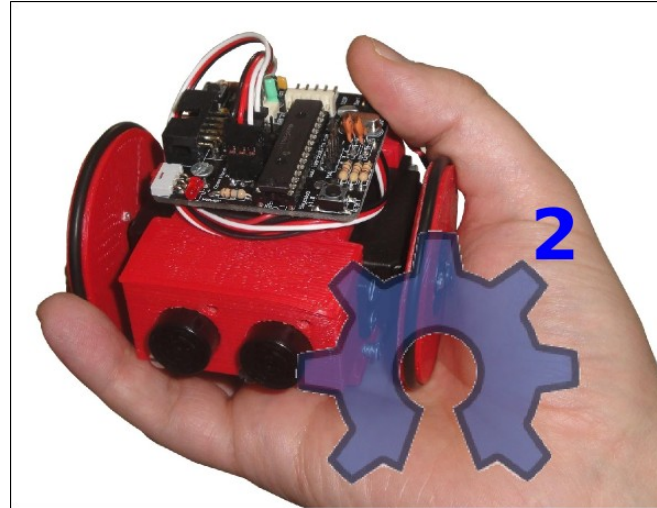


A New Open Source 3D-printable Mobile Robotic Platform for Education

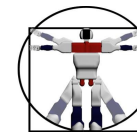


Juan Gonzalez-Gomez, Alberto Valero Gomez,
Andres Prieto-Moreno, Mohamed Abderrahim



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Carlos III University of Madrid



AMiRE

International Symposia on Autonomous Minirobots
for Research and Edutainment

6th International Symposium on Autonomous Minirobots for research and Edutainment

Centre for Interdisciplinary Research,
University of Bielefeld, Germany

2011/May/23

Outline

1. **Motivation**
2. Miniskybot Robot
3. Derivative Robots
4. Conclusions and future work

Open source model



- **The open source model works**

- Distributed around the world
- Thousand of people cooperating
- The concept of communities
- Tools: repositories, wikis...
- Belong to all: World heritage



Open Source Robotics (I)

Why not applying this model to robotics?

Advantages:

- Robots developed by the community
- Shared across the internet
- Evolutionary robots
- Amazing designs!!



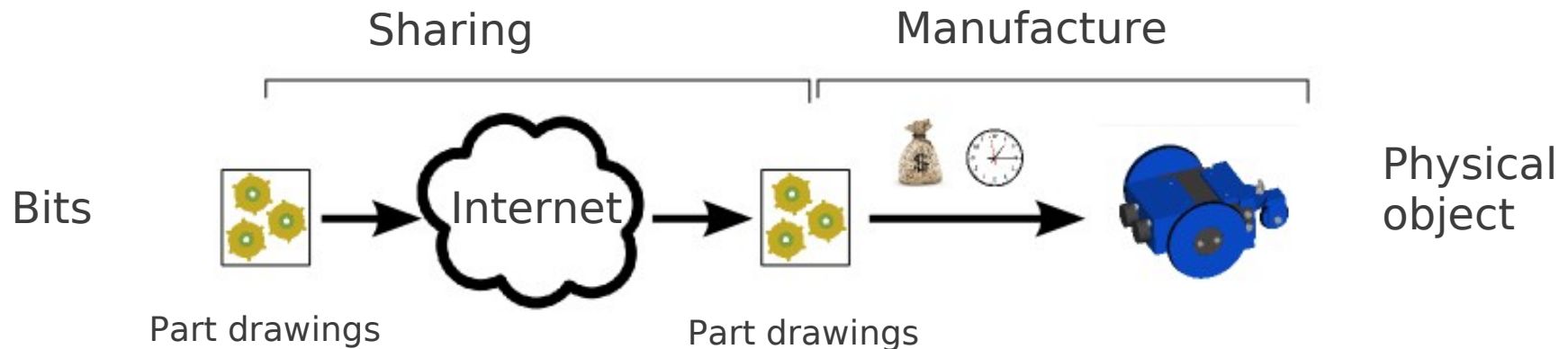
Open Source Robotics (II)

How can it be applied?

Problems:

- Robots are physical objects, not bits like the software
- The duplication requires time and money

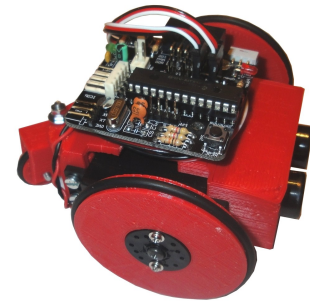
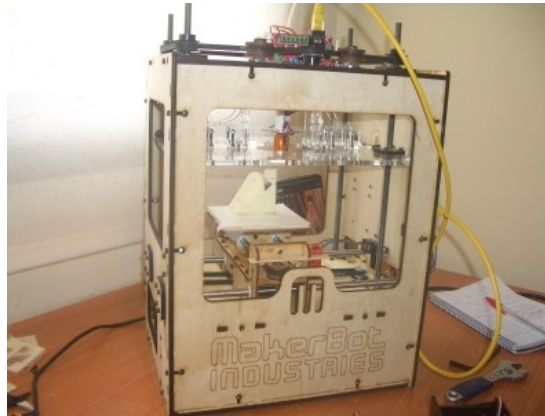
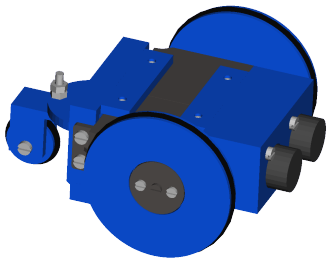
Approach:



- The drawings and schematics are bits. They can be shared easily
- The challenge is to manufacture the robot from the drawings easily and cheap

