Building Robots with Lo-tech Materials

1

By Andrew Fisher

When you think about robots, you probably imagine drones, self-driving cars, or humanoid robots like Atlas or Asimo. Many of these more serious robots start their costs at thousands of dollars, and there is no real upper limit (Atlas costs over a $1M, for example). It is possible, however, to build small, interesting robots with a few inexpensive electronic components coupled with some materials you can readily find at home.

One of the great things about NodeBots is being able to prototype rapidly. The combination of an approachable language like JavaScript with friendly hardware such as Arduino means you can explore ideas and see how things work. Being able to prototype and play with robotic techniques quickly helps with learning and exploring concepts.

In this chapter, we'll explore several robotic concepts using a basic robot called the SimpleBot (Figure 1-1). The first design of the SimpleBot came as the result of a challenge from my child, who asked to build a robot together one evening after dinner. With the clock ticking and only an hour to work before bedtime, it meant using things we had on hand—no laser cutters, CNC mills, or 3D printers. In true hacker spirit, we fabricated using cardboard, cable ties, and rubber bands to get something that worked.

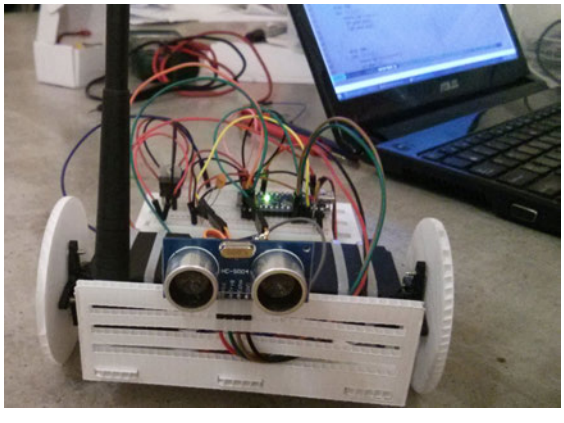

Figure 1-1 *Completed SimpleBot*

Figure 1-2 shows the SimpleBot we made that night. After building it, we fell in love with prototyping using materials such as cardboard, cable ties, and more recently, corflute (corrugated plastic board) for robotics. These materials are inexpensive and easy to work with using scissors or a good craft knife. You don't have to have access to tools such as a laser cutter, though if you do, then you can still work with

these materials—it just becomes even faster to cut things out (and a bit more accurate). Working with these materials allows you to fabricate on your kitchen table and kids can easily work with them, too.

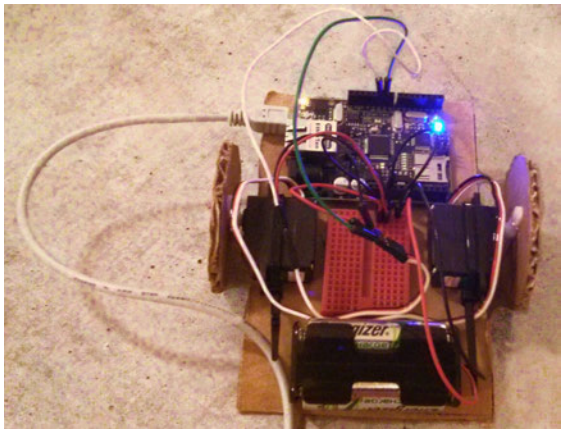

Figure 1-2 *The very first SimpleBot*

After that first effort, the SimpleBot has gone through numerous revisions and is now used as a teaching robot for some NodeBot events. I hope I've convinced you that building robots out of simple materials such as cardboard is a good idea. This chapter is going to cover:

- Building the basic SimpleBot platform
- Cutting the cord and untethering our SimpleBot from our computer

Building the SimpleBot

Before you get building, remember there's no right or wrong way to build your SimpleBot. The design of the SimpleBot was intentionally left open-ended so you can make it any way you want. Others have built versions as minimal as possible on one extreme, as well as automated Nerf-Gun-Toting platforms on the other. The point of the SimpleBot is to play, explore, and extend it, to further your understanding of robotics—so customize away.

Bill of Materials

The SimpleBot project is divided into two parts with components needed at each stage. All of the components for this chapter are listed in Table 1-1, and then the elements needed for each stage are listed again when you get to that point in the chapter. Table 1-2 lists the parts needed for the wireless version.

