

# PERSONAL ROBOTICS

UNDERSTANDING, DESIGNING & CONSTRUCTING ROBOTS & ROBOTIC SYSTEMS

■ BY VERN GRANER

## THE PEANUT BUTTER MONSTER DETECTOR

Build this robotic bedside companion to help ease your child's nighttime fears



**THE PEANUT BUTTER MONSTER DETECTOR** is a combination bedside night light and audible/visual effects generator for reassuring frightened children. If a child is unexpectedly awakened at night, they can easily trigger the unit with a single pushbutton. Once triggered, the unit floods the room with bright white light while it emits sounds, flashes LEDs, and rotates a scan head to the accompaniment of a reassuring spoken dialog. After the unit gives an "all clear," it becomes a bedside night-light that slowly fades out after a few minutes.

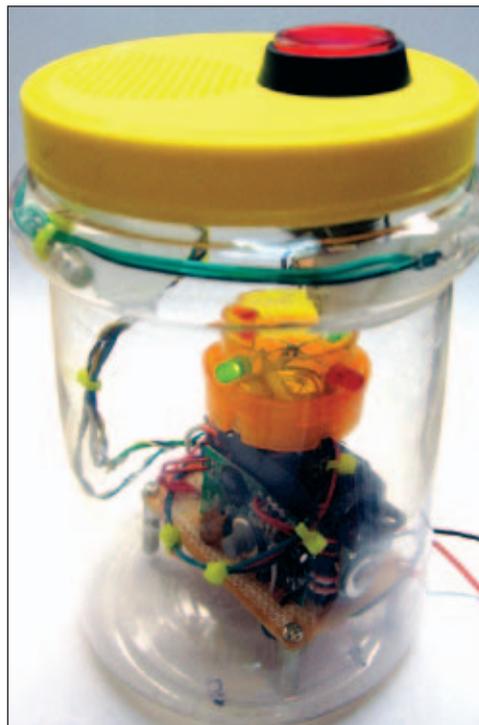
**W**ith Halloween upon us, many times kids are begging to see a scary movie or visit a haunted house, only to find out too late that it was a bit much for them. What was a fun thrill for younger kids (with friends and family around) can become a scary memory for them at bedtime. This usually manifests itself in requests that lights be left on or doors be left open. When the sun goes down and the scary fun becomes just plain scary, the Peanut Butter Monster Detector may be just the ticket to a good night's sleep for your child (and you!).

room!" This is not a completely uncommon happening at my house, and from what I've heard from other

parents, not uncommon in their households, as well. For many young children, occasionally being afraid of monsters is a normal part of growing up. Many kids have various "security blankets" that they use to comfort them or dispel their monsters, allowing them to sleep. But some (like my daughter) require a more "active" reassurance. To try and put my daughter's mind at ease (and, consequently allow dear 'ol dad a bit more shut-eye), I decided to take a high-tech approach and see if I could make a device to assist her in learning to manage night time fears by putting her in charge of the solution.

### WAKE UP! TIME TO CRY!

It's 2:43 A.M. I know this because I can (barely) make out the blurry numbers of the clock radio on my nightstand. I was awakened by tiny ice cold feet and the quiet whimpering of my six year old daughter who has crawled into bed with me. "Daddy" she whispers, "there's a monster in my



### MONSTER THEORY

After giving the problem some thought, I came up with a pretty clear picture of what I wanted to create. The idea was to build something that would double as both an active, immediate anxiety reducer and then act as a standby reassurance system.

It would have to be something easy enough to be operated by a child of five or so, even if she is frightened and in the dark. I figured a large backlit pushbutton switch should work. When pressed, the unit should instantly brighten the room by switching on high-brightness white LEDs. This would help to immediately lower the anxiety caused by the darkness itself.

Next, the unit should act as a “Monster Detector” by performing some type of active scan accompanied by blinking LEDs and a “scan head” that can show the device is actually doing something. A voice recording could narrate the activities and could be accompanied by some beepy sci-fi sound effects for good measure.

After a scan has completed, the unit should declare the area free of monsters and instruct the child to go back to sleep. It could then slowly dim the white LEDs from very bright, to a very low night-light level, eventually turning off completely. During this fade out period, I decided the device should probably not be re-triggerable. I did this to reduce the possibility that the child would multi-trigger the device using it as a toy or as a distraction from going to sleep. So, now that I had a vision of what I wanted to build, it was time to start on a prototype.

## STEP 1: EAT PEANUT BUTTER!

Our family goes through an enormous amount of peanut butter. We seem to always have empty containers and, due to our involvement in Scouting and other school crafting projects, we save all manner of jars, jugs, Popsicle sticks, and the like. While rummaging for a good container for this project, I found the ubiquitous peanut butter jar. Made of sturdy transparent plastic with a large opening and a lid that is easy to remove and replace, it seemed to be a perfect Monster Detector chassis. The

■ FIGURE 2. The junk box components rounded up for the prototype.