Manufacturing with Open source 3D printers

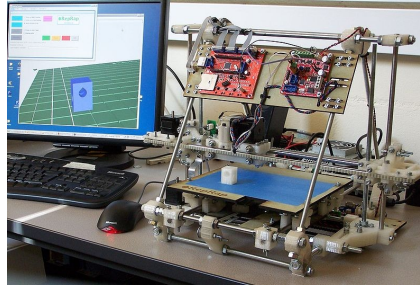
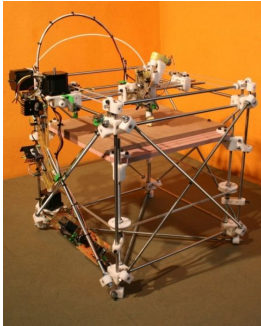
- **3D printers:** Devices that build real objects from files (bits)



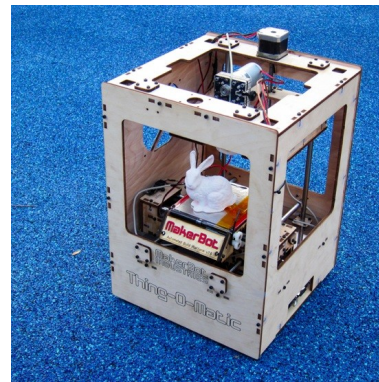
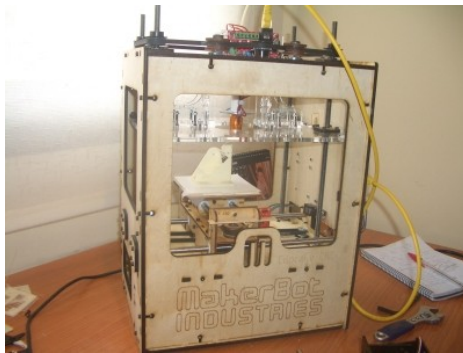
- **Cost:**
 - Comercial 3D printers: 13.000€ - 60.000€
 - Open source 3D printers: **300€ - 2.000€** (very Affordable)
- **Build material:** Plastic (ABS, PLA)
- **Cost of build material:**
 - PLA: 20€/Kg
 - ABS: 10€/Kg

Open source 3D printers

- **Reprap project:** A self-replicant machine (2005)



- **Makerbot:** Start shelling Open Source 3D printer in 2009



- **Thingiverse:** Site for sharing printable objects (2009)



Robots for educational purposes

- We propose to design robots with the following features:

Open source

The design is made publicly available so that anyone can **study, modify, distribute, make**, and **sell** the design or hardware based on that design

3D printable

The robot parts can be manufactured by means of an open-source 3D printer

Open source tools

The design is created exclusively using open-source tools. This guarantees that there will be no constraints for modifying, sharing or manufacturing

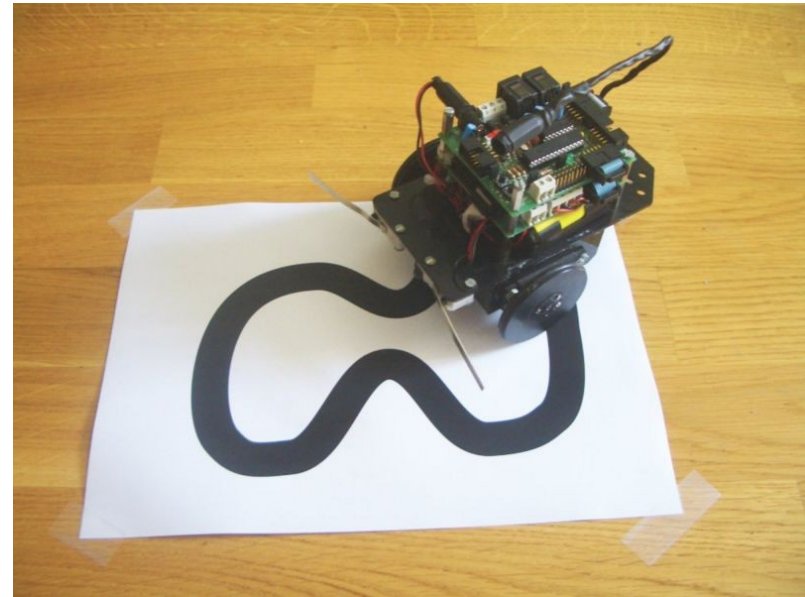
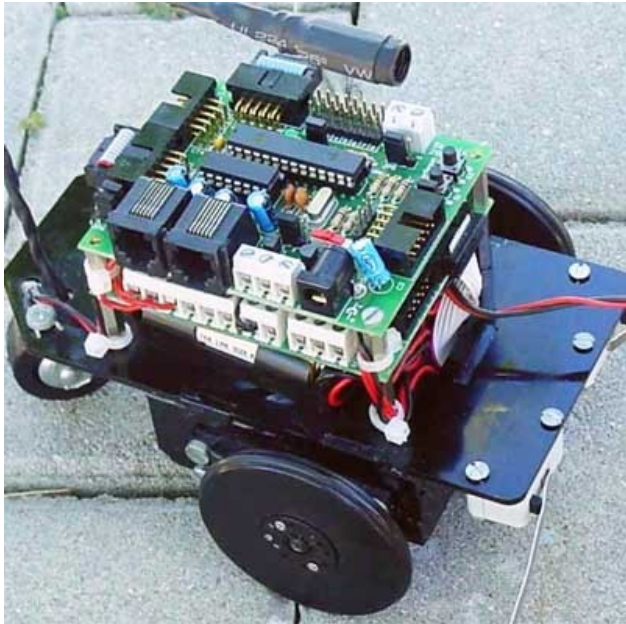


