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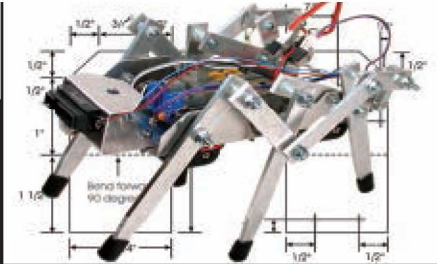
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PERSONAL ROBOTICS

UNDERSTANDING, DESIGNING & CONSTRUCTING ROBOTS & ROBOTIC SYSTEMS

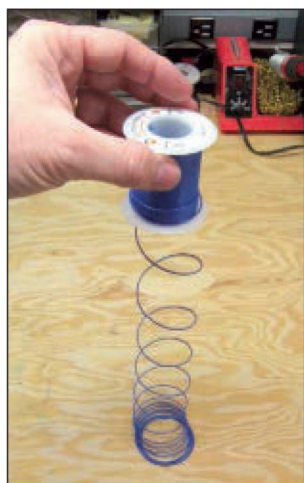
■ BY VERN GRANER

THE HALLOWEEN PROP DROPPER

After all these years dispensing treats, wouldn't it be fun to deliver a few tricks this year? The darkened porch is dimly lit by the glow of a single Jack-o-lantern. Riding a sugar buzz, the costumed trick-or-treaters swarm up the stairs and ring the bell. You open the door and they shout TRICK OR TREAT! You look at them gravely, then slowly raise your eyes to the ceiling above them. Puzzled, they look up just in time to see a big black bat come swooping down towards them! They shriek in surprise, then laugh and giggle when they see it's just a rubber bat that is now winding its way back up to the ceiling. You hand out candy and listen to the kids talk about how cool and scary that bat was and who they're gonna bring to see it. You smile slyly as you think to yourself "This is gonna be a fun night!" then push the door shut to await your next victims.

DROP WHAT YOU'RE DOING!

How fun would it be to drop a Spooky Spider, a Ghoulish Ghost, or a Scary Skeleton right out of "thin air" above unsuspecting trick or treaters? The Prop Dropper is a "quick and dirty" Halloween project you can probably put together in a single night with just a small micro-controller, a couple of servo motors, and a few bits and pieces from the ol' junk box. The Prop Dropper is designed to detect the presence of a person, rapid-deploy a small prop, display it for a moment, then wind it back up out of view, ready for its next victim!



WHERE THE HECK DO YOU GET THESE IDEAS!?

It's not uncommon for folks to ask where the inspiration for this type of project comes from. Sometimes it's just a matter of necessity guiding the development. Other times, it's simply an accident. The idea for this

■ FIGURE 1. If a spool is turned sideways, the wire or string on it tends to fall off the end.

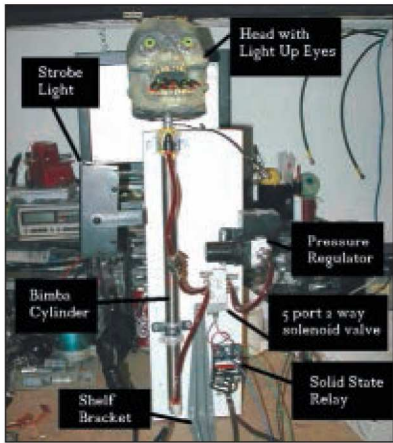
particular project was sparked when I was carrying a small spool of hookup wire. I shifted the spool from one hand to the other as I reached to open a door and the spool turned sideways, dumping a length of wire right off the spool to the floor (similar to the photo shown in **Figure 1**).

As I was grumbling and winding the wire back up, it occurred to me that it might be possible to make a purpose-built device that would do this very same "drop" effect. If there hadn't been a flange on the downward facing spool edge, it seemed likely that the entire spool would have emptied. Based on this observation, I guessed I could put together something that would use this method to quickly drop an item into view and then retrieve it.

STOP, DROP, AND SCREAM!

As I've been involved in putting on various private and commercial haunted houses in the last decade (see Resources), I've seen lots of mechanisms used to pop an item into view. Most of them incorporate sophisticated designs using pneumatic systems or mechanical linkages (**Figure 2**). I wanted something that would perform a similar deploy/retrieve function, but I really wanted it to be simple in operation and easy to build.

After sketching a number of designs, I finally settled on using one continuous-rotation modified servo as a winch and one standard servo to position the winch servo. To drive them, I chose the EFX-TEK Prop-1 controller board that features our old friend the Parallax BASIC Stamp



■ FIGURE 2A and B. The Pop-Up Trash can is an example of a complex pneumatic prop deployment system.