36 oz size jar (Figure 1) has an opening big enough to accommodate some pretty large parts, and the jar itself would make a good acoustic case for the speaker. Some jars have a ridge around the top that would be ideal for holding the white LEDs. The physical size also is about right to sit on a night stand without taking up too much space.

Once the label is removed, the transparent nature of the jar makes it possible to mount all the LEDs inside the jar without having to drill holes. This also leaves all of the circuitry visible while protecting small or fragile moving parts from damage by curious little fingers. If you prefer not to have the circuit boards visible, a paper template could be printed out and then inserted inside of the jar. When back-lit by the LEDs, any printed items would become visible during the scan process and the subsequent monitoring mode of the device. So, now that we have a cheap and useful container, we need the parts to go in it.

## TO THE JUNK BOX! AWAY!

I’m a life-long pack rat and I’m usually surrounded by all kinds of interesting bits and pieces (as those of you who read the September ‘08 Personal Robotics column “Habitat for Hobbies – Part 2” might recall!). So, I began digging through my parts bins looking for the electronic flotsam and jetsam I could cobble together for this device. Experience has shown that a project like this is usually simplest to accomplish by using a

microcontroller. The BASIC Stamp 1 OEM version (Figure 4) seemed a good match for this project because:

- It has a built-in LM2940 5V regulator.
- It is easy to program using the simple and mature PBASIC language.
- It has eight I/O pins which is plenty for a small project like this.
- It has a large library of example code and excellent support from Parallax.
- I already had one sitting in my parts bin!

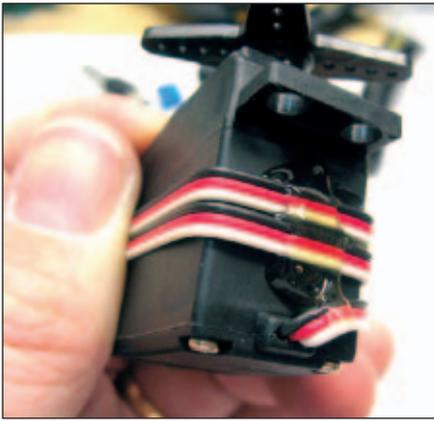
A bit more digging and I was lucky enough to uncover all the things I needed to get started on my prototype (Figure 2) including a nice grid-style perf board, some assorted LEDs, a servo motor, a big lighted pushbutton switch (where I had conveniently replaced the 24V incandescent bulb with a red LED), a low-cost RadioShack sound recorder board, and some white LED Christmas lights. For a comprehensive list of everything, see the Parts List.

## WHAT, ME WORRY?

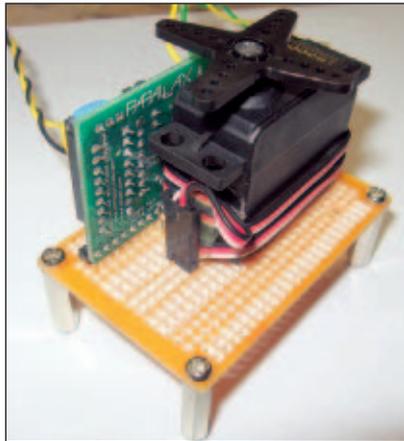
In keeping with my usual style (i.e., “How hard could it be?”), I decided to dive right in and start building. As I was relatively certain of what I was going to do and how the pieces would all fit together, I

■ FIGURE 1. The Peanut Butter Monster Detector chassis.

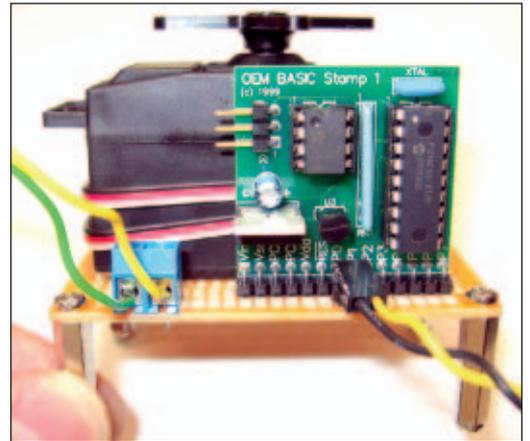




■ FIGURE 3. Excess wire wrapped around the servo and hot-glued in place.



