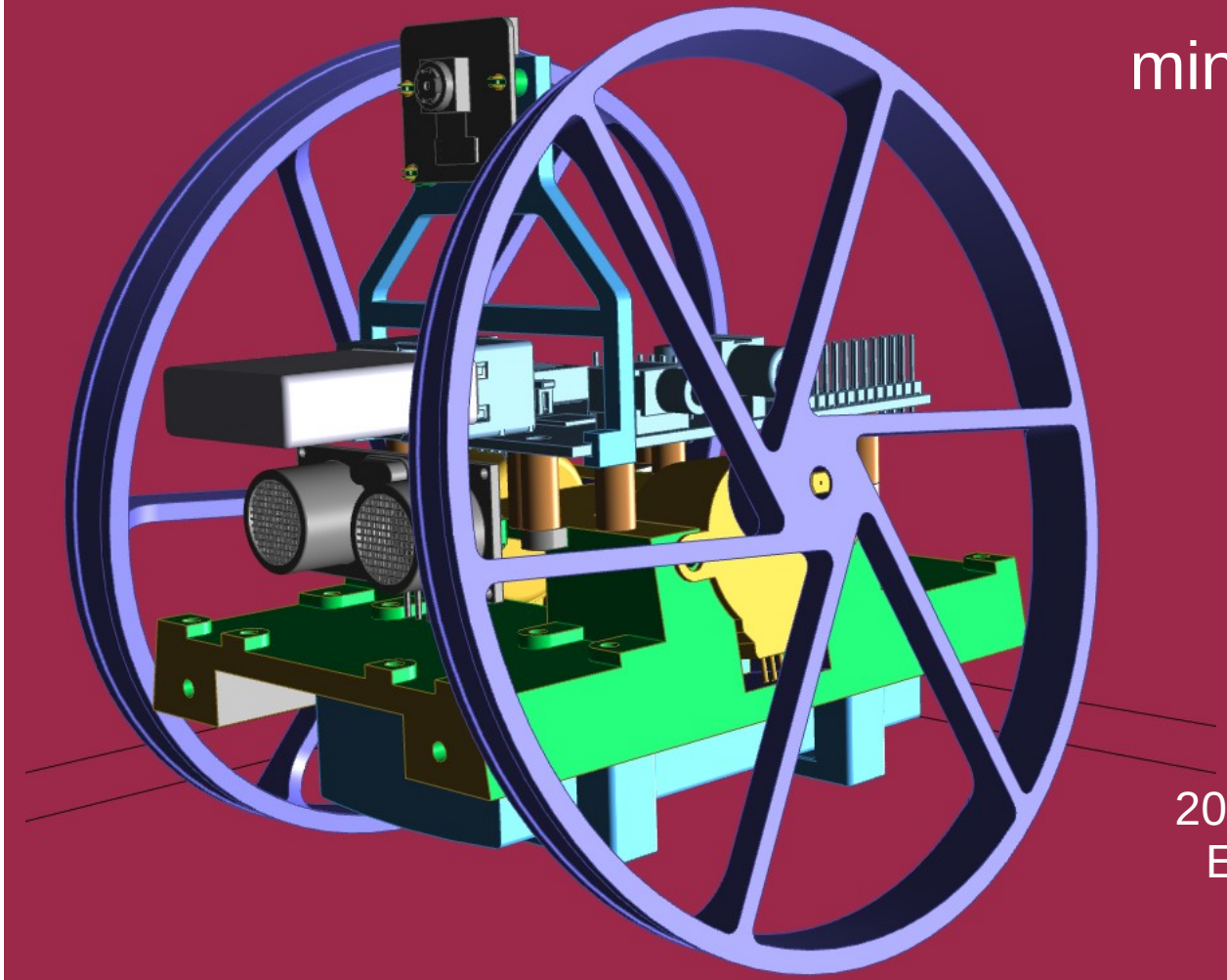
RoboCar



Building a minimalistic robot

Using TCL as controlling software

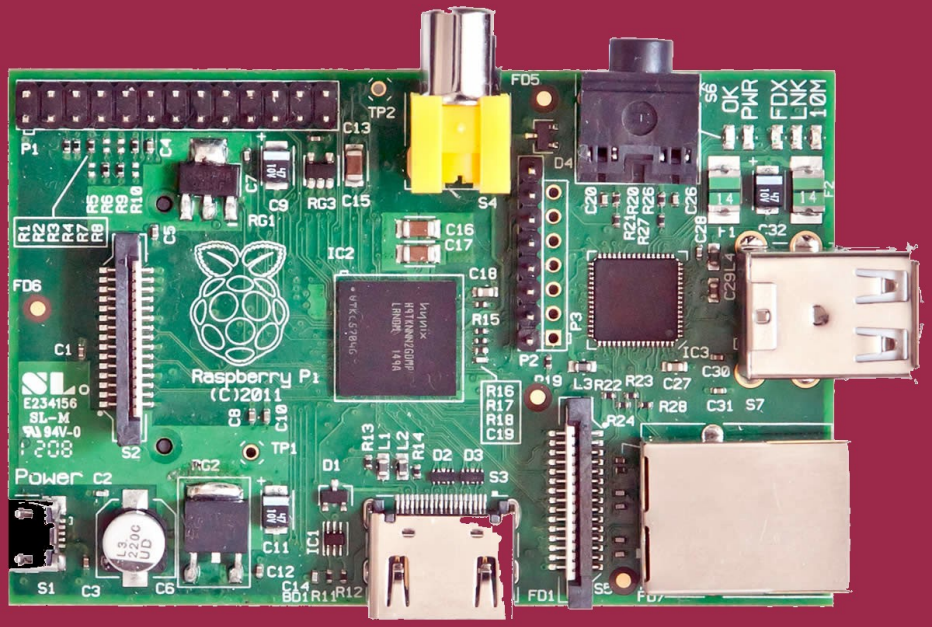
Gerhard Reithofer
2022-06-30, 2022-07-01
EuroTCL 2022, Vienna

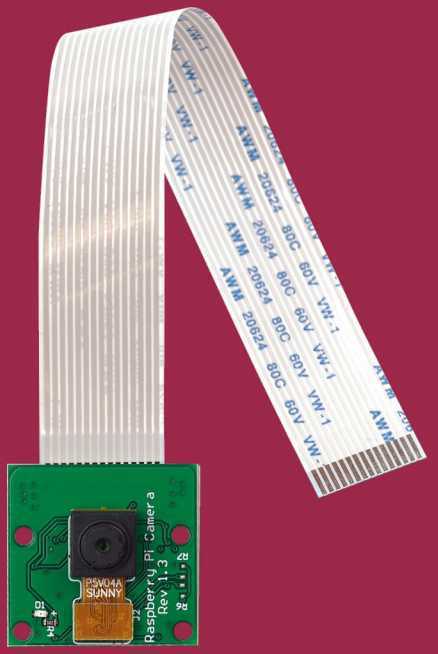
Components

- Control unit: Raspberry Pi 1B (2012) + Pi camera module
- 2 stepper motors (28BYJ-48) + driver (ULNA2003)
- Powered by an Accu pack (Intenso PM5200)
- 3D printed mechanical parts, cad models and STL files
- Control network: Wireless USB-Lan, Pi 3+ have wlan
- TCL Software for controlling Stepper motors
- Images/photos are managed over VLC-client/server
- The control network is SSH a connection in a wlan

Raspberry Pi 1B (2012)

https://www.mbtechworks.com/hardware/raspberry-pi-model-comparison.html





Camera module:
https://www.reichelt.at/

Raspberry Pi 1B (2012)

Feature	Pi 1B
Released	Apr 2012
Architecture	ARMv6Z, 32-bit
SoC	Broadcom BCM2835
CPU	700 MHz, ARM1176JZF-S
Cores	1
GPU	Broadcom VideoCore IV HD 1080p
Memory RAM	512 MB
Operating System	Primarily Linux based
USB 2.0 Ports	2
Camera Input	15-pin CSI (Camera Serial Interface)
Video Output	Composite 3.5 mm RCA and HDMI
Audio Output	Analog 3.5 mm jack, Digital via HDMI
Storage	SD slot
Ethernet	10/100 Mbps
Input/Output Pins	26
Power (less peripherals)	5v 700 ma
Size	85 mm x 56 mm