Outline

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Previous robot: Skybot

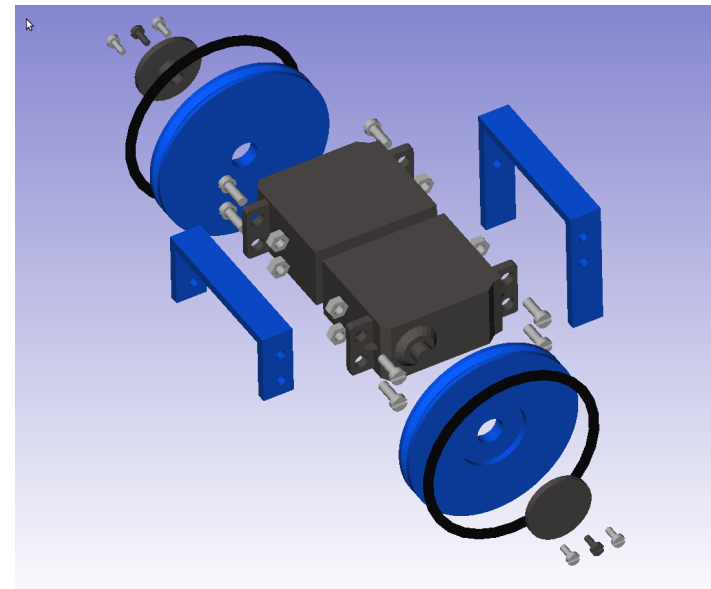
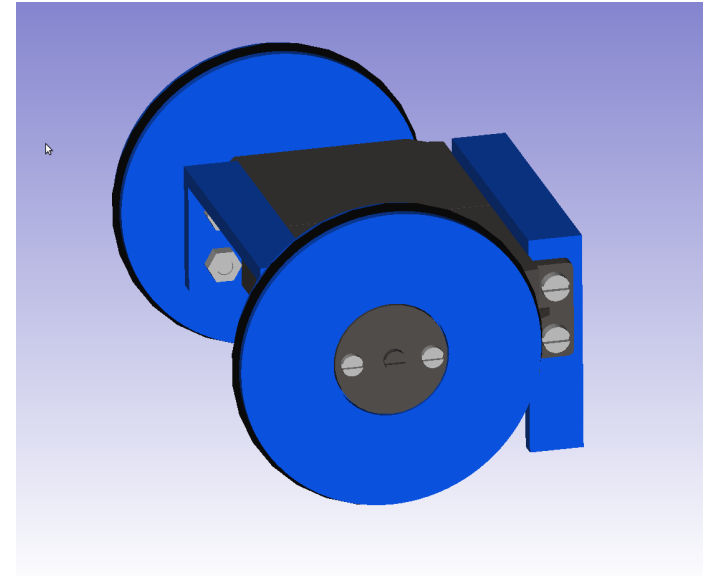
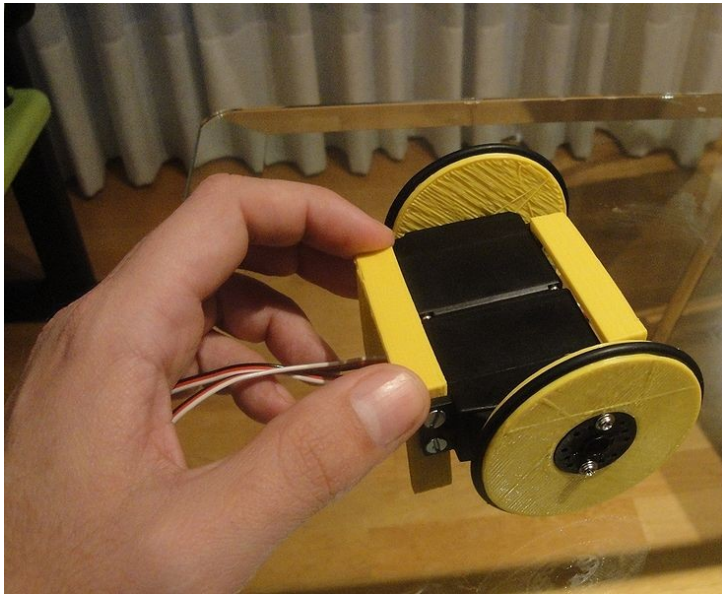
- Open source robot
- Since 2005
- Laser cut parts
- Microcontroller: PIC16F876A
- Chassis not evolved by the students



Miniskybot 0.1: Minimal chassis

- Learning 3D printing
- Viability of printable robots
- Minimal chassis for stimulating the students
- The evolution starts!

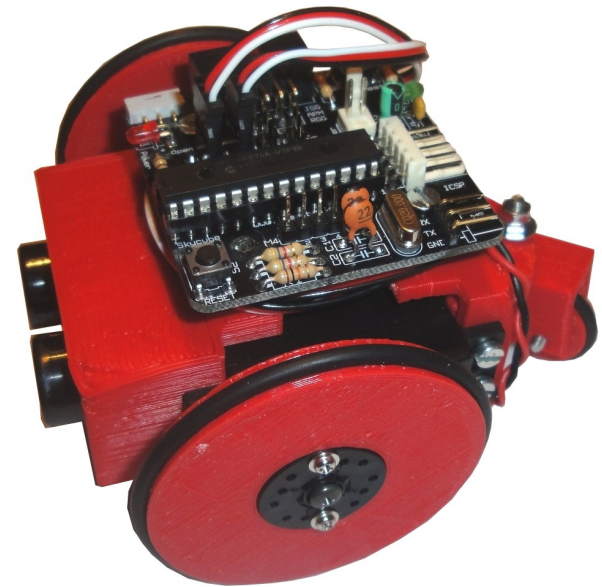
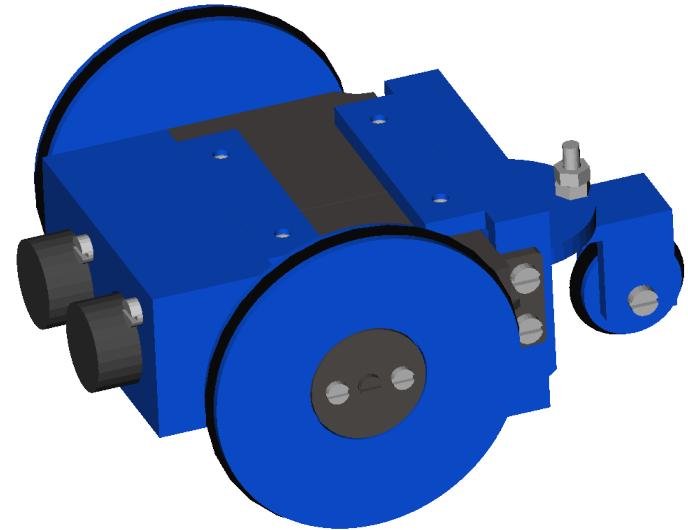
<http://www.thingiverse.com/thing:4954>