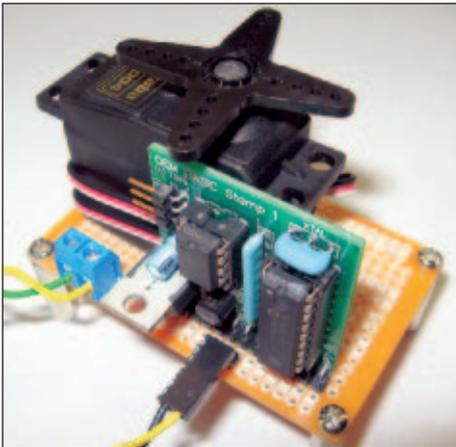
■ FIGURE 4. BASIC Stamp 1 OEM module and servo mounted to PCB.



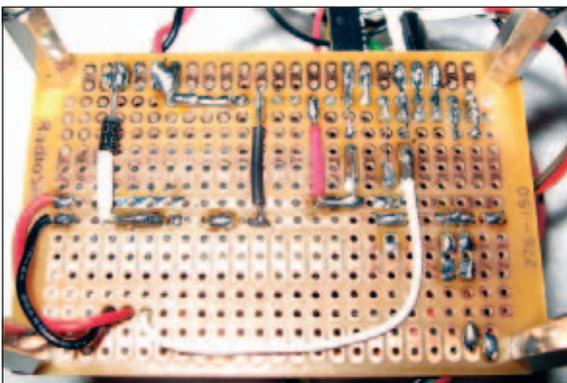
■ FIGURE 5. Checking the servo motor has clearance to turn above the BS1 OEM board.

skipped breadboarding the circuit and just started soldering the BASIC Stamp 1 onto the perf board. The .100" pin spacing lined right up and it was nice and solid once soldered. I then took the servo motor and wrapped the excess lead length around the body (Figure 3) creating a

■ FIGURE 6. Screw terminals for power and headers for pushbutton/LED connections.



■ FIGURE 7. Solder-side view of the PCB with all wiring complete.



nice "candy stripe" look. I then hot-melt glued the servo to the perf board (Figure 4) after checking to be sure that with a servo horn attached, it would clear the top of the BASIC Stamp board (Figure 5). I flipped the board over and added a three-pin .100" header for the servo, a 90 degree, right-angle two-pin header for the pushbutton and the pushbutton's LED, and a pair of screw terminals for power input (Figure 6). To make the board easier to mount in the jar, I added some metal standoffs to its four corners.

The grid-style PCB (printed circuit board) worked well for this design as I could use the strips that go down the center as a power bus; the pads at the edges let me bring out the pins from the Stamp 1 to the edge (Figure 7). As the BASIC Stamp OEM board has a full LM2940 regulator on it, I decided to use it to regulate power for the entire project. This way, the Detector could be powered by a six volt battery pack or by a higher

voltage external power supply.

If you decide to build the unit using a standard BASIC Stamp 1, I suggest you add an LM2940 voltage regulator to provide the V+ as this way you won't have to worry about destroying components if the wrong voltage level is accidentally applied. Also, if you look closely at the solder side (Figure 7) you will notice I included a diode in series with the power input as insurance against improper polarity. I took these extra steps since I knew the unit would be used around children and there was a good chance the wrong wall wart might be used to power the unit by accident.

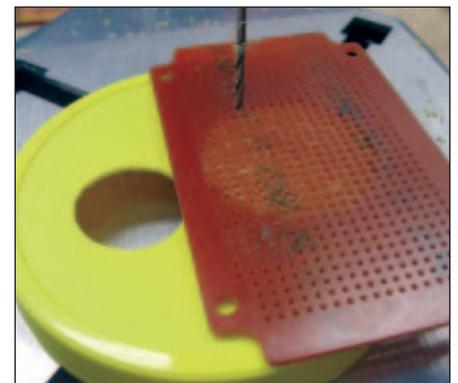
## MOUNT 'EM UP!

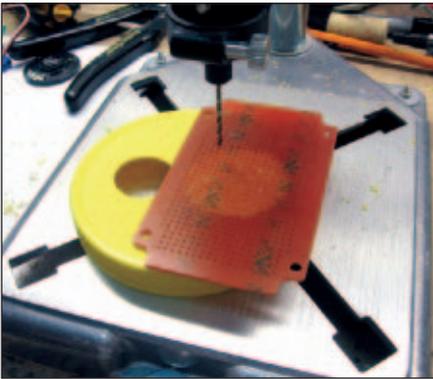
Now that I had the PCB mostly settled, I wanted to get started on the top of the enclosure. It was fairly easy to use a Dremel to cut a hole for the pushbutton switch (Figure 8), but the next step would require some pretty

■ FIGURE 8. Lighted push-button mounted in jar lid.

