■ FIGURE 14. Texas Instruments EZ430 microcontroller kit.

practically giving the kit away for a measly $20. For those of you who would like to sharpen your programming chops on the road, this nifty device is a must-have.

VIRTUALLY DONE!

I'm sure I have only scratched the surface here and that some of you may have favorite programs that were overlooked. Please feel free to email me with your favorites and recommendations. In the meantime, I hope that some of the offerings above have whetted your appetite for working with robotics even if you don't have the space, time, or money to buy all the latest devices. With a PC, you should be able to experiment and play with robotics without a bucket full of gadgets at your beck and call. Of course, this is not to say that a bunch of spare parts and a well-stocked workbench aren't helpful! In fact, if you're looking at building your first workbench or remodeling your old one, keep an eye out for an upcoming article where I feature the "Habitat for Hobbies" featuring workbench designs for robotics and electronics hobbyists.

For those of you that have been in the game for a while (you know who you are!), please take a few photos of your workspace and email them to me. Include a description of what you consider to be must-have items and a short summary of what you would do differently if you had it to do all over again. Don't be shy! Send in pictures of your work area just the way it is, messy or meticulous! Send submissions to the author at vern@txis.com. **NV**

of your own. Available from the "Freeware" section on their website.

LILLIPUTIAN PORTABLE PROGRAMING PRODUCTS

Though I've focused on the software-based virtual offerings throughout this column, I wanted to point to a couple of very cool (and tiny!) pieces of real hardware that are especially interesting if you travel or don't have the

room or bucks for a lot of equipment.

IS THAT A MICROCONTROLLER IN YOUR POCKET ... ?

Our good friends at Parallax have once again come up with a neat little solution to BASIC Stamp coding on the run. The BS1USB (Figure 13) is a small memory stick sized BASIC Stamp that is completely self-contained, drawing power from the USB port on your computer and allowing you to simply plug it in and program. The device has a small DIP socket that provides ready access to power, ground, and eight I/O pins for small-scale experiments. It's $39.95 from the Parallax website.

ITTY BITTY TI

The folks at Texas Instruments have a neat little memory stick sized programming environment called the TIMSP430 (catchy name, eh?) that not only offers programmability, but also sports dime-sized interchangeable modules so you can work on different projects at will (Figure 14). TI is