Adding a motorised base Part 1

DIFFICULTY: ADVANCED

So far we have focused on controlling the robot arm part of this project.

The robot arm is a very exciting piece of kit with lots of possibilities, but I would also like to cover another area that could open up the field of robotics to a lot of people, particularly if you are working on a modest budget and can’t quite get your hands on one of these yet.

Getting Around

Any robot needs a way to move around. In most cases robots use motorized platforms, but there are a few notable exceptions to this.

In the first part of this article I’m going to devote some space to the different types of “mechanical platforms” that are out there.

I am also going to have a look at some ideas for “do it yourself” and finally I will explain my own solution to this mechanical platform issue.

Let’s begin by looking at nature. There are insects with multiple legs, mammals with four legs (or two) and then there are snakes which don’t have any legs at all! There have been some wonderful developments in the field of robotics which incorporate all of these forms of locomotion.

There are now even swimming robots that hang out with real fish to hunt and identify the bad guys who pollute our oceans!

For the most part, the technology that is used to make these kinds of robots work is prohibitively expensive for the amateur enthusiast, not to mention excruciatingly complicated and almost certainly out of range of those of you who might be considering making a robot on a pocket money budget.

The alternative is to build a motorized platform with some sort of wheels. This instantly brings a robot back down to earth in terms of price and the level of difficulty. The first thing to consider here is – what sort of platform?

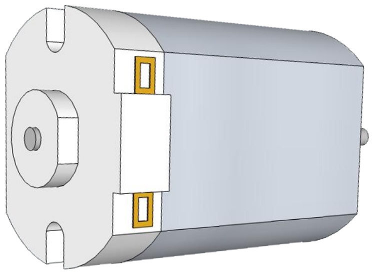
There are basically two options. The first is a “differential” platform which works in a similar way to a tank. You have a motor on each side of the robot that’s attached via some gears to a wheel.

When the wheels are turning in the same direction, the robot will move in that direction. If the wheels rotate in different directions then the robot will turn.

The second option is to use “car” steering, where one motor drives the robot forwards or backwards and a second method, such as a servo, is used to change the angle of the front wheels and thus to steer it. Out of these two methods, the differential platform has the advantage in that it can perform turns in much tighter spaces than the car steering method.

Types of motors

Another consideration is the type of motor that could be used. The simplest and cheapest option is to use a DC motor.



This uses a single coil (containing thousands of turns) of wire attached to the motor shaft, called a “commutator” and two opposing magnets. Applying an electric current to the coil creates an electromagnetic field. The poles of this field are attracted to the opposing fields of the magnets and this makes the shaft move half a turn until the opposing poles are as close to each other as they can get. At this point it switches the commutator and reverses the polarity of the electromagnetic field. The coil is then repeled away from the magnetic poles it was just attracted to, moves the rest of the way around to the opposing fields and the cycle begins again. More power makes it go faster (up to a point, and then it burns out or blows up!). Reversing the current makes the motor run in reverse. This is nice and simple but the drawback is that it is next to impossible to make the DC motor move by an exact amount.

Another option is to use something called a stepper motor. Instead of having a single coil and a commutator, a stepper motor has many coils and a magnet. Each one must be switched on and off in sequence in order to move. This means the motor turns in many tiny little ‘jerks’. You can specify with extraordinary accuracy how far to move a stepper motor but the disadvantages are that they are much more complicated to control and have much less torque (rotational force) than a DC motor.

Whichever motor option you decide to use, it is unlikely that you will simply be able to connect some wheels to it and ‘hey presto’ off you go. The motor will either be too fast or have insufficient torque or “horsepower”. In order to make it useful we will need to use a system of gears or pulleys. For example, a motor that revolves at 10,000 rotations per minute will be rather fast, to say the least. What's more, attaching this directly to any robot with anything more than the tiniest weight and it will be too weak to budge it.

A more sensible (but still nippy) speed might be in the order of 2,500 RPM. In order to achieve this we would need to use gears (or “cogwheels”) with a ratio of 1 to 4. In that way the speed is reduced by a factor of 4 and the torque is increased by the same amount. That means that the gear attached to the motor needs to be four times bigger than the one attached to the wheel. You can achieve the same result by using a combination of smaller gears. Nevertheless this adds another level of complexity to our project.

It is possible to buy electric motors with prefabricated gear assemblies that are specifically made for the robot and hobby market. These have the advantage that a wheel can be directly connected to the axle on the motor, without having to worry about making your own gear assembly. The disadvantage is that they are comparatively expensive, often in the order of £10 or more for a single unit.