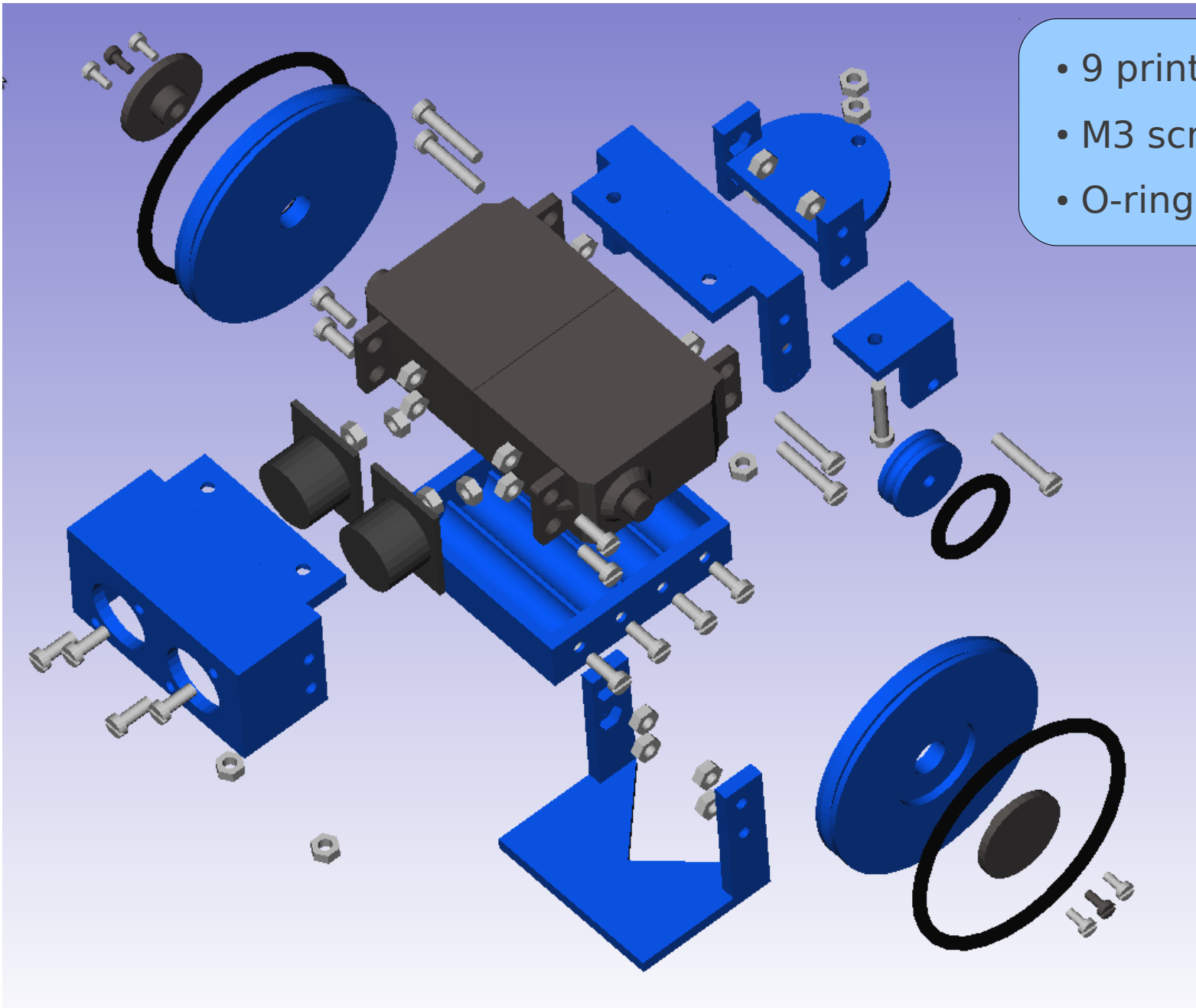
Miniskybot 1.0

- Differential robot with castor wheel
- Complete robot: chassis + electronics + batteries + sensor
- The students can easily modify it

<http://www.thingiverse.com/thing:7989>



Mechanics



- 9 printable parts
- M3 screws and nuts
- O-rings as tyres

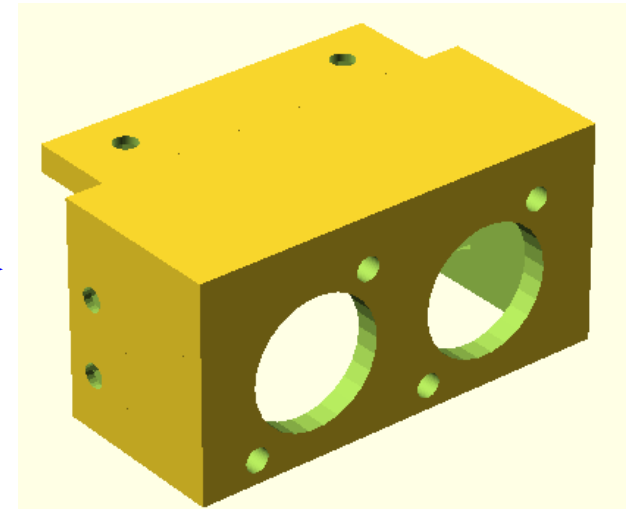
Mechanics: Design tools

The following open-source tools are chosen:

OpenScad

- Parts are described by **scripts** that produce graphical meshes when compiled

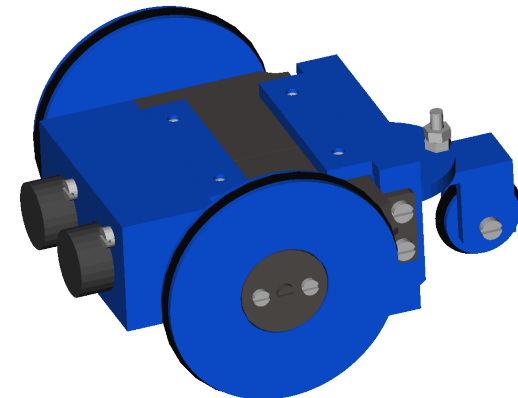
```
module U_front_skycube() {  
  difference() {  
    union() {  
      //-- Main part: U-piece  
      Futaba_U_union2(bottom_thick=bottom_thick,h=h);  
      //-- Ear 1  
      translate([d1_x,0,0])  
      cube(size=[ear_x-0.01,ear_y,bottom_thick],  
          center=true);  
      //-- Ear 2
```



- Specially easy and useful for computer science students!

FreeCad

- Used for visualizing the robot with all the part



Parametric design

- The parts are **parametric**. New parts can be obtained just changing some parameters in the source code

- **Examples:**

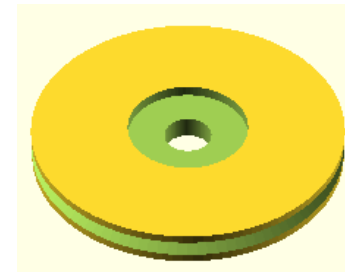
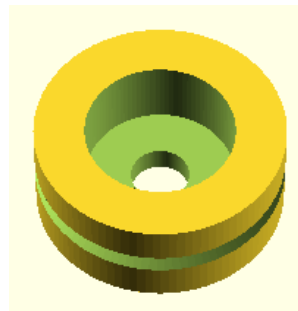
Battery pack:

- Type of batteries
- Number

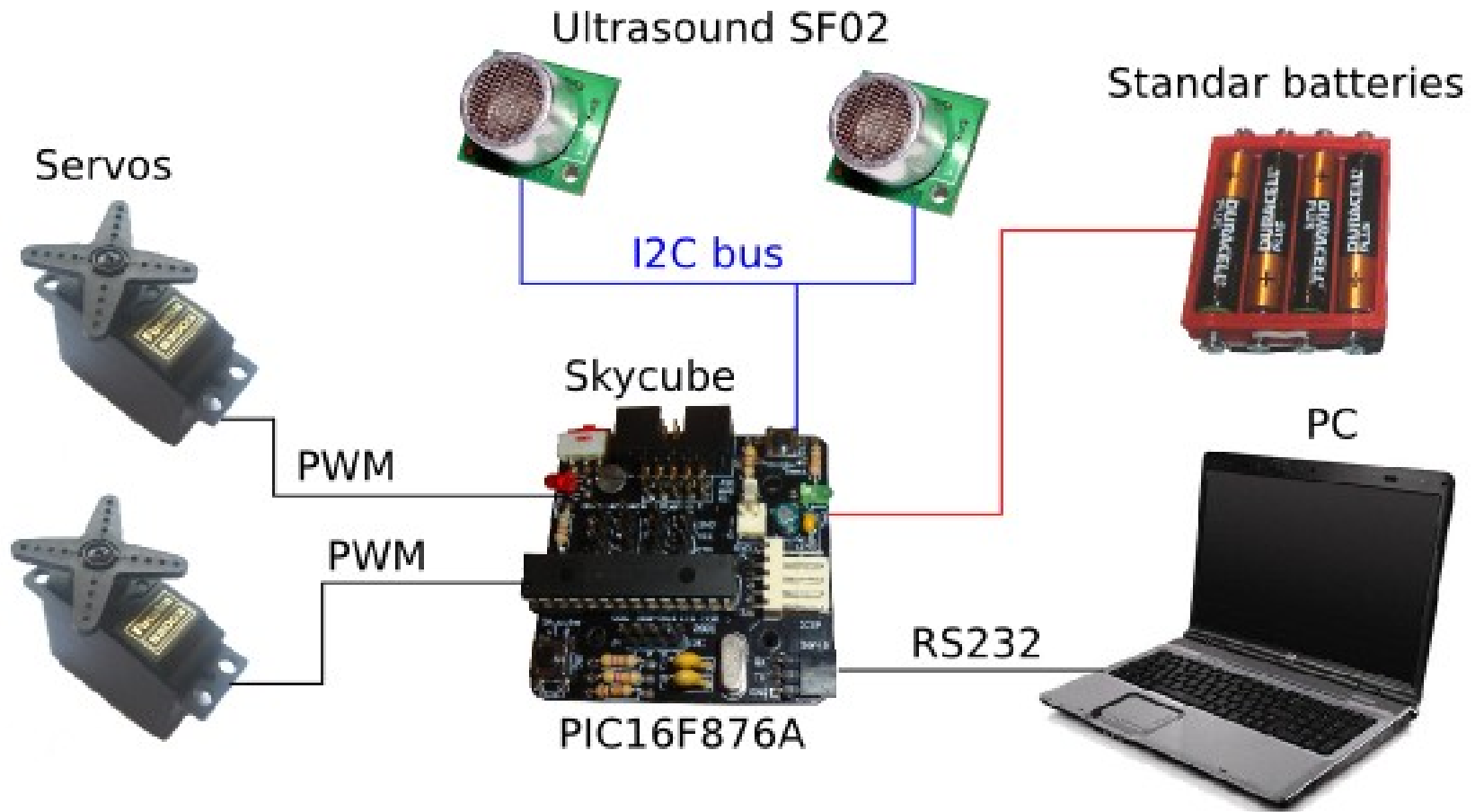


Wheels:

- Diameter
- Height
- ...

