Here are the parts list for the Robot Car (more will be added in Chapter 14):

1. Tiva Launchpad (TM4C)
2. 7805 Voltage regulator to lower 8.4V battery source down to 5V to power the Launchpad (connected to the VBus input)
3. Motor connectors - These can be substituted with any wire connectors.
4. TIP120s - A transistor used as a switch for high-current loads (http://itp.nyu.edu/physcomp/Tutorials/HighCurrentLoads (http://itp.nyu.edu/physcomp/Tutorials/HighCurrentLoads)). It has three connectors, the *base*, the *collector* and the *emitter*.
5. Two diodes (IN914) connect in parallel with the motor. This will prevent large voltages that can occur when switching current across an inductor. Without these diodes hundreds of volts can develop across the motors, which will zap your microcontroller.
6. Two DC geared motors, HN-GH12-1640Y,GH35GMB-R, Jameco Part no. 164786, 0.23in or 6 mm shaft (get hubs to match)
7. Two motor mounts 1-1/4 in. PVC Conduit Clamps Model # E977GC-CTN Store SKU # 178931 www.homedepot.com
8) some way to attach the LaunchPad (I used an Erector set, but you could use rubber bands)
9) Two wheels and two hubs to match the diameter of the motor shaft
- Shepherd 1-1/4 in. Caster Rubber Wheel Model # 9487 www.homedepot.com
- Two 6mm hubs Dave's Hubs
- 6mm Hub Set of Two Part# 0-DWH6MM www.robotmarketplace.com
- Two 3-Inch Diameter Treaded Lite Flite Wheels 2pk Part# 0-DAV5730 www.robotmarketplace.com
10) Battery - 8.4V NiMH or 11.1V LiIon. I bought the 8.4V NiMH batteries you see in the video as surplus a long time ago. I teach a real-time OS class where students write an OS then deploy it on a robot. I have a big pile of these 8.4V batteries, so I used a couple for the two robots in this class. NiMH are easier to charge, but I suggest Li-Ion because they store more energy/weight. For my medical instruments, I use a lot of Tenergy 31003 (7.4V) and Tenergy 31012 (11.1V) (internet search for the best price). You will need a Li-Ion charger. I have used both of these Tenergy TLP-4000 and Tenergy TB6B chargers.
.

Connect the battery to one end of the motor, and connect the other end of the motor to the *Collector* of the TIP120. The *Emitter* of the TIP120 is connected to ground. The *Base* of the TIP120 is connected to the Launchpad output pin that controls the motor (repeat this for both wheels). I like to place a 1k resistor between the microcontroller output and the base. This resistor controls the maximum current that can flow from collector to emitter. The microcontroller pin is the one on which we generate a PWM signal whose duty-cycle we manage to control the speed of the motor.

The key is the make sure the large currents needed by the dc motors are not supplied by the microcontoller but by the external circuitry. Furthermore, the current should flow from battery, across the motor, through the TIP120 from

collector to emitter, and back to the battery (without flowing through the LaunchPad).

VIDEO 12.4DPRE: BUILDING A ROBOT CAR

C12 4d pre Building of robot car YouTube

DR. JONATHAN VALVANO: Let's build the robot circuit.

Here are male-male pins so we can later attach the LaunchPad.

Next, we'll build a regulator with a 7805.

Which will convert 8 volts from the battery to 5 volts for the LaunchPad.

We'll use this connector here to attach the motors.

We'll build two motor driver circuits with

0:28 / 0:28 1.0x

TESTING WITH THE OSCILLOSCOPE

C12 4d Waveforms YouTube

DR. JONATHAN VALVANO: Next we're going to test the robot car.

Similar to a logic analyzer, an oscilloscope

is a non-intrusive hardware debugging instrument

that allows us to observe signals in their amplitude versus time behavior.

I have connected up to channel 0 one end of the motor.

So we see when the motor, power is applied.

1:23 / 1:23 1.0x

On channel two we have the output of the microcontroller, which

is the PWM, or Pulse Width Modulated Signal here at 10%.

So over here we've got a measurement going, 10%,

and now we're going to push some buttons.

And now we're going to 20%.

You see the motor has started.

30%.

Faster.

40%.

50%.

60%.

70%.

80%.

90%.

Help

VIDEO 4E: DEMO OF THE ROBOT CAR

C12 4e Robot Car YouTube

	1:29 / 1:29	**1.0x**			

DR. JONATHAN VALVANO: This is the robot car with two DC motors--

DR. RAMESH YERRABALLI: Operated by these two switches.

The switch-- one will reduce the speed, the other will increase the speed.

DR. JONATHAN VALVANO: Let's go faster.

Here we go.

DR. RAMESH YERRABALLI: So this is a high duty

cycle, which you already know about.

And we'll see whether the car--

DR. JONATHAN VALVANO: Let's go.

DR. RAMESH YERRABALLI: --moves fast.

So here's the car moving really fast.

Good catch.

Let's see what's the maximum speed we can operate it at.

DR. JONATHAN VALVANO: Yeah, faster!

Do it again.

Come on, let's go!

[LAUGHTER]

DR. RAMESH YERRABALLI: And you could operate it at a low speed.

This is a 10% duty cycle.

DR. JONATHAN VALVANO: Car won't move.

DR. RAMESH YERRABALLI: Not enough umph.

This is a joyride.

DR. JONATHAN VALVANO: I think it needs sensors to tell where it's going.

Don't you?

Help

Later in Chapter 14, we will use the analog to digital converter (ADC) to interface sensors to this car. Using the sensors we will develop a control system that drives this robot down the middle of a road.