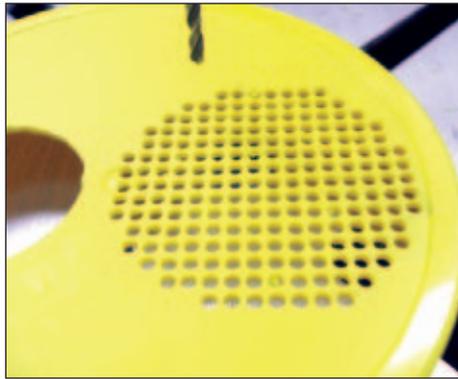


■ FIGURE 9. Old PCB hot-melt glued to lid top as a drill template.





■ FIGURE 10. Dremel drill press used to drill holes for speaker grill.



■ FIGURE 11. Speaker grill after PCB drill template is removed.

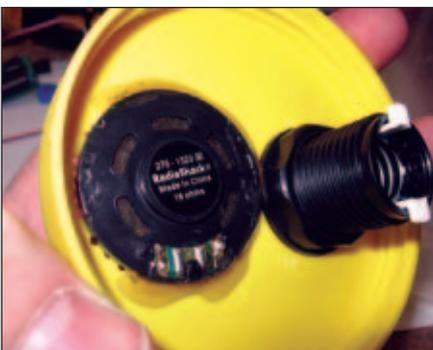


■ FIGURE 12. Speaker hot-glued to the bottom side of the jar lid.

precise drilling in order to get a nice professional look. Since there was going to be a speaker in the jar lid, there would have to be holes to let the sound out. Though I could have just randomly drilled a lot of holes, I didn't want the unit to look quite that rough. So, to get nice, even spacing, I took an old piece of .100" perf board and hot-melt glued it to the top of the jar (Figure 9). I then placed the lid on my Dremel drill press and used the perf board to guide the bit as I punched holes to make a nice circular grid (Figure 10). When I was done, I popped the old PCB off the top leaving a nice speaker grill (Figure 11).

Next, I hot-melt glued the speaker that came with the 20 second sound module to the underside of the jar lid (Figure 12). I placed the pushbutton back into its hole (Figure 13) and then did a test-fit on the top of the jar (Figure 14). I put the main PCB with the servo on it down inside the jar and marked four dots on the bottom that corresponded to the locations of the four standoffs. I drilled four holes and ran in a couple of screws to hold

■ FIGURE 13. Pushbutton test-fit next to speaker.



the PCB in place to see how I was for clearance from the servo horn to the pushbutton body (Figure 15). It fit with room to spare! Now that I had a button and a speaker, it was time to get the sound module working.

## SOUNDING OFF!

The RadioShack 20 second sound module is a cute little device that really lends itself to hacking. Though the sound quality isn't terrific, it's usually good enough to playback voice quality recordings. Strangely,

the external pushbutton switch is the one used for recording, the playback button is located on-board (seems sorta backwards to me!). Through some trial and error, I discovered that the onboard playback pushbutton can be remotely operated by adding a wire to the top resistor pad of R3 as shown circled in red in Figure 16. When this wire is taken to ground and then released, the unit will begin to play back its stored sound.

I hot-melt glued the sound module to the opposite side of the servo motor on the PCB and then ran the power

## MONSTERS DETECTED! RUN FOR YOUR LIFE!

Inevitably, when I've described the operation of the detector to friends and colleagues, someone always asks "can you set it so that once out of every three or four activations, the unit sounds a siren and yells 'MONSTERS IN THE CLOSET! RUN FOR YOUR LIFE!!'"

Though we all got a chuckle out of imagining the result of such a scan, in reality I have never considered actually doing this, even as a joke. Some folks also asked "Could you have the unit periodically declare a monster is present on the first pass and then, after the second pass, declare the monster has left?"

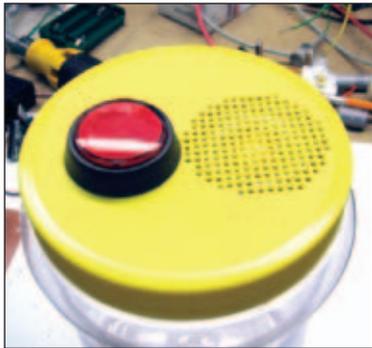
I considered the dialog very carefully and even went so far as to consult some friends in child care and child development to insure that the dialog had the intended purpose. In the end, I decided that the Peanut Butter Monster Detector should never detect a monster. If it ever gave a "positive" reading, that would tend to lend credence to the concept that imaginary monsters exist OR that the detector could be "fooled". If you think about it, giving a false positive leads to the question, "Could it give a false negative?"