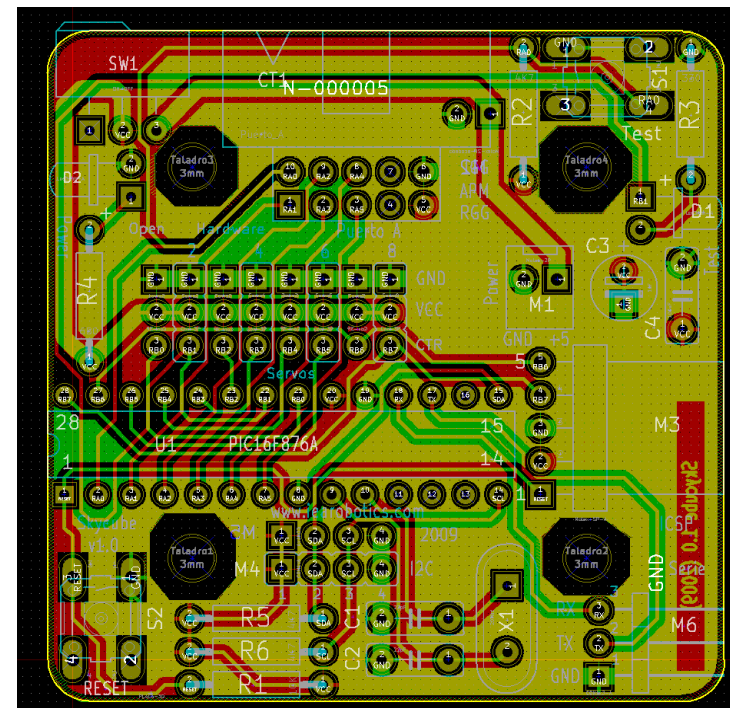
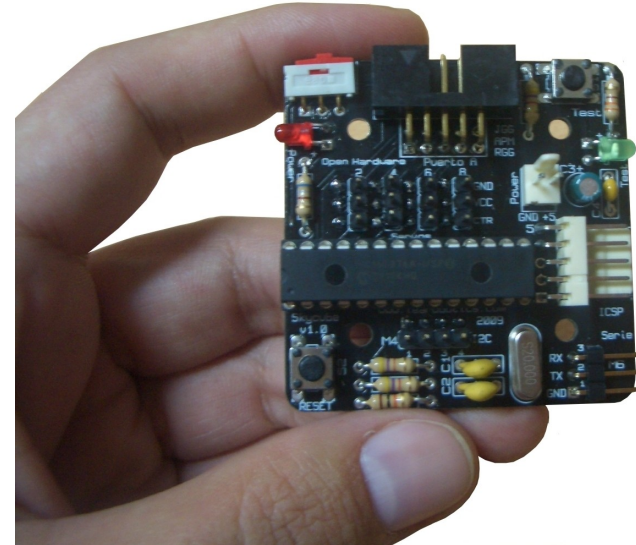
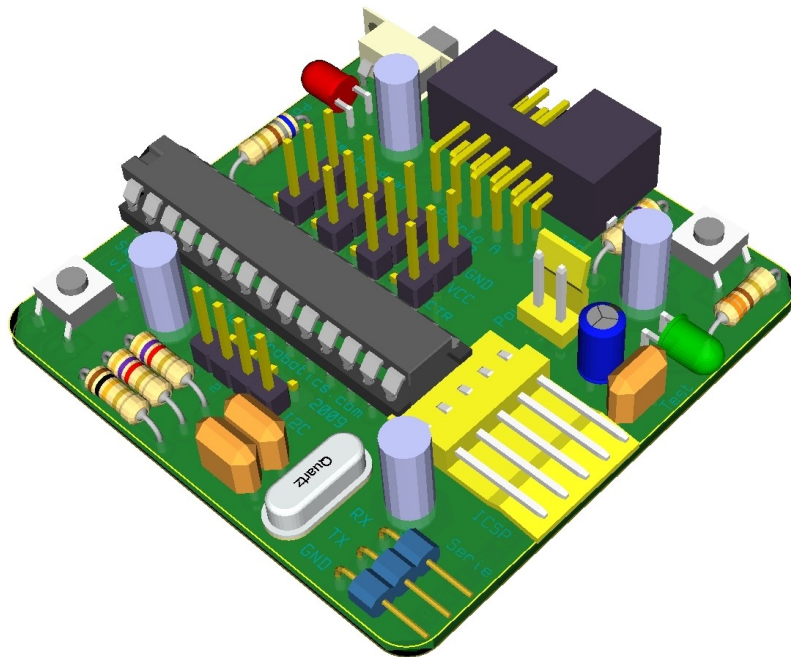


Electronics (I)



Electronics (II)