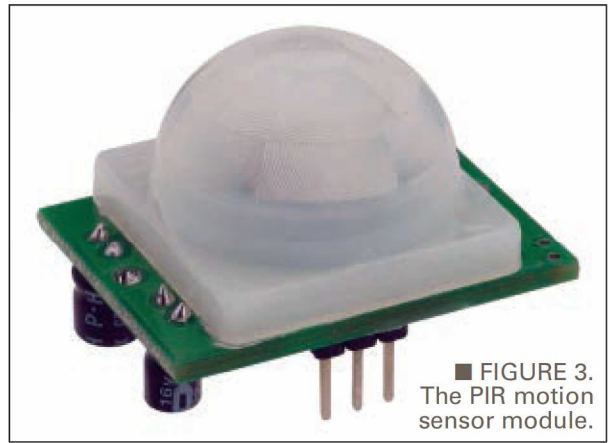
microcontroller. The Prop-1 control board was specifically designed to be used in commercial devices and has proven to be very robust. To allow the Prop Dropper to operate without requiring an operator, I used a low-cost PIR (passive infrared) motion detector as a trigger (Figure 3).

SCARE BY NUMBERS

In this month's article, I'll walk you through making the Prop Dropper step-by-step from hardware assembly through wiring, and then on to software and testing. First thing to do is get all the parts together (see Parts List). If you have a reasonably stocked junk box, you may be able to come up with everything you need just by digging around your workbench. If you don't have all the parts at hand, an entire kit of parts can now be ordered from the *Nuts & Volts* website (see resources for link). Either way, once you've gathered the parts, start with assembling the servos.

THE POSITION AND WINCH SERVO

For the first step, get the winch servo, the position servo, the large round servo horn, the small round servo horn, and the wire nut together on your workbench (Figure 4). Begin by attaching the small round servo horn to the position servo (Figure 5). Manually rotate the servo horn so that



■ FIGURE 3. The PIR motion sensor module.



■ FIGURE 4. The position servo (left) and the winch servo (right) ready for assembly.

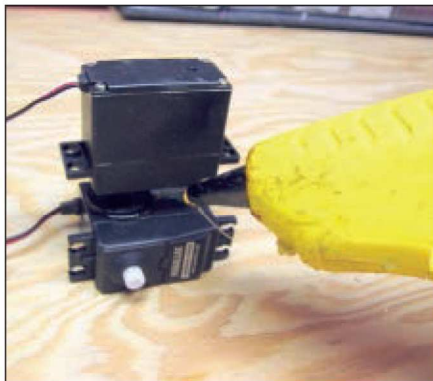


■ FIGURE 5. The position servo with small round horn attached.

the position servo is placed at approximately 90° (i.e., roughly centered). This is an important step, as you want to have the ability to move the winch servo to a straight-down position to deploy the prop, as well as a slightly up-canted position to allow you to wind the prop back up.

Using a hot-melt glue gun, attach the small round servo to the body of the winch servo as shown in Figure 6. Next, mount the large round servo horn on the winch servo as shown in Figure 7. As the winch servo has no "stop" points, you do not need to take any precautions on pre-positioning the horn before you screw it down. Next, use a few drops of hot-melt glue to attach the wire nut to the center of the large round servo horn as shown in Figure 8. Once the glue has set, you should have a nice positionable winch assembly!

■ FIGURE 6. Hotmelt glue the position servo to the winch servo.



■ FIGURE 7. Winch servo with the large round servo horn in place.

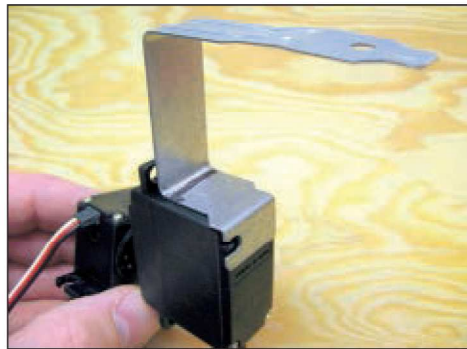


■ FIGURE 8. Winch servo with wire nut glued to the center of the large round horn.





■ FIGURE 9. Drilling a hole where the string to the prop can be attached.



■ FIGURE 10. A temporary bracket created from an old PC card back plane, glued to the position servo.



■ FIGURE 11. The Prop Dropper in place with a prop wound up and ready to drop.