Acquiring a motor

You might be reading this and be starting to feel a little bit daunted at the complexity and cost of embarking on a project like this, but don’t worry. I'm going to tell you about another method you can use to make a motorised robot platform. You can cheat!

There are countless reasonably priced motorised toys on the market which, with just a little bit of hacking and bodging that, you can make into a robot platform that can compete with some of the best. Even better is that you don’t even have to pay full price for something like this.

In almost every country in the world there are “car boot sales” or “yard sales” or such like where, with just a little luck and some good hunting, you have a good chance of being able to find a suitable toy which can be converted into a platform – it is likely that such a toy will use DC motors and you have a greater chance of finding a toy that uses car steering instead of a differential but these sales hold some real gems for the resourceful amateur robot builder.

I have used this cheating method for my own skutter robot. I obtained a Big Trak toy, which you can buy new for about £20 (it's not unlikely that you might find one of these in a car boot sale too, if you are lucky).

To help show you how you can adapt toys into robotic bases I'm going to describe to you how I adapted this Big Trak for my Skutter.

Adding a Big Trak platform

1. Removing the bumper
First disassemble the Big Trak. Most of the screws are easy to access. However one is hidden behind a grey plastic bumper on the rear.

To get to this screw, first unscrew all others to allow Big Trak to be prized open just enough to allow the bumper to be unclipped from inside.

2. Removing the keypad
After removing the lid, unclip all accessories such as the plastic turret etc. Some will be stiff but eventually came off with a bit of patient wiggling.

The keypad and ribbon cable to the electronics beneath prevents the lid being removed. This keypad is glued in place and can be peeled off easily to allow complete removal of lid.

Snip off the wires that are attached to the motors. Solder two double core “bell wire” type cables to each + and – terminal on the two motors.

4. Test the motors
Now test that the motors work. A standard D cell 1.5v torch battery will suffice to see the base trundle forward, reverse and turn depending on how the two wires are held to the battery terminals. In a nutshell that’s it! A fantastic motorized platform for a robot.

To control the motors some reasonably simple electronics are required so that the GPIO on a Raspberry Pi can instruct them to move. (A stern word of warning – do not under any circumstances electrically connect a motor directly to any part of a Raspberry Pi, doing so will certainly cause it to try to handle too much power and will, putting it bluntly, kill it. I will deal with the electronics to safely interface the motors with the GPIO header in another article)

5. Mounting the robot arm
Further adaptions to the Big Trak are required to mount the robot arm inside. The

hole for the “turret” on the Big Trak is almost in the perfect location and size to allow the base of the arm to sit inside with the “shoulder” protruding through.

For complete perfection, score around the edge of the hole with a stanley knife or similar and then use a pair of wire snippers to cut out and break off sections of the lip around the turret hole.

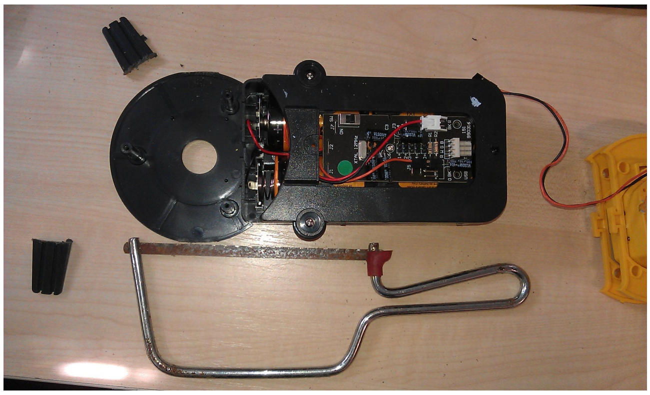
Use a file to smooth the rough edges or sandpaper, or even the side of a box of matches.

A little more work on the Big Trak body is needed to enable the base of the arm to fit inside.

Use the wire snippers to cut away the plastic loudspeaker mounting on the bottom of the Big Trak.

6. Fitting the arm
Finally, a modification to the robot arm base is required, remove the stabilizers from the base of the arm with a hacksaw. (I don’t think the arm really needs these anyway).

The robot arm base should now be quite a good fit inside the Big Trak.



Some extra work is still needed to make sure the arm will be stable. At the moment for building and testing I am just using tape and rubber bands but in due course I will use something stronger to secure it.

I may go with duck tape for this. Gaffer tape is a favourite “bodging tool” of mine because it is strong but allows you to easily remove it if needed, however there are numerous other methods that you could use with a bit of lateral thinking.

The final product as you can see is a finished skutter body.