For maximum reassurance, not only does the unit NOT detect a monster on the first pass, it then double-checks to make sure that the first pass was not mistaken. Not only is this doubly reassuring, this also causes the unit to make sounds and perform actions for about 20 seconds or so, helping the child focus on the device and forget about whatever noise or feeling awoke them in the first place.

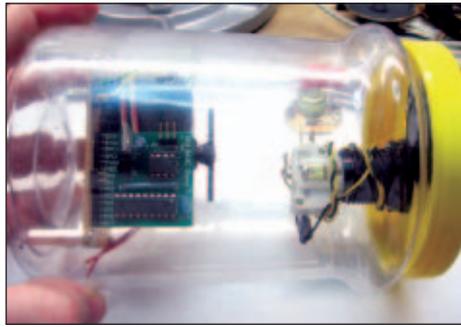
So far, this approach has worked very well to provide reassurance and to empower my child by providing a way for her to take charge of her own fears and learn to help herself sleep through the night.

So, if you were thinking of writing to ask me about this, no you're not the only person who's thought of it.

Also along these lines, when you are recording the dialog for your detector, make sure you are alone and that any older siblings aren't around to see how you do it. Recording over your reassuring words with "GIANT MONSTER DETECTED UNDER THE BED! RUN FOR YOUR LIFE!" is just the sort of trick older siblings might love to play on the younger ones! You have been warned!



■ FIGURE 14. Lid test-fit back on the jar.



■ FIGURE 15. Test-fit for clearance from the servo horn to the bottom of the button.



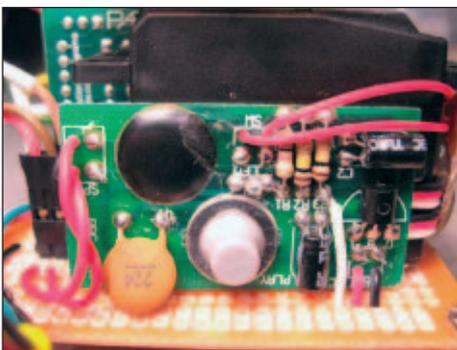
■ FIGURE 16. Add a trigger wire to resistor pad R3 (circled in red).

leads down through the PCB to the center power bus. I ran the speaker leads to a two-pin header that would lead up to the speaker in the jar lid. I threaded the “trigger” wire from the R3 pad down through the PCB and across to the P3 pad for the BASIC Stamp 1 (Figure 17). I hot-melt glued the record pushbutton to the back of the servo motor (Figure 18). As a quick test, I recorded a “hello world” message and then wrote a small program for the BS1 to toggle the pin. I found a dwell of about 500 ms was perfect to get reliable triggering of the sound sample. So far, so good!

## JUNK BOX SCAN HEAD

So now that I had sound, I started to think about the scan head that the servo motor would be rotating. I dug around in the junk box and came up with an old prescription pill bottle with a child proof cap. I cut around the bottle about 1/2” from the top with a Dremel tool and then drilled holes at four cardinal points to hold the LEDs (Figure 19). I used two small screws to secure the pill bottle to the

■ FIGURE 17. Trigger wire from pad R3 through the PCB to BS1 pin P3.



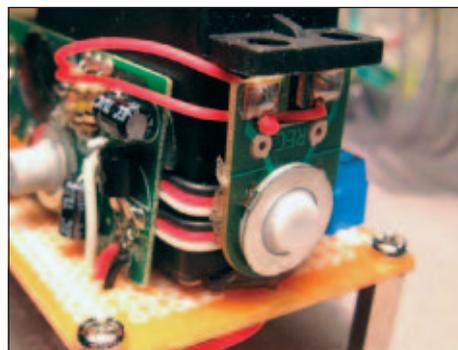
the servo horn (Figure 20), hot-melt glued a small tire hub from a discarded toy to the top (Figure 21), and voila! I had my high-tech scanner head.

## MIXING IT UP

When I was sketching up the original plans for this device, I had intended to have both the audio playback from the sound recorder and the BS1 beepy sound effects both coming from a single speaker. I figured I could just force feed the sound from the BS1 to the sound board’s speaker by loosely coupling the output pin from the BS1 to one of the speaker leads using a small capacitor.

When I tried this, the volume from the sound module dropped drastically and became very distorted. I tried a few other methods to mix the signal from the sound playback board and the output from the BS1 including a small transformer and even a couple op-amps to make a small mixer. The circuit was getting more complicated and the results were still pretty dismal. I decided to take a simpler approach and create a mechanical mixer.

■ FIGURE 18. The record button hot-glued to side of servo.

