pico
imu
openservo


## pico: Quite possibly the world's smallest robot.*

*Autonomous (free-roaming), self-powered, sensing, moving, parks on a dime.

9/10/2007
Kits are not likely to be available anytime soon. Important parts have been discontinued. Thanks for the interest.

5/12/2007
Added basic code.

4/22/2007
Added schematic under hardware design

4/4/2007
created by zac wheeler

I know, the claim gets bounced around a lot. I honestly believe it's the case here.

view other dimensions (with measurements)

**Quick stats:**

0.5 inch / 12.5 mm on a side
0.125 cubic inch / 2 cc volume
15 minute run time

0.5 f/s / 0.15 m/s maximum speed
Microcontroller
Infrared sensing

**Video:**

These are just its first steps - as you can see the sensors don't stop it before it leaves the table. I apologize in advance for the Pabst, but I needed a can to go with the AA.

**Overview:**

This robot has been in the works for a while. I was inspired to start trying when Sandia Labs released a video in 2003 showing the small robots they had created. Given the pace of technology, it was only a matter of time before someone put the pieces together and one-upped Sandia National Labs. I'd love to see how quickly pico might be displaced as champion if they dedicated some funding to restart the project, though. This bot has greatly improved sensing over the older Sandia bots, including infrared sensors to detect whether it is on the ground, and even perform obstacle detection or follow a line.

Pico qualifies as the smallest in its category in spite of the existence of a 1 cc class in some Japanese robot competitions because to my knowledge (to date), none of those robots have contained their own power source, and many of them don't even contain any circuitry.

Some people have also pointed out a cool little nano-tech inch-worm from Dartmouth that moves along a mesh of wires. Do I even have to defend pico's place here? "...it reacts to electric changes in the grid of electrodes it moves on. This grid also supplies the microrobot with the power needed to make these movements." While I'm impressed with the (incredibly) micro-bot, it still can't carry around its own juice. I can't compete at a nano-level, so here's hoping they don't make a battery soon that can strap to its back.

pico has great potential as a small robotic platform, and by relaxing the size constraints a little, a lot of technology could be added including wireless communication via ZigBee, a camera, GPS, and a host of other sensors.

**Back Story:**

I initially started trying to build this 'bot in 2004, but the tech just wasn't there. I even went so far as to have PCBs made (and they mostly worked). The missing link was the battery. The current capacity just wasn't there in a form factor that would work. I didn't have access to smoovy motors or any expensive equipment. Li-Poly batteries were reasonably new to the scene, and while small cells were available such as those from Kokam, they sure didn't fit.

I also didn't (and still don't) have a lot of machine shop ability. That hurt me more when I was less creative with my

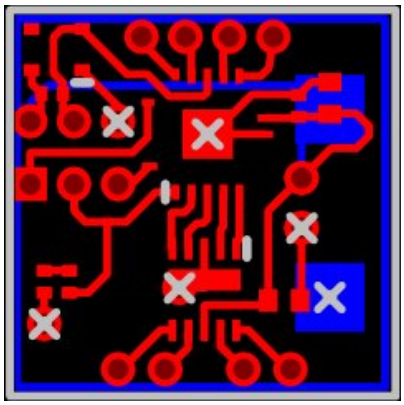
material sources and more reliant on my manual dexterity.

**Design Revitalized:**

This winter the inspiration hit me again and I gave it another shot. After looking around for a bit, I realized that tiny 10mAh batteries with high current draw are stocked thanks to the indoor flier RC crowd. Actually, a lot of the tech I used is only easily available because the room fliers blazed the way. Even very thin PCBs are more commonly available to hobbyists because of their popularity with the RC crowd for weight-saving. I needed them because I couldn't afford to waste a millimeter.

Schematic

So with the batteries in hand I redesigned the board and had it made on a 0.5mm laminate:



Some of the goofy routing is due to the large minimum via size of .024" that the manufacturer was limited to.

**Main Board Parts:**
Atmel ATtiny44 microcontroller
Allegro A3901 stepper motor driver
Yellow LED
Analog ADM6713 battery monitor/reset supervisor
Some caps and resistors

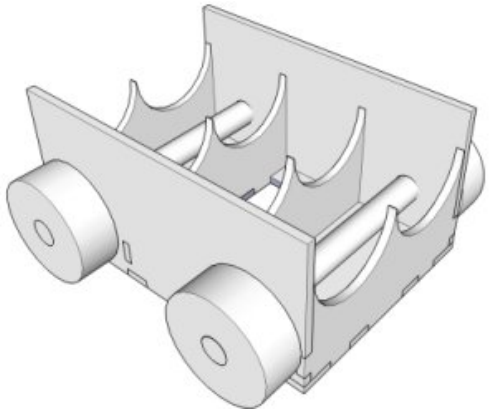
And then the sensor board:

**Sensor Board Parts:**
Two infrared Sharp GP2S60 sensors
Some resistors

The sensor board fits between the two axles and has a good view of the ground. You can also fit one on each side above the wheels but below the main board. I haven't tested them in the side-viewing configuration yet.

**Mechanical:**

At that point I started in on the mechanical "design" if you want to call it that. As I said, there is no rocket science going on here. Simple circuits, simple mechanics, just really small by hobbyist standards.



The mechanical design is straightforward. The gear train is a mechanical beginner's mistake consisting of a motor-mounted worm gear driving a thin-cut pinion gear on the axle for a 9:1 reduction. There is currently no thrust support for the worm gear so it will likely pull the shaft right out of the motors sometime soon. For the moment it works well, and the gear reduction combined with some torquey motors are more than enough for the 'bot to get out of its own way.

I initially planned to have pico treaded like the Sandia design, but the friction from the treads' tension (orthodontic rubber bands - 5/16" light) was too much for my carbon-on-plastic sort-of-bearing. It still moved, but the motors had to work much harder than they should. It now runs on some rubber bands I shortened that wrap around the wheels. Each side has a driven wheel and an idling wheel. The driven wheel is a seized ball bearing (it's easy with super glue!) while the idling wheel is a ball bearing that hasn't been filled with adhesive. The flanges to hold the tread on are also laser-cut plastic.

**Power:**
Full River 10mAh Li-Poly (squished)

**Mechanical:**
Two Didel MK04S-24 motors
Didel 0.3 module gears
Ball bearings
Carbon tubes

Laser-cut plastic chassis (**thanks Jason @ FannoCreek Designs!**)

### The Code:

You can download the code which is written for avr-gcc. It is pretty simple it its first revision.

### The Name:

The name for this bot is derived from the fact that this bot would qualify for (and may become responsible for the creation of) the Pico class of Sumo Robots, which up until this point has been talked about but never realized.

### The Future:

Shicoh has some 3.2mm diameter pager motors available. There is talk of a 5 mAh Li-Poly in the works too. Nowhere near femto (yet), but these smaller parts would open up space for additional functionality. I would love to get a wireless bootloader on the thing so I no longer need to pull the board out and probe it for programming.