Table 1-1 *SimpleBot materials*

Count	Part	Estimated price	Part numbers/source
1	Arduino Uno - R3	$24.95	MS MKSP99; AF 50; SF DEV-11021
1	Half-sized breadboard	$5	MS MKKN2, SF PRT-12002, AF 64
Multi	Jumper wires (male to male)	$4.95	MS MKSEEED3, SF PRT-11026, AF 758
Multi	Jumper wires (male to female)	$5	MS MKKN5, SF PRT-09385, AF 825

Count	Part	Estimated price	Part numbers/source
2	Continuous rotation (CR) servos; if you have standard servos, an Adafruit tutorial shows how to mod them into CR servos	$14	MS MKPX18, AF 154, SF ROB-09347
15	Cable ties (3–4mm wide and about 200mm long is perfect)	$1	Various suppliers/stores
1	7.4v RC battery pack (LiPo, Li-Ion, or whatever you can get a hold of)	$5	Old or broken RC toys are good sources of these
1	LM7806 or NTE962 6V voltage regulator (drops the voltage to something the servos can use)	$2	RadioShack or Amazon
1	Chassis material—a square of thick cardboard or corflute (3–5mm thick), approximately 400mm square	$2	Various suppliers/stores
1	A printout of the template file	Free	Included with source code

Table 1-2 *Wireless SimpleBot materials*

Count	Part	Notes	Estimated price
4x	50V 0.1uF ceramic capacitors	Ceramic is best, but others will work	$0.50
1x	USR WiFi232-T module	*http://www.usr.so*	$15

Build Steps

1. Start by cutting out the template on your cardboard. It doesn't need to be perfect. A knife, a cutting mat, and a ruler make it easier to do the inside holes than scissors. With the wheels, the center hole can be cut out or just left, it's only a target so you know where the center is so you can screw through it to the servo.

   You should now have a full set of chassis pieces. The large piece with the bumps at the end is the base, and the bumps are the front. Use the bumps to push through the small holes on the smaller rectangle, which you can use as a bumper to mount things on.

2. Next, mount the wheels to the servo. Take the cross-shaped servo horn (you should have a packet of different shaped plastic fittings with your servo) and align the center with the center of the wheel. You can use a piece of wire or a needle to poke small holes in your material to mark the points to screw (Figure 1-3).

   Screw the wheels securely to the servo horn. If you prefer, just glue them on (but then you can't reuse the servo horns later)—either way works fine.

Once you have the wheels mounted on the servo horns, screw through the center of the wheel and the horn into the small gear on the servo. Go easy and hold everything in place while you turn the screwdriver; being rough here can strip the gears in your servo and cause them to slip. Do this for both servos so you now have two wheels.

Figure 1-3 *Mark screw points using the servo horn and a piece of wire*

Gently rotate the servo to ensure it turns freely. If you're using cardboard or corflute, your mounting screws may be a little long. They don't have to go all the way through, but make sure they clear the body of the servo when you turn them.

3. Next, mount the servos to the chassis, as shown in Figure 1-4. You want to place these more or less to the front so the weight balances. You can put them anywhere, but bear in mind you may need to weigh down one end if you find it's tipping. Mount the servos so the side with the wheel is closest to the front of the chassis, and attach them with two cable ties through the mounting holes to keep them in place. Use two cable ties so the servo body doesn't twist when you start driving.

When you attach the cable ties, only tighten them enough to stop movement, but not so tight as to rip the cardboard or corflute.

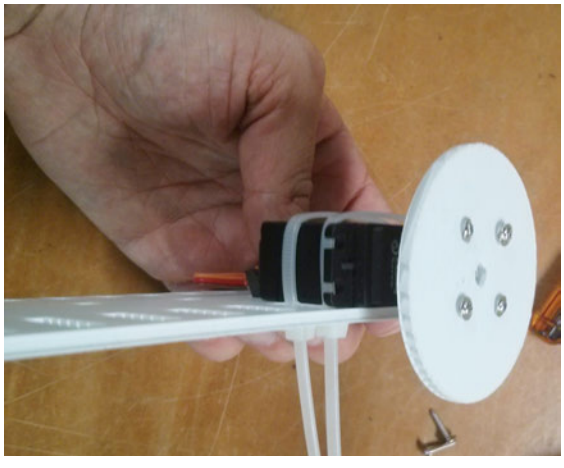

Figure 1-4 *Servo mounted to the chassis*

4. Mount the battery between the wheels as in Figure 1-5. Again, you can use a cable tie, but double-sided tape or a bit of Blu-Tack works well here, too, if you want to recharge easily. Trim the cable tie excess off as you go or it gets a little hard to mount everything.