At this point, you need to drill a hole in the large round servo horn to allow you to attach the string that connects to the prop (Figure 9). For testing, I fabricated a temporary hanging bracket using an old PC back plate that I glued to the back of the position servo (Figure 10). I then attached a small rubber bat to the large round servo horn and hung the completed assembly from the ceiling in my shop for testing (Figure 11). A video of the Prop Dropper in action is available online (see resources).

WIRE IT UP

Strangely for an electronics project, the wiring for this device is one of the simplest steps! The EFX-TEK Prop-1 controller makes it a literal matter of plug-and-play — there is no soldering involved in assembling this entire project. To illustrate, the schematic is shown in Figure 12 and a photo of how the servos and motion sensor are attached is shown in Figure 13. (Note: This simple assembly process makes the Prop Dropper an ideal project to share with youngsters!)

Following the schematic, plug the winch servo into the P0 header, the position servo into P1, and the motion detector into P7. When connecting the servos and the

motion detector, be sure to watch the polarity of the plugs to make sure the white lead is connected to the "W" pin of the jack. The pins are clearly labeled at the top of the Prop-1 with W, R, and B to help guide you.

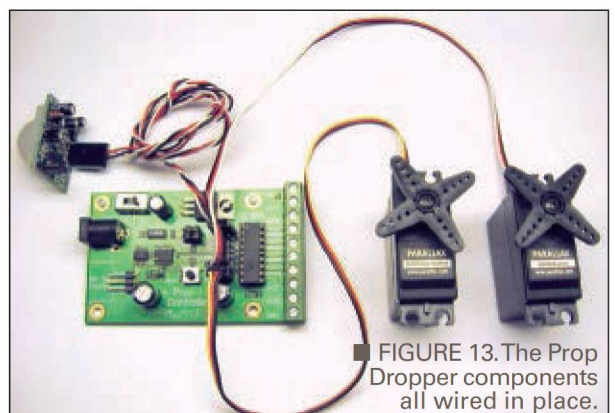
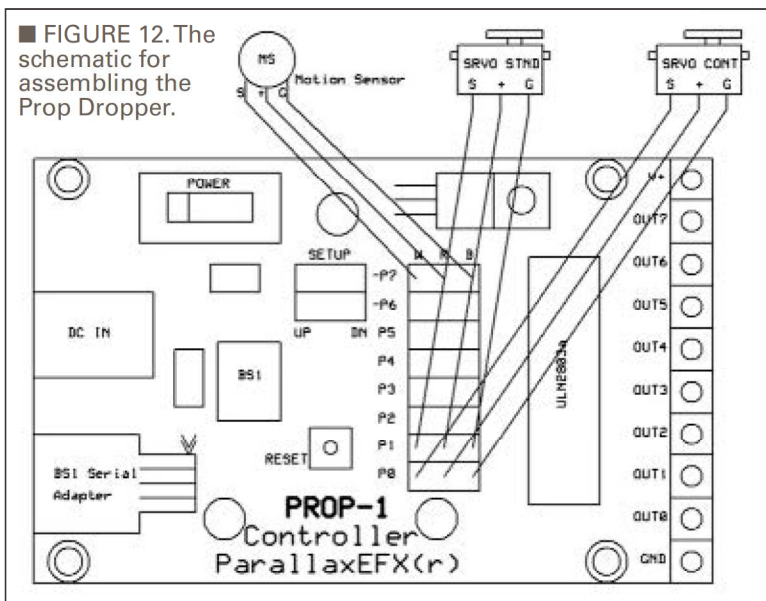
DROPPER CODE

Now that we're all wired up, it's time to get familiar with the software. The basic software used to operate the Prop Dropper consists of a single loop with one decision point in it. The flow chart is shown in Figure 14. Following the flowchart, you can see we begin by waiting in a loop for the input to be triggered. Once a trigger has been detected, we send pulses to the position servo that causes it to move the winch servo to its "pointing down" mode. This causes the string to fall off the end of the wire nut and allows the prop to drop.

Next, we wait a bit while the prop dangles in the air, then send pulses to the position servo to position the winch servo pointing up to the retrieve angle. Once the retrieve angle has been reached, we send pulses to the winch servo to cause it to wind the string back up. The amount of time the winch servo runs is based on the length of the string, i.e., longer string = more wind time. Once the winch servo has retrieved the prop, we then pause for a bit to keep the prop from being prematurely re-triggered immediately after deployment.

