VersaBot *Junior*: A step-by-step guide to building a versatile modular mobile robot – Part 1.

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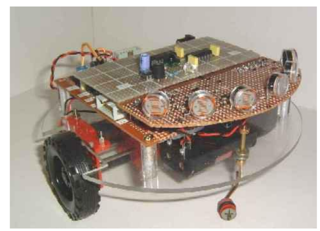
Thoughts on design

Firstly, VersaBot Junior is not a toy. Like its more powerful brother VersaBot, it is designed so that all age groups from primary school children to university research students can use it to further their interests in robotics, or electronics, or mechatronics, or artificial intelligence, or even synthetic psychology. Junior is a simplified version of the original, based on a PIC microcontroller to make home construction possible. The need to satisfy as many interests as possible has led to a design with the following features:



- Robust construction. If it is to survive several years of abuse at the hands of students it will need to reasonably tough, but have readily replaceable parts should the worst happen. The prototype uses a disc of 3mm Perspex (3mm aluminium could also be used) as its main platform for mounting electronics and motor-gearboxes.
- A good turn of speed on a flat surface, but able to supply high torque at low speed for rough terrain work. This meant using high-torque motors and providing feedback sensors so that a velocity control loop could be implemented.
- Able to perform complex processing of data from multiple sensors quickly. A fast microcontroller with built-in features such as analogue to digital conversion and as many input/output ports as possible is called for.
- It must be 'sensor rich'. That is to say it must be possible to attach many sensors at one time. This is where the modularity comes in. There are three expansion board 'stations': front, top and rear. The main processor board contains the microcontroller chip, power supply regulators, a comparitor chip, an oscillator for the IR link and an interface to other VersaBots that may be chained together. Most sensor boards will plug in to the front sockets and IR communications, optional keypads, pen-holders and even a core drill fit on top.

- Able to be controlled/programmed from a PC. An InfraRed and eventually a Bluetooth wireless link will be available.
- Simple power requirements. VersaBot Junior runs on a single pack of four AA-size rechargeable batteries. A charger socket is provided on the main board.

With these ideas mind let's look at some hardware and the first steps in building the chassis and mechanical assemblies.

Components for the main chassis

The chassis or baseplate can be cut from a piece of 3mm Perspex or aluminium.

For each box you will need the following:
1 x 920D multiratio gearbox kit from Como Drills http://www.comodrills.com/ . I replaced the motor with another having a higher voltage rating and longer shaft (see next).

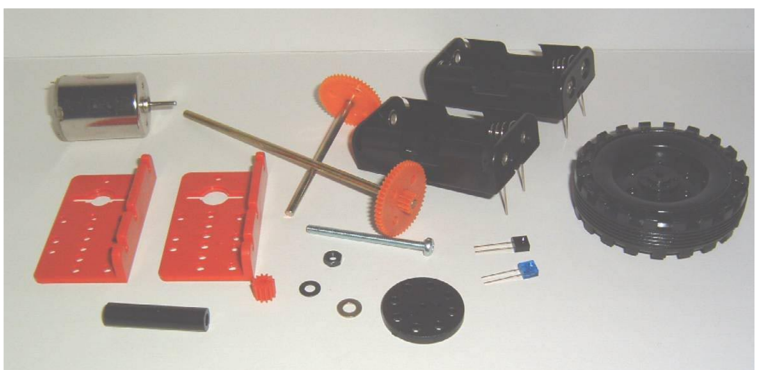
1 x 23013-1 High Torque motor from Commotion http://www.commotiongroup.com/technology.htm Commotion will also supply the gearbox, but with small motors fitted. Using this kit will involve enlarging a hole and finding longer spacers and bolts. The High Torque motor is more suited to the supply voltage used, has a lower speed and takes less than half the current off load than the motor supplied with the 920D kit.

1 x 8-hole tachometer wheel. You can make this yourself or Swallow Systems will sell you a pair. http://www.swallow.co.uk/

1 x IR LED/phototransistor pair. I used the TCZT8012 obtainable from Farnell. http://uk1.farnell.com

1 x 56mm diameter road wheel, part no. 917D2509 from Como Drills.

