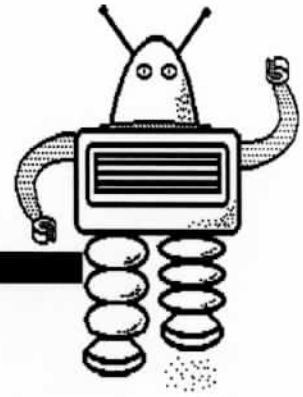


# THE ROBOT COMPANION

The Newsletter of the Dallas Personal Robotics Group
June, 1989
Stan Spielbusch, Editor

## JUNE MEETING AGENDA

The June meeting will be held on June 10th, 2:00 PM at the Dallas Infomart.

Ed Rivers will discuss the Bill Gates/Microsoft presentation from last month.

The Computer Council elections for Secretary and Treasurer are coming up. The previous treasurer has agreed to carry over to next term. Lonnie Green of the DALTRUG group has been nominated for secretary. If anyone is interested in these offices, speak up now!

Ed has been contacted by a recruiting firm specializing in robotics. They have positions available in a large area, not just Dallas. If anyone is interested in a new career, contact Ed.

The primary topic of discussion for the June meeting will be "what do we do now" and "what's going on"? We need a collection of current projects by members, and suggestions for what we should be doing. Judging by member enquiries, the checkers program has gathered some interest, as well as the home navigation. I think also that any projects related to homebrewing are popular and necessary. I'm happy to see that homebrewing is still alive, even with the Heathkit robots available. (I'm not really surprised, just happy.)

Bring your ideas to the meeting, if you want them heard.

There might even be a demo for the meeting -- be there, because if you miss it, it's not likely to be repeated soon unless I get a van with a motorized lift for my robot! What is it? I'm not telling, but it has something to do with robot obedience.

## MAY MEETING MINUTES

**by Stan Spielbusch**

Due to the Bill Gates speech in May, the meeting was a very informal gathering. In fact, since our meeting door was locked, it was held on the hallway floor! Despite this, it was one of the most interesting meetings I've been to. With no "club business" to attend to, discussions started right off with interesting stuff, like robot architecture, future robotics, remote control techniques, and so forth.

We greeted two new people interested in robotics, both of which I hope to see join the club. They seem to have the ambition and enthusiasm to get some projects going.

# MEMBER FEEDBACK

**by Stan Spielbusch**

Frank McKenney of Virginia owns a HERO Jr, and needs some help with a few problems. First of all, he would like to reprogram it, but cannot find information on the Heath ROMs (Heath won't release the listings), and he's found conflicting information in the Technical manual about how the PIA bits are used. He's trying to work his way through the code with a disassembler, but it's slow-going. Any information to speed up progress would be welcome.

Also, he wonders why the HERO would, in "explore" mode, suddenly decide to spin in place, indefinitely. And has anyone found a second source for batteries (cheaper than $22.50)?

Frank can be reached at 3464 Northview Place, Richmond, VA 23225, or through Unix mail at {...uunet!talos!mckenney}.

# ARTICLES OF INTEREST

**by Stan Spielbusch**

First let's start off with a product announcement. The latest DAK catalog has a couple interesting items in it. First there's a PC-compatible video digitizing board (black and white) for $169. It has 256x256 resolution with 64 shades of gray. You can also get a B&W camera for $129 (but they show no picture of the camera). Too bad the HERO 2000 doesn't have a PC bus!

Also, they have a cute little close-circuit type camera with monitor for $149. Brian Vaceluke is fairly certain the camera would work with his digitizer circuit. The great thing is that the camera weighs only 7 ounces, and has a little mounting bracket that would work great with the HERO 2000 arm! I'm also pretty sure it runs on 12 volts, since they show it being used with a motorhome (they mention AC/DC operation and low power, small cable).

Contact DAK Industries at 8200 Remmet Ave., Canoga Park, CA 91304. 1-800-888-7808.

## ARTICLES

Neural nose to sniff out explosives... EE Times, May 1, 1989. The FAA is about to install the first neural-based bomb detector at JFK airport. The system recognizes gamma-ray patterns reflected by various explosive chemicals using a neural net. If it's uncertain about a particular bag, it's routed aside to be hand-inspected, and the uncertain data is saved for later algorithm improvements. The beauty of it is that when new explosives are invented, it simply learns their pattern, no modifications needed. Also, since it uses gamma radiation (simple neutrons) instead of X-rays, it's perfectly safe for people, film, and magnetic media. It weighs 20,000 pounds and costs nearly $1 million.