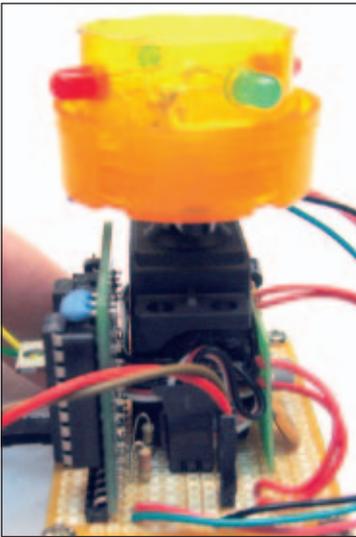


Instead of trying to mix two signals into one speaker, I placed a second speaker coaxially mounted on top of the first speaker! I did this by cutting a ring from the remains of the pill bottle I had used earlier for the scan head, and then hot-melt gluing it to the existing speaker. I then glued a small surplus speaker I found in my junk box to that ring (Figure 22). This method worked very well and made the BS1 sound effects audible right along with the spoken dialog from the sound module.

This also meant that it would be possible to build this device with a second speaker grill, maybe even facing in a different direction. This way, the beeping effects could appear to come from the scan head while the dialog from the sound module could come from near the main LED light source. You could even consider mounting the second speaker on the scan head itself so the sounds would move around as the direction of the scan head changed. Of course, the path I took isn’t a requirement; you can construct your monster detector in any container and with any method you like. Make

■ FIGURE 19. Scan head with LEDs mounted and servo horn attached.





■ FIGURE 20. Scan head attached to the servo motor.



■ FIGURE 21. Tire hub from an old toy glued to the top completes the scan head.



■ FIGURE 22. Second speaker piggy-backed on top of first speaker creating a "mechanical mixer."

the "Cigar Box Monster Detector" or the "Cookie Tin Monster Detector" for example. Just follow the schematic (Figure 23) and place the components however you prefer.

## CODING IT UP

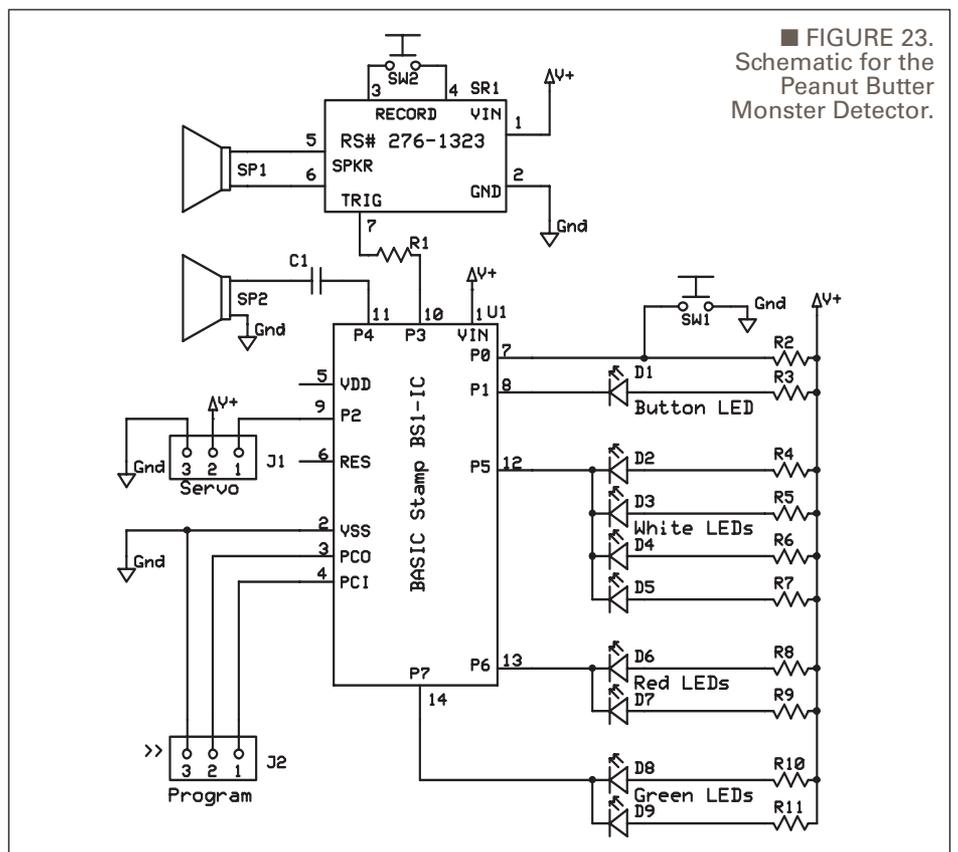
Now that I had the hardware done, it was time to pull up the BASIC Stamp programming environment and start to construct the code. Though its considered a bit "long in the tooth" by some and many other micro-controllers surpass it in speed and command set flexibility, there is still a surprising amount of power in the venerable BASIC Stamp 1. For example, I was able to take advantage of PWM output for operating the servo motor and to fade the LEDs, use constants to hold the servo START and END positions, and the random number generator to create those vintage science fiction sounds. Though the complete source code is available on the website ([www.nutsvolts.com](http://www.nutsvolts.com)), I wanted to take a moment to go over the basic functions here so you can better understand how the code works and to help you modify it to make it operate the way you want.