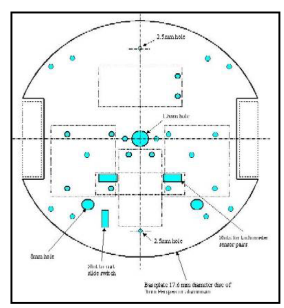
1 x 0.1µF dipped ceramic capacitor for interference suppression on each motor.



Other parts:

2 x AA battery holders. Loads of people sell these, but I got mine from Rapid Electronics with part no. 18-2965. These have connector wires that project through the baseplate and are soldered directly to the processor board on top. http://www.rapidelectronics.co.uk/ . Rapid also sell the motors, gearboxes and wheels.

The Chassis Baseplate



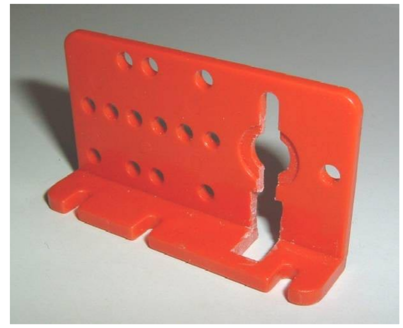
I made mine out of a disk of 3mm Perspex, but aluminium would do just as well. Go to the VersaBot Support section of my website at: http://www.wgmarshall.freeserve.co.uk/ .

1. Download and print the pdf file VBJBase. This contains a full size template with all the holes marked. Before drilling the gearbox mounting holes, check your assembled gearboxes against the template to check for any discrepancies.

Making the Gearboxes

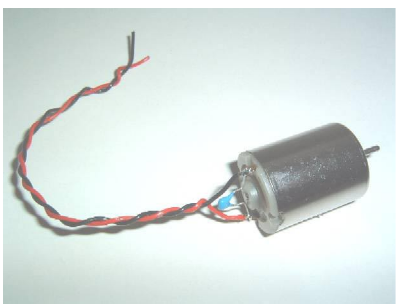
2. Before assembling the gearboxes, a slot must be cut in one bracket (the one at the shaft end of the motor) on each side to clear the tachometer sensors (See picture). This allows the flat, side-looking

LED and phototransistors to be fed through the baseplate and located either side of the tachometer wheel. The slot is just slightly wider than the sensor cases. Fit the motor and the tachometer wheel temporarily and check that the lens of say, the LED, can be located right behind the ring of holes in the wheel and 'looks through' them. These sensors are about the same thickness as the bracket wall, so one of them sits snugly with its back to the motor and the tacho wheel just in front.



3. Solder a 0.1µF capacitor across the motor terminals and attach say 15cm of insulated stranded wire to each. The capacitor should be mounted so that it will go through the slot on the rear bracket. Further capacitors between each terminal and the motor case may be necessary. Should these need to be fitted don't forget to attach a wire from the motor case to the '–' terminal of the battery pack as well.

4. Assemble the gearboxes as shown in the picture. Note the orientation of the bracket feet and that only one screw and spacer is used. The tacho wheel should be pushed on to the motor shaft first so that it just spins clear of the bracket, followed by the small pinion gear. Cut an axle down to 47mm and push on orange intermediate gear. Slide on the short brass spacer tube and then slide the axle into the gearbox so the gear meshes with the motor pinion. There is nothing to stop this intermediate shaft from sliding back until the road wheel axle and gear is fitted. Cut another axle down to 72mm, and force on another orange gear wheel. Slide the longer brass spacer tube on to this axle and fit to the gearbox so the large gear meshes with the intermediate pinion. The axle is retained by a plastic push-on collar supplied with the kit. You now have a gearbox with a total speed reduction of 16 to 1.



5. Fix the gearboxes to the baseplate with M3 pan-head machine screws and nuts making sure the screw heads don't foul the gears. The new slot in the gearbox bracket should line up with the corresponding slot in the baseplate. The tacho sensor pairs will be soldered to a single piece of stripboard which is held in position by two of the gearbox mounting screws. I'll cover that and how to make the castors in part 2.