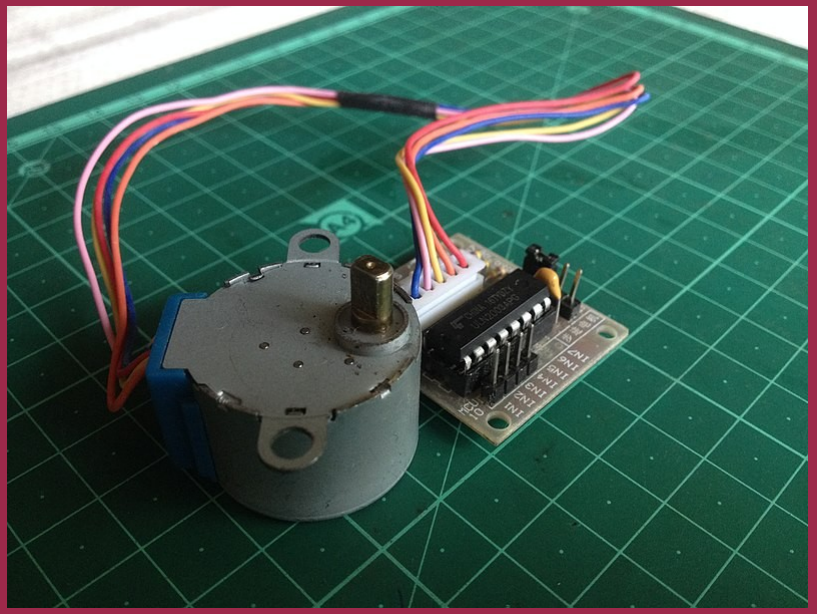
- USB-wlan Stick
  - No bluetooth
  - No wlan on board

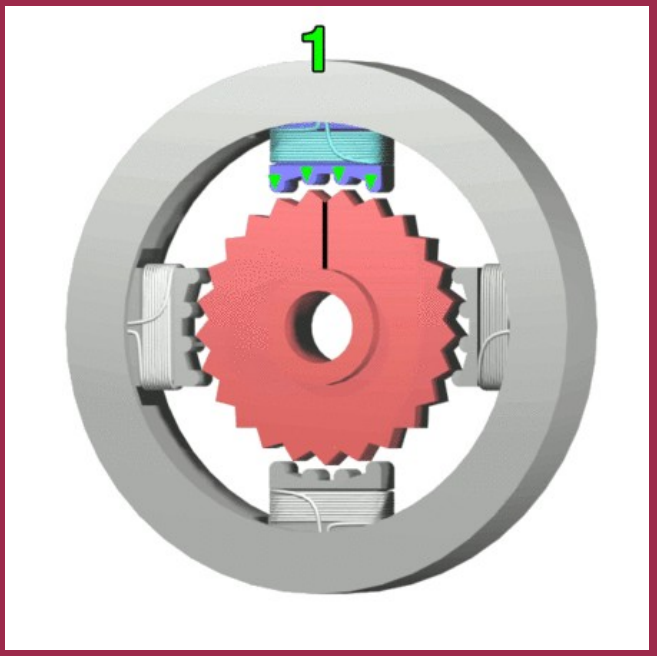
Controlling is done via SSH remote session