- Designed with: KICAD
- Open source software



Programming

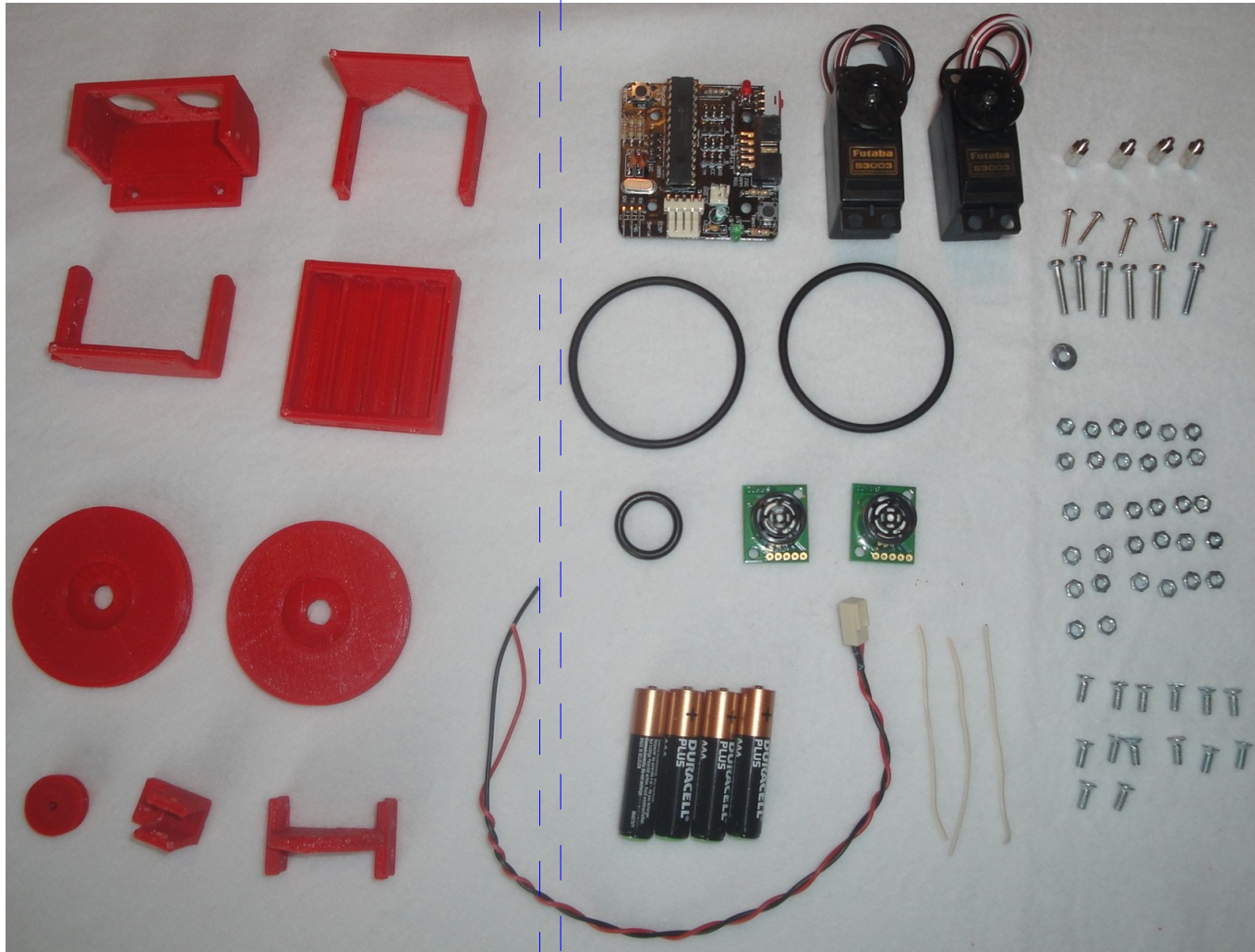
- Robot programmed in C language
- Compiler: SDCC (Open source)
- Pydownloader: our own downloading application (Open source)



Building the robot

Printable parts

Non Printable parts



- Printing time: 3h

Cost

Total:
Around 60€

<1€

20€

18€

2.5€

1.5€

2.5€

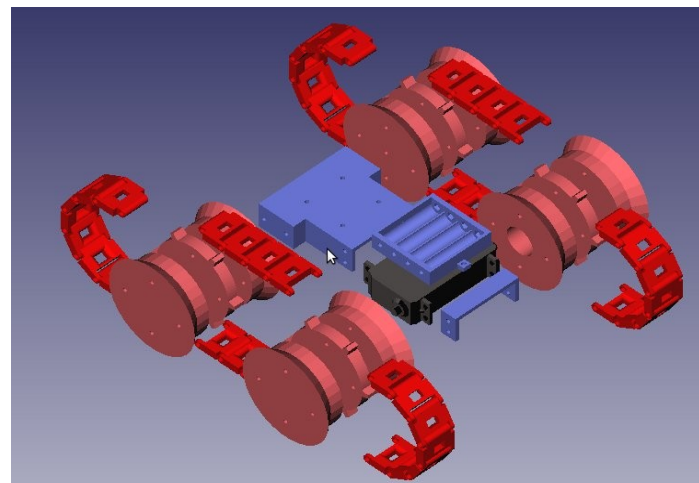
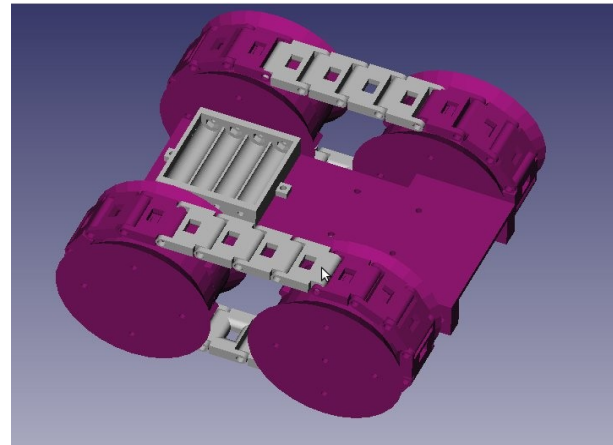
12€

The image displays a variety of components for a project, organized on a white background. On the left, there are several red plastic parts, including a small rectangular piece, a larger L-shaped bracket, a square plate with vertical ridges, two circular discs, and a small circular cap. In the center, there is a microcontroller board with various components, two black rings of different sizes, two small green modules with circular features, and four Duracell Plus-MC cells. To the right, there are two black servo motors, a collection of screws and nuts of various sizes, and two thin white strips. Arrows point from text labels to specific items: '<1€' points to the red plastic parts, '20€' points to the microcontroller board, '18€' points to the servo motors, '2.5€' points to a group of screws, '1.5€' points to a single nut, '2.5€' points to the batteries, and '12€' points to the thin white strips. A dashed blue box surrounds the entire collection of parts.