## A PIN BY ANY OTHER NAME ...

I started the coding by defining

all the pins at the top of the program. This way, I could use more human readable code statements. I find it much harder to understand code such as "IF X = Y THEN GOTO Z" as opposed to "IF BUTTON = PUSHED THEN GOTO PLAYSOUND." In keeping with this idea, I allocated the pins of the BASIC Stamp 1 with what I felt were useful names:

- PIN0 – Trigger (N.O. pushbutton to GND pulled "up" via R2)
- PIN1 – LEDTrigger (LED inside pushbutton)
- PIN2 – Servo (servo motor)
- PIN3 – SoundBoard (sound module trigger)
- PIN4 – Speaker (audio out to speaker)
- PIN5 – LEDWhite (white LED string)
- PIN6 – LEDRed (red LEDs in



■ FIGURE 23. Schematic for the Peanut Butter Monster Detector.

## SCHEMATIC PARTS LEGEND

|         |  |
|---------|--|
| ■ U1    | BASIC Stamp 1                          |
| ■ SR1   | Sound recording module                 |
| ■ SW1   | N.O. momentary lighted button          |
| ■ SW2   | N.O. momentary button (included w/SR1) |
| ■ SP1   | 8 ohm speaker (included w/SR1)         |
| ■ C1    | 2.2 $\mu$ F decoupling capacitor       |
| ■ D1    | Red LED (internal to SW1)              |
| ■ D2-5  | White LEDs                             |
| ■ D6-7  | Green LEDs                             |
| ■ D8-9  | Red LEDs                               |
| ■ R1    | 100K resistor                          |
| ■ R2-10 | 330 ohm resistors                      |
| ■ J1    | .100" three pin header                 |
| ■ J2    | .100" three pin header                 |

scan head)

- PIN7 – LEDGreen (green LEDs in scan head)

The program starts by initializing

■ FIGURE 24. Sami Graner fast asleep next to her Peanut Butter Monster Detector.



a few things such as turning on the LED in the pushbutton and then playing a beep through the speaker to let you know it has woken up and is ready to work. Next, the system goes into a loop where a few things happen. First, PWM is used to dim the LED in the pushbutton to a low level so the button doesn't light up the room. This setting is adjustable in the software so you

can modify it to taste. Second, the loop generates a random number for each pass so that when the button is pressed, a new "seed" is used making sure that the random numbers used

■ FIGURE 25. The Peanut Butter Monster Detector featured on KOOP radio in Austin, TX.



for the sound effects are more truly random and less pseudo random. Last, the loop checks to see if the pushbutton has been pressed. These three tasks continue indefinitely until the pushbutton is detected.

When the button is pressed, we drop out of the loop and do two things immediately. First, the LED in the pushbutton is turned on to full brightness; second, the white LEDs are turned on. Once this is accomplished, a short acknowledge sound is played out of the sound effect speaker by running through a FOR loop that plays 32 notes for only 1 ms each. This makes an upward sounding "Zrrrrp!" audio effect. After this sound effect is played, the red and green LEDs on the scan head are both switched on.

At this point, the Stamp toggles the sound module trigger line by taking it LOW for 500 ms, then bringing it back to HIGH. This starts the sound module playing back the narration (see sidebar for the dialog I used in my Monster Detector). At this point, both the red and green LEDs on the scan head are turned off and we drop to the first Scan routine.

Scan #1 is a FOR loop that steps from the START position of the servo (0 degrees) to the FINISH position for the servo (180 degrees). The servo should have a pulse sent to it every 20 ms in order for it to continue to move but, rather than placing a 20 ms pause command in the loop (as is typically done), I drop to a subroutine that plays random tones through the speaker. After the subroutine returns, I toggle the state of the red LED in the scan head. This makes the red LED strobe on and off as the servo pans the head to enhance the scanning

## PARTS LIST

- 1 BASIC Stamp 1 — Parallax BS1-IC
- 1 BASIC Stamp 1 Serial Adapter — Parallax (item code 27111)
- 1 Hobby servo motor — Parallax (900-00005) or Futaba (3004)
- 1 20 second sound module — RadioShack (#276-1323)
- 2 Green LEDs and 2 red LEDs — RadioShack Assorted LEDs (#276-1622)
- 1 Grid-style PC board — RadioShack (#276-150)
- 12 330 ohm resistors — RadioShack Five-pack (#271-1315)
- 1 100K resistor — RadioShack Five-pack (#271-1347)
- 1 Metal standoff with screws (four-pack) — RadioShack (#276-195)
- 1 N.O. pushbutton switch — Happ Controls (D54-0004-20) or All Electronics (LPS-1R)
- 4 White LEDs — All Electronics (LED-75)
- 1 .100" snappable header — All Electronics (SHS-32)
- 1 Empty peanut butter jar (yum!)