5. Next, fashion a simple "skid" for the SimpleBot to stay balanced. You can do this by looping a cable tie toward the back of the SimpleBot in the middle of the chassis. Do this from the top so the catch of the tie doesn't get caught on anything. The underside of the loop should be about the same height as half the wheel so the body sits level. It will feel "loose," but don't worry, you secure this with the breadboard in the next step.

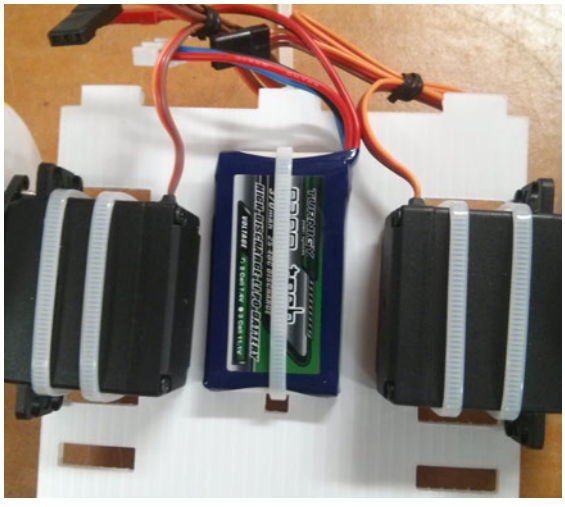

Figure 1-5 *Battery mounted to the chassis*

6. Finally, add the breadboard. Mount this across the point you put the skid cable tie so the board holds the skid down. The cable tie can go down the length of the board where the channel is and you can still place ICs across it.

   Now that you've finished the mechanics, it's time for the electronics. The complete wiring diagram is shown in Figure 1-6, with each piece explained next.

7. Start by creating a battery power rail. This goes to the back of the breadboard and gives you at least 7.4V. Join the grounds on both sides of the breadboard together. Mount the Arduino Nano at one end and join its ground. As you can see with the Nano, position it to either side of the main channel, over the cable tie, and position the USB connection on one side so it's easy to plug in, as shown in Figure 1-7.

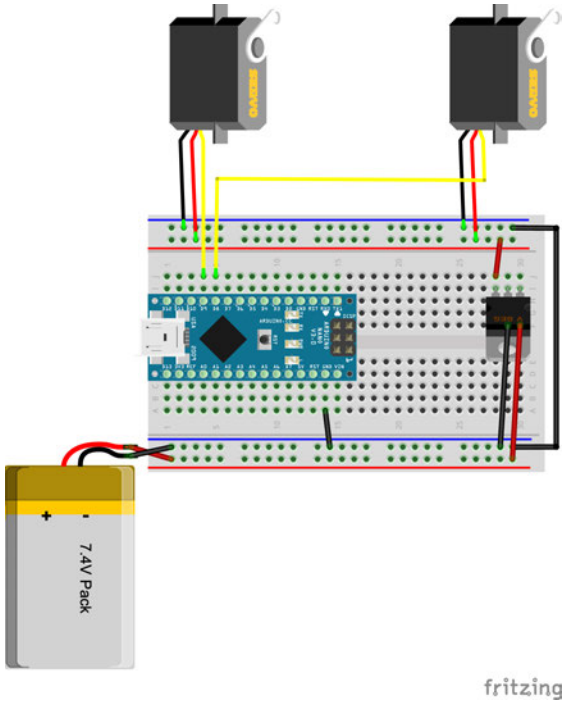

Figure 1-6 *SimpleBot wiring diagram*

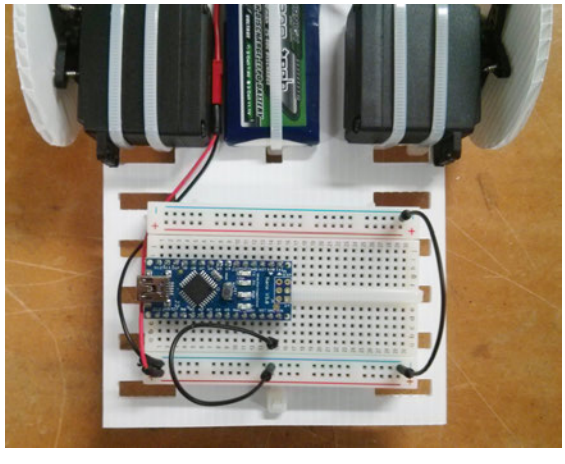

Figure 1-7 *Distributing power*

8. Now create the power for the servos. The servos want 6V so the battery will give them a bit too much, so use a +6V voltage regulator to output a nice clean 6V for the servos. Put that 6V on the other rail of the breadboard so you can attach the servos there.