DOWNLOADING AND TESTING

You can download the source code for this



■ FIGURE 13. The Prop Dropper components all wired in place.

project from the *Nuts & Volts* website (see resources for link). Once you have the code downloaded, you will need to configure some of the values to match your specific construction. First, you will need to discover the value that causes your winch servo to stop moving. Typically, this is when the pulses sent are at 1.5 ms or center position for the servo. In the source code, this is the line where you set the pulse width value:

```
SYMBOL Hold = 150 ' Value to cause Winch Servo to stop moving
```

If the continuous-rotation servo motor doesn't halt with the default value of 150, you can either choose to change the 150 value slightly to accommodate your specific winch servo or insert a small screwdriver into the small hole in the side of the servo to adjust the servo's stop point.

The next value to look at is the one that controls the winch servo's position. This is the line:

```
SYMBOL Drop = 200 ' Value to move Position Servo to "drop" position
```

You need to change this value until the winch servo is moved to the drop position. On my test setup, a value of 200 was about right. The last value to deal with is the position of the winch servo when it is winding in the string. The line to look for is here:

```
SYMBOL Retrieve = 120 ' Value to move Position Servo to "hoist" position
```

Again, with my test system here, a value of 120 placed the winch servo with a slight upward angle that kept the string snug against the large servo horn. The optimum angle for your rig might be different depending on the type of string you're using, the position at which you are mounting the device, the weight of the prop, and other variables. The best idea is to test it with varying values until you get a consistent reeling of the prop.

The last value you will need to adjust is the amount of time the winch servo spends winding up the string. This is done by varying the value in the line here:

```
FOR cntI=1 TO 640 'Adjust for hoist time (i.e. higher value=longer string)
```

The value of 640 causes my version to run the hoist for approximately 10 seconds. You will need to vary this so the winch runs the appropriate amount of time for the length of the string on your prop and the diameter of the wire nut you use.

In addition to the above values, you can also change the "hold off" value to adjust how long the prop waits between allowed activations. On my rig, I set the value to 12 seconds to allow people to clear out from under the prop before the motion sensor started looking for motion again. The line of source code you need to adjust is shown here:

```
PAUSE 12000 ' hold off a bit before we trigger again
```

Once you've made the changes above, download the

RESOURCES

The Prop Dropper Video
www.youtube.com/VernGraner

The Spider's PreyGround Haunt
Main Page:

www.spiderspreyground.com

Video from 2004:

www.youtube.com/watch?v=ICf6EjPZtNI

Video from 2005:

www.youtube.com/watch?v=xoku6LpYxd4

Complete Kit of Prop Dropper
Parts at the *Nuts & Volts* Store

store.nutsvolts.com

Prop Dropper Source Code
www.nutsvolts.com/index.php?/magazine/downloads

CR P300-120 Audio Board
<http://store.nutsvolts.com/product.php?productid=16885&cat=0&page=1>

EFX-TEK Professional
Prop Electronics
Main Page: www.efx-tek.com
Promo Video:

www.youtube.com/watch?v=7ncaX9QNSrl

source code into the Prop-1 and test the values until you get it dialed in.