IC guru Mead blasts neuro hot shots... EE Times, May 29, 1989. Carver Mead has harsh words about overly anxious neural-net architects who build unrealistic systems. His beef is about the design of massive digital networks that are so general-purpose that they can't be taught quickly. Any useful design must incorporate some specific "genes" that instruct it how to learn. He also proposes using analog nets instead of digital, because the packing density and speed are much greater, and analog is better at "fuzzy" problems. Analog can even be very fault-tolerant -- many more neurons than necessary can be packed in, and failure of a few wouldn't be noticed. Power consumption is also an issue -- comparing a particular digital net with an analog net of the same functionality, the digital net would consume hundreds of watts, while the analog would consume about a tenth of a watt.

Software's the talk in speech recognition...EE Times, May 15, 1989. This article review some of the latest advancements in speech recognition technology, particularly software. One interesting advance is a study of using visual clues (lip-reading) to improve the accuracy. Also mentioned is the DragonDictate 30K, which can recognize 30,000 words at a dictation rate of 15 to 60 words per minute (running on a 20 MHz 80386).

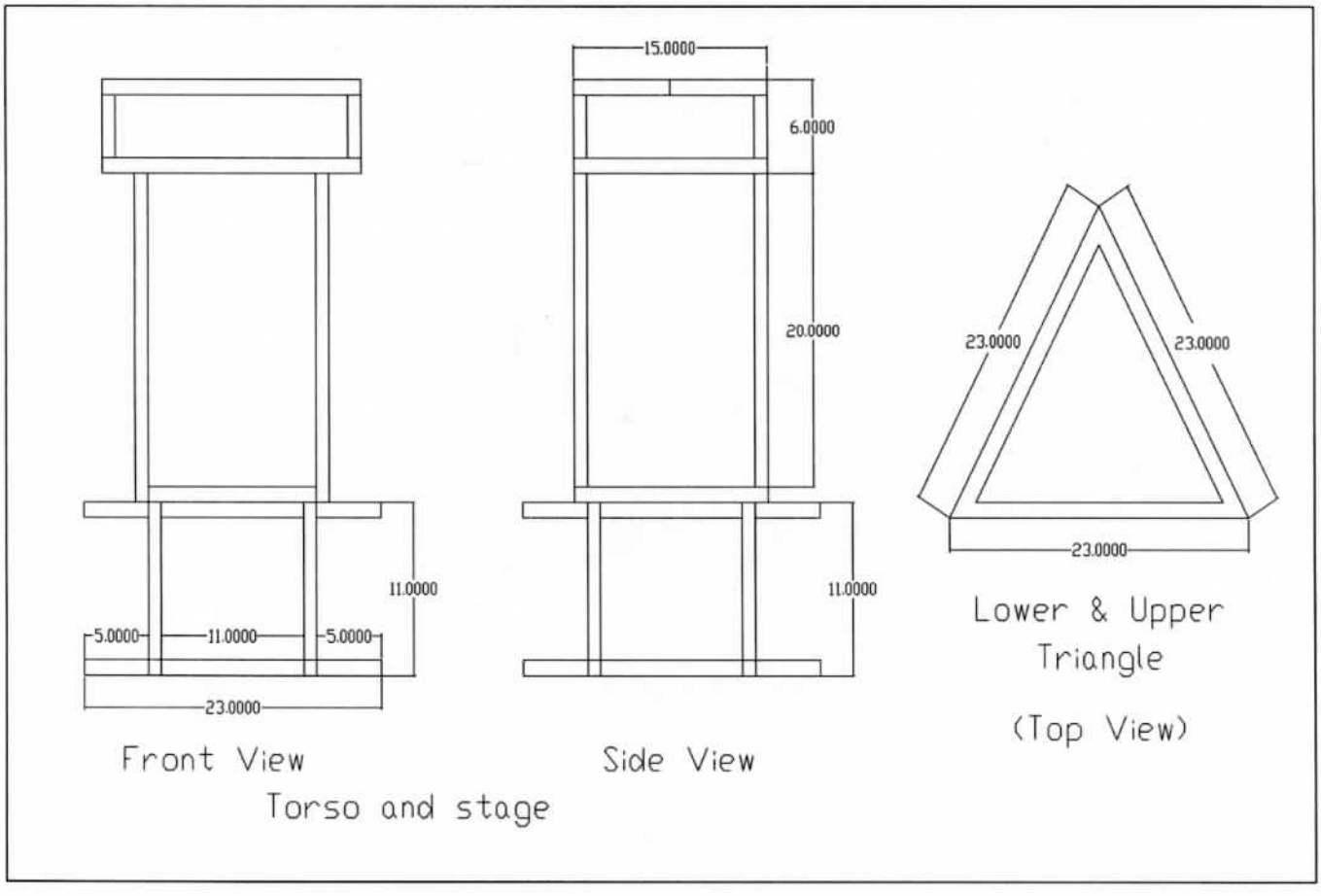
The Limbo project, Part 2...Micro Cornucopia, July-August(?) 1989. Bob Nansel continues his project of a maze-running 'mouse' robot. He provides more details on the IR ranging system using two IR transcievers, and calculations to find the ideal battery considering weight/power trade-offs. Also discusses the drive motor system and body construction. Note that he does the hard work first, leaving the electronics and software to the last. A good suggestion for any homebrewers out there! Design the body and muscles first, and the brain is a simple matter, with many possibilities to choose from.