## RESOURCES

■ Parallax  
[www.parallax.com](http://www.parallax.com)

■ All Electronics  
[www.allelectronics.com](http://www.allelectronics.com)

■ Video of the Peanut Butter Monster Detector  
[www.youtube.com/VernGraner](http://www.youtube.com/VernGraner)

■ Interview with Samantha Graner:  
[www.notepad.org/SamiPBMD.mp3](http://www.notepad.org/SamiPBMD.mp3)

effect. These commands take approximately 20 ms to complete, so the pulses arriving at the servo are timed about right. When Scan #1 has completed, I call a subroutine (called "BLINKY") that uses a FOR loop to light the red and green LEDs alternately for 200 ms each, making it appear the unit is evaluating the results of the scan. When the BLINKY routine is complete, the green LED is lit and the BASIC Stamp plays a high-pitched tone to indicate the results of the scan have been evaluated. It then lights the green LED to indicate that all is well. At this point, another scan is initiated but with the START and FINISH values of the servo reversed so that the scan head returns to its starting position. The same lights and sounds are played and at the end of the second scan, the green LED is again lit and then it blinks on and off at half second intervals for five seconds to draw attention to the fact that the scan result has not detected any monsters. With the second scan completed, the red LED button is turned off and then the unit goes into another FOR loop. A PWM command is used in the FOR loop to slowly fade the white LEDs from full brightness to completely out. During this time, the unit will not respond to another button press (this could be changed if desired). Once the white LEDs are completely off, the unit jumps back to the top where it places the pushbutton LED in a dim glow and is again ready to start a scan when a button press is detected.

## PEACEFUL, EASY FEELING

When my daughter goes to bed, she insists on having her Peanut Butter Monster Detector on her bedside table. Recently, we moved to a new house and her bedroom wasn't quite ready yet. She opted to sleep on the sofa, but only if I put the Detector on the end table so she could reach it, just in case (Figure 24).

## MONSTER DETECTOR SCRIPT

```
"Monster Detector Active. Scanning ..."
(pause 5 seconds)
"No monsters detected. Scanning again ..."
(pause 5 seconds)
"All clear! No monsters detected in vicinity!"
"Go back to sleep"
"All Clear"
"Go back to sleep"
```

The unit has been quite a hit with her and she enjoys telling people how it works (check the resources section for an audio interview where she describes the detector herself). The Peanut Butter Monster Detector was even featured on a local radio program where it got its own chair and microphone (Figure 25)!

## THE MONSTROUS CONCLUSION

If you're interested in making your own Monster Detector, but maybe don't have a junk box as well stocked as mine, fear not! I've been kicking around the idea of putting together a kit. No definite plans as of yet, but it will be very similar to the project in my article. You might want to stop by <http://store.nutsvolts.com> once in a while and see what's new! In the meantime, I'd love to hear from anyone who decides to build their own Monster Detector. As always, if you have questions or comments drop me an email at [vern@txis.com](mailto:vern@txis.com). Have a safe and Happy Halloween! **NV**

## THANK YOU

I want to thank my daughter, Samantha, for helping inspire and test the Peanut Butter Monster Detector, and my son, Nicholas, for lending me the small plastic monsters we used for testing the Detector. (*Of course* it didn't detect them because they weren't *real* monsters! Duh!). A special thanks to John Richter for drawing the Peanut Butter Monster Detector logo/mascot. Also, a special thank you to Robin Lemieux for her patience and persistence ... without which this article would never have seen print!



OS5000  
Shown Actual Size

Our Low Cost Compass  
Gives Your Product a  
New Sense of  
Direction.

OceanServer offers solid state, 3-Axis Attitude Sensors for a variety of applications where size, functionality and cost are the keys to successful integration.

Our compasses are tilt compensated with a USB, RS232 or TTL interface.

OceanServer compass products provide precise heading, roll and pitch data, ideal for rapid attitude measurement.

**OceanServer**  
TECHNOLOGY, INC

[ocean-server.com](http://ocean-server.com)  
(508)-678-0550