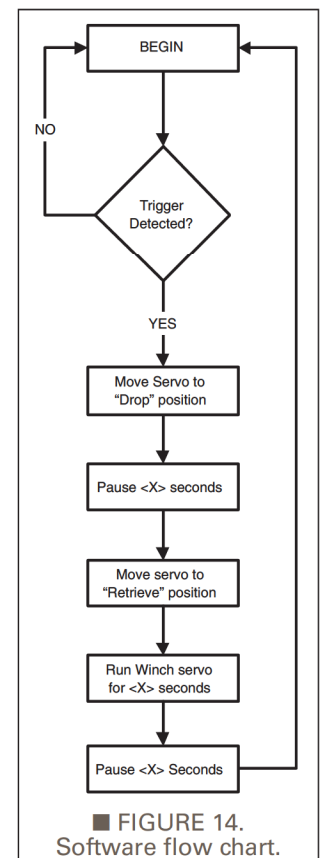
PROJECT CASE IDEAS

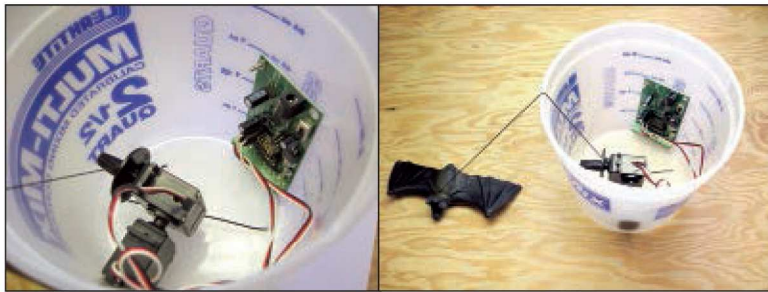
Depending on your intended mount point, it is possible to operate the Prop Dropper "uncased" as I did when testing (Figure 11). However, I found that a small plastic bucket made a very good case for the unit while also providing a place to hide the prop before it is deployed. Check out **Figure 15**. If the bucket is painted black, it will likely disappear into the darkness. I added a length of wire to allow me to hang the bucket from a single attachment point and drilled a hole in the center of the bucket to allow an exit point for both the DC power supply wire and the motion sensor lead (**Figure 16**).

I found it best to attach the motion sensor to a point adjacent to the bucket (not directly on it). I did this for two reasons: first, to make sure that the sensor wouldn't be affected by the swinging of the bucket when the prop deploys; and second, to allow me to aim the motion sensor at a specific location. I also added an (optional) RCA female jack with two wires that I can attach to the P7 trigger input. This allows me to test-deploy the Prop Dropper with an external input like a simple pushbutton.

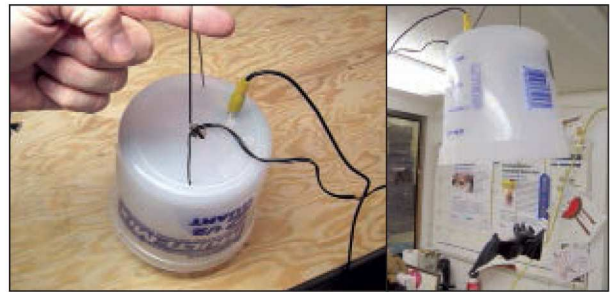
OPTIONAL PILL BOTTLE BUTTON TRIGGER

Though I love the effect of having the unit drop when





■ FIGURE 15 A and B. Prop Dropper servos and Prop-1 board mounted in plastic bucket.



■ FIGURE 16 A and B. Prop Dropper bucket with power lead and suspension wire.

it detects motion (I've even managed to startle myself!), I wanted to experiment with other methods of triggering. If you're wanting to have pin-point control of when things drop, you can use this simple pill bottle button trigger (Figure 17). I found that palm-sized prescription drug bottles with child proof caps make for very good enclosures for a home-brew handheld trigger. The device is created by drilling a hole in the bottom of the pill bottle (Figure 18) and mounting a small pushbutton switch. Though pretty much any pushbutton momentary switch will do, I used a RadioShack CAT #275-1571 model switch (Figure 19). Next, drill a hole in the cap and mount a female RCA jack (Figure 20). By using a female RCA jack on the button and also on the Prop Dropper itself, it's easy to get the right length of cable by simply using any male to male RCA cable you happen to have lying around (Figure 21).

VARIATIONS ON A THEME

At this point, you should have a fully operational Prop Dropper to use for Halloween. However, I want to point out that this little design has quite a bit of hack potential. In the course of developing this device, I came up with a bunch of improvements and modifications, some of which I've already built and tested. As a way to excite your imagination, I've compiled a list of the various ideas I had on how you can alter, update, and re-use the Prop Dropper design:

Use a Different Prop — Though all my examples above show the Prop Dropper being used to drop a Halloween scare, the Prop Dropper could just as easily be used to drop snowflakes, Christmas ornaments, a sprig of mistletoe

(that should get you thinking!), Easter eggs, or even a Birthday card. You don't have to limit the Prop Dropper to the Halloween decorations bin as you can surprise your guests or family with any seasonal or occasional item that the servo motor can hoist. In fact, you could reduce the design to a single servo that held a small paper cup. Fill the cup with confetti and you could have a synchronized confetti drop for a party!

Smaller or Stronger — The first Prop Dropper I constructed used standard servos only because they were what I had handy. It is quite possible to build a much smaller or even much larger Prop Dropper using some of the more powerful or more compact servo motors available on the market.

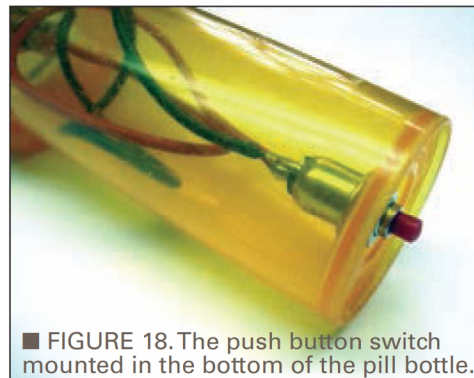
More Droppers = More Fun! — The EFX-TEK Prop-1 can accommodate up to six servo motors along with a motion sensor and still have one I/O pin left over! It is possible to connect six servos and have the software trigger a sequence of drops down a hallway.