# VICTOR'S PROJECT CONTINUES

**by Victor Sturm / Stan Spielbusch**

Here are some drawings of Victor Sturm's homebrew robot project. This is the body construction, made from 1" aluminum stock, I believe.

Victor is having trouble designing the hand for the robot, and would like some assistance, if anyone has some ideas. From his sketches, it would appear that he wants to make a 3-fingered hand, in a triangle shape. Each finger is to have 2 sections, for grasping objects. His main question is how to get the fingers to move back and forth using motors. Well, grasping is done easily enough using wire tendons, but they will probably have to be spring-tensioned to open back up. Anyone have any ideas?



# AN IR TRIANGULATION SYSTEM

**by Loren Heiny**

## IR Beacon

One of the most difficult parts of working with a mobile robot is accounting for its imprecision when it moves. Ideally, we'd like our robots to be able to follow any motion command we give them -- exactly. But this is not the case. Wheels slip, floors are uneven, carpeting is irregular, and, in general, just about anything that can throw a robot off its track seems to happen!

You can add a few judicious sensor readings -- like a sonar reading to a nearby wall -- to verify that the robot is on course, but it's difficult to use these readings when something goes awry -- a common occurrence.

One solution often proposed is to place beacons at known positions around the robot's environment which it can easily sense and calculate its position relative to. Unfortunately, it's hard to find any mention of how this technique can be implemented. This article will uncover the secrets.

## Beacons and the Resection Problem

First, let's get some math out of the way. Assume that we have placed three beacons around a room as shown in Figure 1. (You'll need three or more beacons to unambiguously determine your robot's position in a room.) The positions of and the angles between the beacons are known. The goal is to calculate the robot's location in the room -- indicated here as Rx and Ry.

It seems like it should be a simple matter of applying some old high school geometry to come up with a mathematical solution to this problem. Believe me, it's not that easy! However, it turns out that the solution to the beacon problem can be found in many surveying textbooks. Officially it's called a resection problem. It also turns out that there are several different solutions that people have come up with over the years. The one most appropriate for our robots is called the Tienstra method. Briefly, the location of the robot (Rx,Ry) is given by the equations:

$$Rx = \frac{K1Ax + K2Bx + K3Cx}{K1 + K2 + K3} \qquad Ry = \frac{K1Ay + K2By + K3Cy}{K1 + K2 + K3}$$

where

$$1/K1 = \cot A - \cot\alpha \qquad 1/K2 = \cot B - \cot\beta \qquad 1/K3 = \cot C - \cot\gamma$$

Note that these equations only require your robot to be able to sense the relative angles between the beacons in order to determine its position in a room. This is easy to do with a scanning beacon detector.

Also notice that these equations will blow up when the robot is in some locations in a room. You'll have to handle these situations separately.

## Building Beacons

Now let's look at the beacons. Although a beacon system can be constructed from any number of things, I've experimented with infrared (IR) beacons placed around a room and a single scanning IR detector on the robot.

In the past, building IR circuits has been a task best left to the analog gurus. Not any more. All you need to do is go down and pick up an IR detector from Radio Shack (Part number RS276-137) and a set of high power IR LEDs (RS276-143). The detector provides a set of schematics that should get you up and going in very little time.

I won't go into the theory here on how the beacons operate, except to say that each beacon is designed to emit a different frequency. The detector is designed to detect the frequency of this beacon and others if they exist. (You'll need to modify the Radio Shack schematic to detect multiple frequencies.) Note that by using a unique set of beacon frequencies your robot will not only be able to determine its position in a room but will also be able to determine which room it's in since each room can be given its own unique three beacon code.