Outline

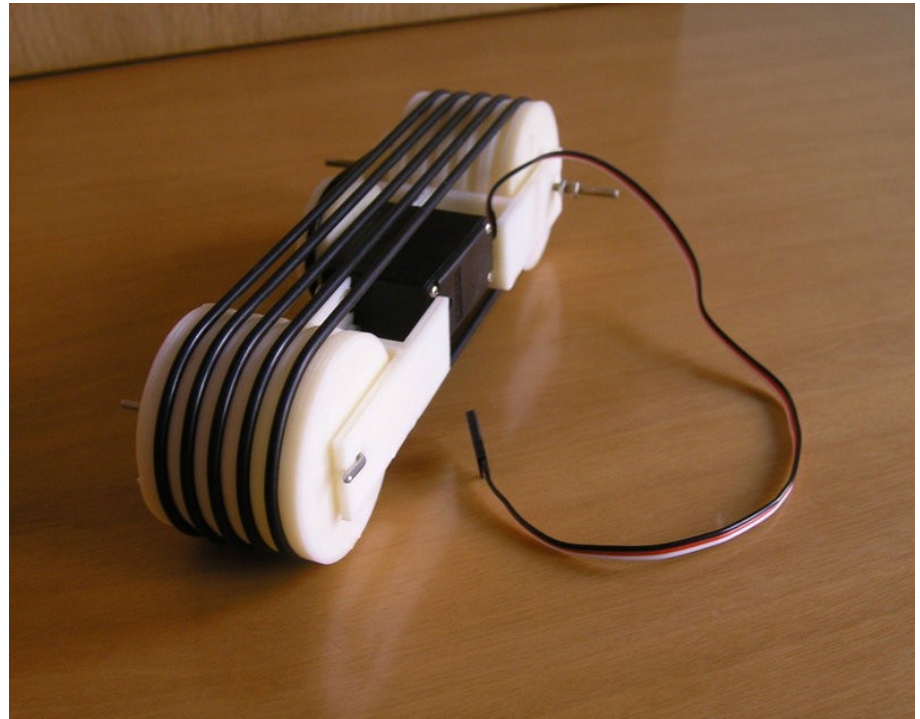
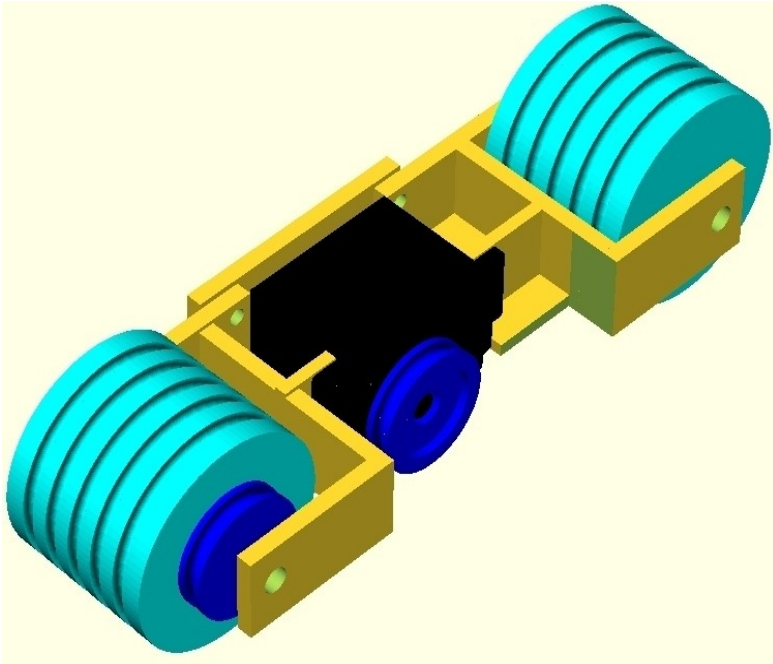
1. Motivation
2. Miniskybot Robot
3. **Derivative robots**
4. Conclusions

Tracked robot



<http://www.thingiverse.com/thing:8559>

Unitrack



<http://www.thingiverse.com/thing:7640>

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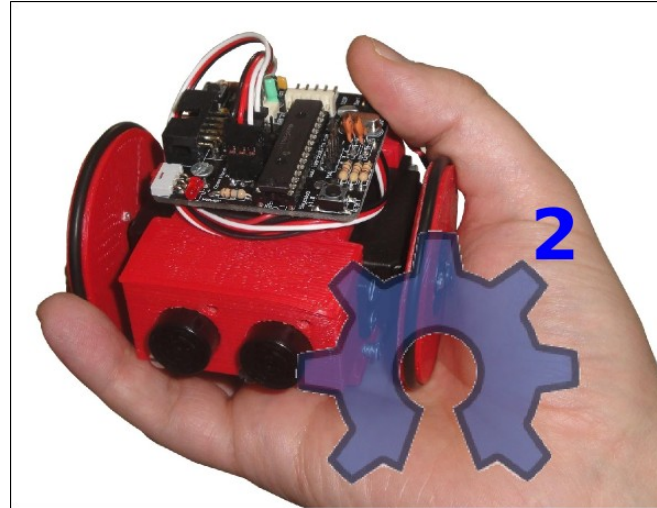
Conclusions

- 3 requirements: Open source, 3D-printable, Open source tools
- Very low cost
- Very easy to modify
- Evolutionary robot
- A good candidate for educational purposes

Future work

- Creation of communities around it
- Continue evolving the robot
- Electronic compatible with Arduino (ATMEGA microcontroller)
- Building Repraps 3D printers for the students

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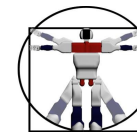


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