Sound Effects — Since the Prop-1 board uses a Parallax BASIC Stamp 1 chip, it is capable of using the SOUND command to create noise. It's possible to add some lines of code to create a siren-like sound or a loud chirp to help draw attention to the prop when it drops.

Pull Up or Sideways! — Using some pulley, or even a couple of cup-hooks, you can place the Prop Dropper on the floor and have it drop "up." This may allow you to drop something from a space that normally wouldn't accommodate the entire mechanism overhead, or allow you to place a scare without the bulk of the Prop Dropper overhead to give it away. Also, consider that if you need the deployment to be soundless, you could move the Prop Dropper to another location and just



■ FIGURE 17. Pill bottle pushbutton trigger.



■ FIGURE 18. The push button switch mounted in the bottom of the pill bottle.



■ FIGURE 19. RadioShack CAT #275-1571 pushbutton switches.

run the line to where it's located.

Synchronized Sound Effects! — You can add a serially controlled sound effect unit such as the CAR P300 Audio Board kit from the *Nuts & Volts* store. This will allow you to trigger just the right sound when your prop drops! Make a scary synchronized scream, play a Happy Birthday tune, play the graduation march, or launch into a Christmas carol to accompany just about any surprise reveal.

Add a Limit Switch — Rather than using the timed retrieve method, it's possible to place a marker or device to indicate that the prop has been completely retrieved. One implementation would be to use a lever switch and a bead on the string. Cut a hole in a Popsicle stick, then run the drop line through the stick. Write a process that continues to loop waiting for the switch closure before it stops winding up the prop. This would allow different string lengths without having to re-program the chip with new winch time values. It would also allow a consistent retrieve distance even if the string stretched a bit with use.

Add a Variable Time Control — By adding a small potentiometer and using the POT command in PBASIC, you should be able to adjust one of the values of the device on-the-fly. For example, you could adjust the amount of time for the hold off or the length of time the prop is left dropped before it's wound back up. By changing some of the hard-coded values to POT created values, you could adjust for line length without having to build a limit switch or adjust how far you prefer the prop to retract after use.

Use RANDOM to Create Variety — Use the RANDOM function to have the Prop Dropper dispense a different surprise on each trigger or to have it set a random hold off value. The random function can be used in various ways to alter the device's deployment to make it less predictable, especially if you're using the motion sensor



■ FIGURE 20. The pill bottle pushbutton switch ready for assembly.



■ FIGURE 21. Female RCA jack mounted on the pill bottle cap ready for connection.

to activate your Prop Dropper.

IN CLOSING

As you can see, with a little imagination the Prop Dropper can become a very fun and useful little gadget to have around. I hope you build one and use it. If you do, please write and let me know how it went. I can be reached at vern@txis.com. **NV**

PARTS LIST FOR THE PROP DROPPER

QTY	DESCRIPTION	MANUFACTURER
1	Prop-1 Controller Board	EFX-TEK 31101 or equiv
1	PIR Motion Sensor	EFX-TEK 555-28027 or equiv
1	4" Extension Cable	EFX-TEK 805-00035 or equiv
1	Continuous-Motion Servo	Parallax 900-00008 or equiv
1	Futaba 3004 Standard Servo	SparkFun ROB-09064 or equiv
1	Wirenut	Home Depot 30-072 or equiv
1	Prop to drop	Oriental Trading IN-25/1258

The Prop Dropper now in KIT FORM!

Due to some fancy footwork from the folks at EFX-TEK and the good folks over at the *Nuts & Volts* Store, you can get a complete kit of parts to make your very own Prop Dropper. This is great if your junk box is a little light on parts or if you don't have the time to scrounge around for stuff. The Prop Dropper kit includes both a continuous-rotation and a standard servo, as well as the Prop-1 unit from EFX-TEK. All you need to do is spend a bit of time assembling it with a hotmelt glue gun and you should be ready to go! The Prop Dropper kit is a fantastic foundation for more experimentation in special effects.

A kit can be purchased online from the *Nuts & Volts* Webstore www.nutsvolts.com or call our order desk at 800-783-4624.

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- Make Music on a piezo element
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- Optically isolate voltages
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