Stepper motor movement

Wikipedia: **https://en.wikipedia.org/wiki/ULN2003A**

Animation: **https://en.wikipedia.org/wiki/File:StepperMotor.gif**





Controlled by single repeatable steps

4 signals are sufficient for reliable movement

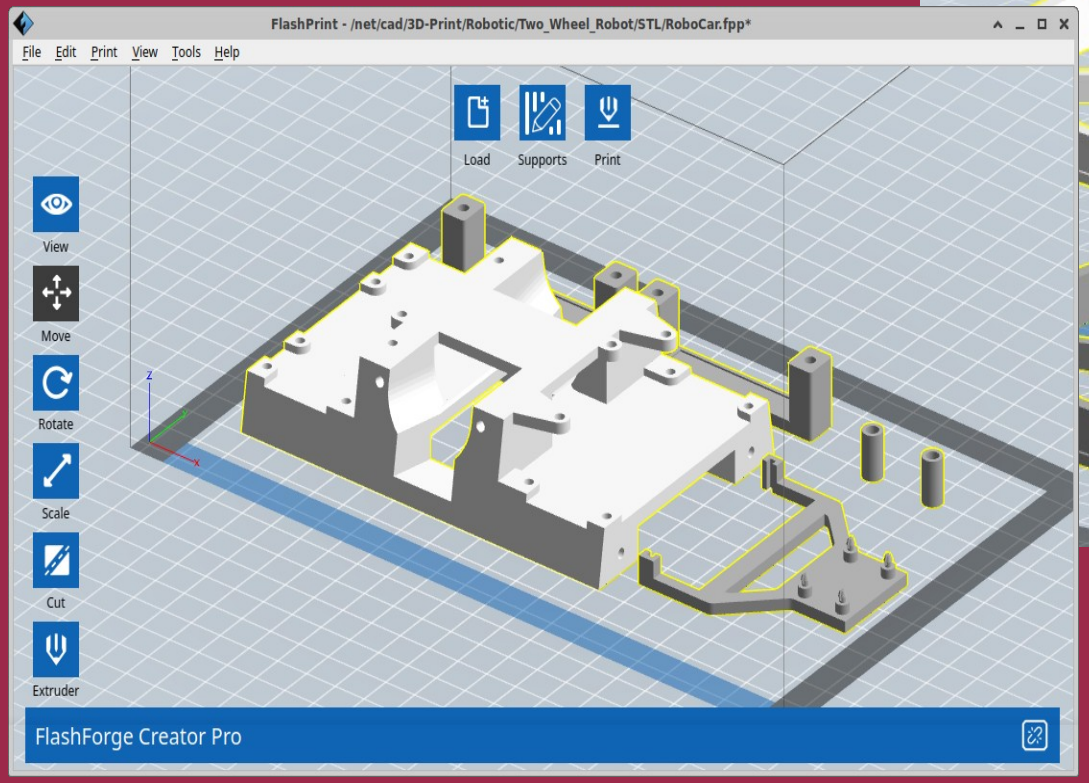
Power Hardware

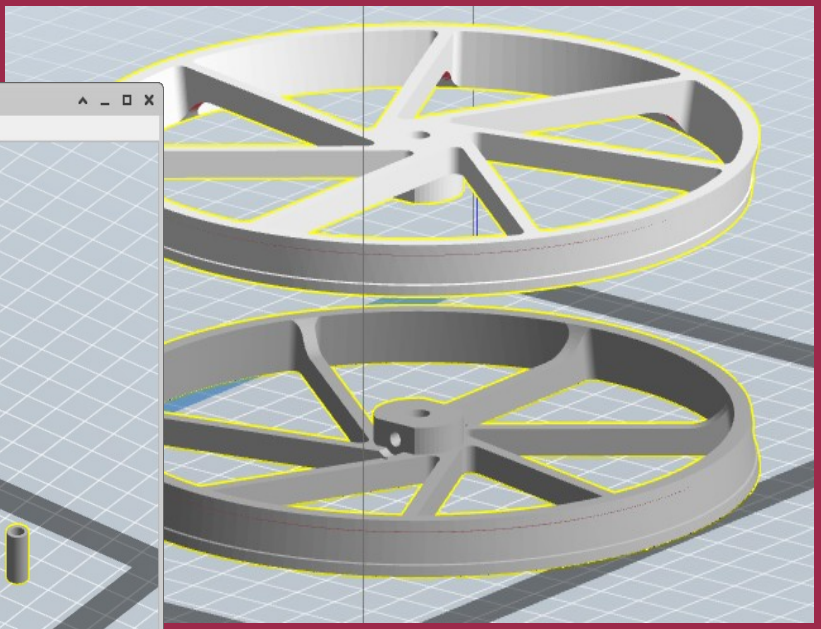
Powerbank

Intenso PM5200

Charging slots	1
Capacity	5200 mAh
Charging current (max.)	1000 mA
Technology	Li-ion
Weight	136 g
Dim	(L x W x H) 96 x 43 x 25 mm
Connector type	USB-A 1x, Micro USB 1x
Powerbank features	Status display
USB-C current input (max.)	1 A
USB-C voltage input (max.)	5 V
USB-C current output (max.)	1 A
USB-C voltage output (max.)	5 V
Product type	Power bank