## Scanner

You'll need to place the IR detector unit (and possibly its supporting circuitry) on a scanning unit. There's not much to say here except that you should choose a motor/gear combination so that the scanner's angular resolution is as high as possible. If you work through the equations you'll find that the resolution of the robot is very sensitive to the detector's angular resolution. If you can get your system to resolve down to a tenth of a degree, your robot will be able to determine its position to within a few inches in a typical room. However, this resolution is pretty high for most home projects. A more realistic angular resolution would be around one or two degrees. This will give your robot the ability to determine its position within a foot or so in many places in a room worst case. This might sound awful, but it's quite workable.

## Making It Work Well

In order for this beacon system to work well there are several rules of thumb that you must follow. First, the better the scanning resolution of the IR detector, the more precise your system will be. Second, the equations are more sensitive to errors in some areas than others. The shaded areas in Figure 2 are the regions least sensitive to errors for three types of beacon arrangements. Try to arrange the beacons so that your .pa

robot spends most of its time in these areas. Third, errors increase dramatically whenever the robot is within a few inches of any of the beacons. It's best to try to avoid these situations. Fourth, the beacon system does not work well over large distances. The maximum range from any one beacon (without a lot of extra circuitry) is about 10 feet. And lastly, the IR detector from Radio Shack has a wide acceptance angle. In other words, it will detect an IR beacon even when it is not directly aimed at it. We don't want this. We want the detector to detect a beacon only when it is pointing directly at it. To solve this problem you can place a long tube in front of the detector to restrict the incoming beam.

## Conclusions

I've left out a lot of details on how to implement an IR beacon system, but I hope I've provided enough information so that you can easily fill in the blanks.

Purists may not like the idea of placing beacons around their house to guide their robot. Although I tend to agree, I think you'll find that the added navigation ability far out ways the drawbacks. Anyway, there's nothing stopping you from using natural features around the house as "beacons." For instance, you might try developing sonar algorithms that enable your robot to triangulate to corners of a room. Maybe you can think of others. Share your discoveries with others in the Robot Companion.