CAD design + 3D printing



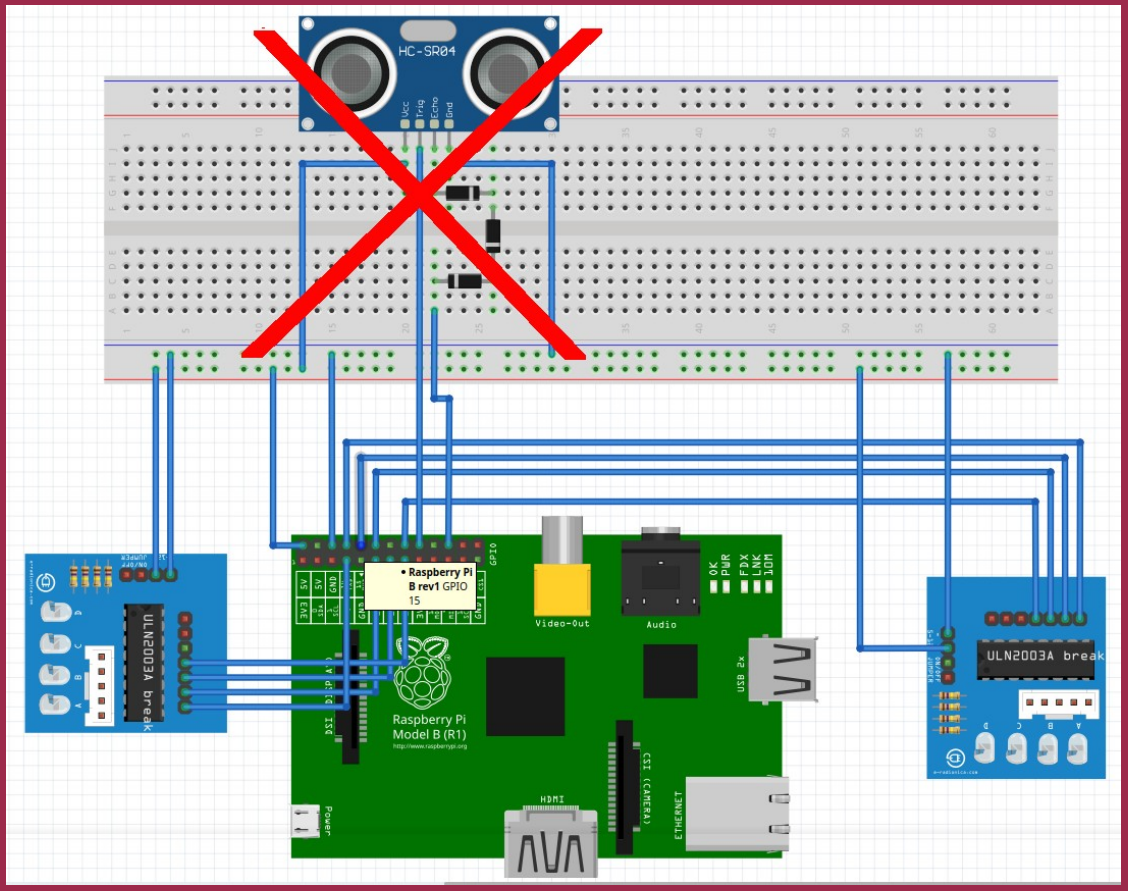


Hardware/Wiring

Physical connections

- G eneral
- P urpose
- I nput
- Output

Simple cheap jumper cables



Software/Hardware Interface

Communication via /*sys*/class/gpio filesystem.

```
GPIO Directory: export unexport gpiochip0

set fd [open /sys/class/gpio/export {WRONLY}];puts $fd "15";close $fd
After export:  export unexport gpiochip0 gpio15

GPIO15 directory: direction active_low device subsystem edge power uevent value
Setting direction to 'out'
set fd [open /sys/class/gpio/gpio15/direction {WRONLY}];puts $fd "out";close $fd

Writing value „1“ to port 15
set fd [open /sys/class/gpio/gpio15/value {WRONLY}];puts $fd "1";close $fd

Destroying connection to port 15
set fd [open /sys/class/gpio/unexport {WRONLY}];puts $fd "15";close $fd
GPIO Directory:   export unexport gpiochip0
```

Module: raspi2.tcl
On TCL wiki https://wiki.tcl-lang.org/page/Raspberry+Pi

Used Tools

Remote Shell to start a control session

```
ssh -l pi -X robocar
```

Video/Photo connection:
VLC as client and server for image/video transfer

```
$ ./live_video.sh
Call:
   vlc tcp/h264://192.168.0.192:3333
on remote machine to view.
Waiting for a TCP connection on 0.0.0.0:3333...
```

Programming

Motion control: Tcl 8.6
Command line based robot controlling
No specific extension is required

```
Usage: ULNA2003.tcl [-h] [-a {axid1 [axid2]}] [-d delay] [-t drivetype] [-x macro ] [-f {0|1}] wheelsteps
 Default axis isds are: st0..st5
 -h .. command line syntax help
 -a .. stepper motor id (axis) st0..st5 (Def. st2 st0)
 -d .. stepper delay value (min=1) (def. 1)
 -f .. fix end position (def. 0)
 -t .. drive id - one of f, d, m, h (def. d)
 -x .. execute macro
 The wheelsteps value must be a sequence of steps for L/R wheel
 Possible cycle ids are:
     f - full step mode - 4 micro steps
     d - drive step mode - 4 micro steps.
     m - mix of full and halve - 6 micro steps
     h - halve step mode - 8 micro steps
 See also: https://dronebotworkshop.com/stepper-motors-with-arduino/
```

Final Demonstration

Thank you for your attention