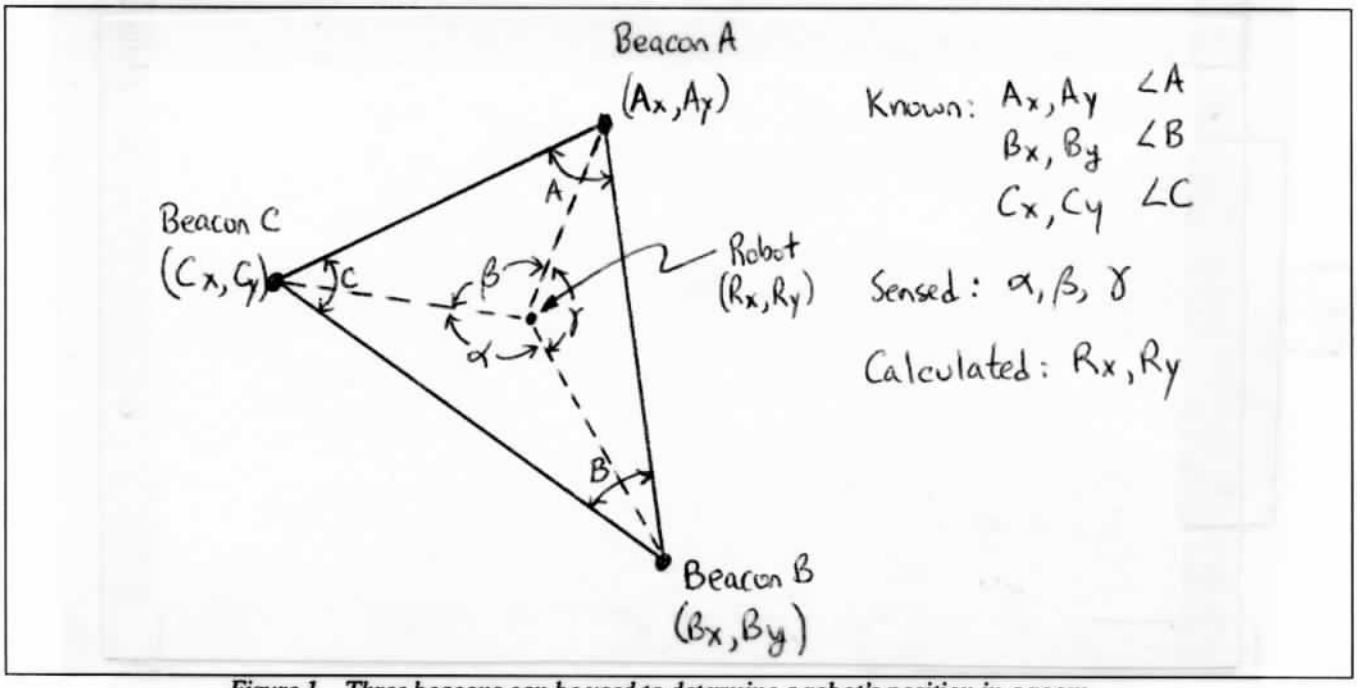



*Figure 1. Three beacons can be used to determine a robot's position in a room.*

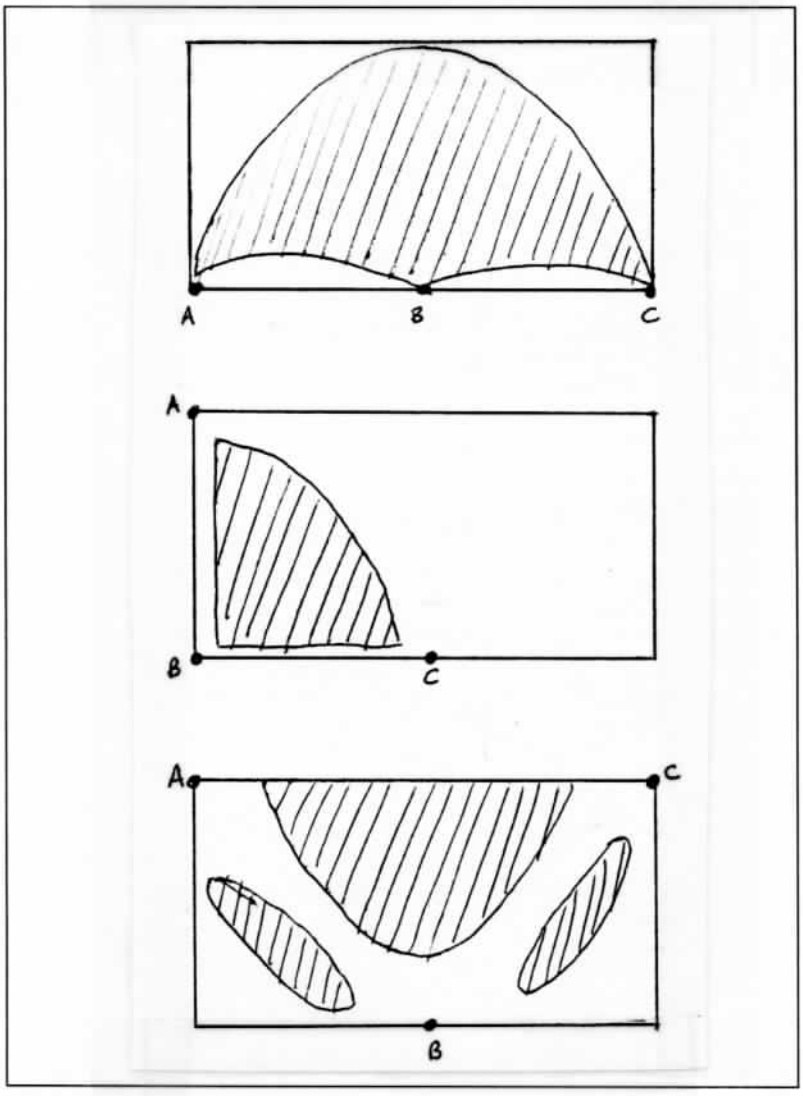



*Figure 2: Three beacon arrangements are shown along with shaded regions that indicate where the beacon systems will yield the best results.*

## FROM THE LIBRARY

**by Stan Spielbusch**

If you have a program to submit, put it on an MS-DOS format disk (double sided, double-density standard format) and bring it to the meeting or send to:

Stan Spielbusch, 2404 Via Barcelona, Carrollton, TX 75006

****** Please ***** include a description of the program, either as comments in the program or as a separate .DOC file. I don't have the time to study each program to figure out what it does!

When you submit a disk, you receive credit for 1 disk in return. Let us know which one(s) you want, or if you just want your original disk back.

We currently have 4 disks in the library -- a HERO-1 BASIC disk, a HERO-2000 BASIC disk, a HERO-1 Assembler disk, and Loren Heiny's EyeSight program.

If you want a copy of a disk, the best way is to bring a blank, formatted PC-DOS/MS-DOS disk to the meeting and trade with me there. If you forget to bring a disk, we will have to collect $2.00 per disk. Mail-order -- $3.00 per disk -- no need to include a disk with order. Send orders to Stan (address above).