







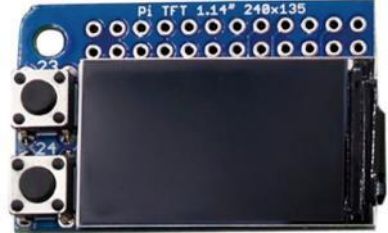
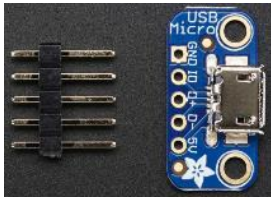
Supplies

CUBOTino micro: The World's smallest Rubik's cube solver robot

Andrea Favero, Groningen (NL)

10/03/2023 Rev. 0 (always check if a newer version is available)

Q. ty	Part	link to the shop I used	Cost (€)	Notes
1	Rubik's cube 30mm Highly recommended GAN 330key-chain	See next page	10	
2	Servos I used: Adept Micro Servo Motor AD002 9G Metal Geared (180deg 2Kg/cm, Pulse width 0.5 to 2.5ms)	https://www.adeept.com/ad002-servo-motorx2_p0274.html or https://www.amazon.com/Adeept-...	10 (2 servos + arms)	
1	Raspberry Pi Zero2W (H needed, yet the header can be bought at side) Raspberry Pi ZeroW works too	https://www.sossolutions.nl/	27.5 (Zero2W version, Dec 2023)	
1	microSD HC 16GB	https://www.dataio.nl/sandisk-ultra-micro-sdhc-16gb-uhs-i-a1-met-adapter/	8.5	
1	PiCamera V1.3 (PiCamera V2 should by changing the <i>s_mode</i> parameter. Not verified the minimum focus distance!)	https://www.amazon.nl/gp/product/B01M6UCEM5/ref=ppx_yo_dt_b_asin_title_o05_s00?ie=UTF8&th=1	7.5	
1	16 cm cable Raspberry Pi Zero/Camera Note: The Raspberry Pi Zero uses a specific ribbon cable! See picture	https://www.amazon.com/A1-FFCs-Cable-Raspberry-Camera/dp/B07T4SHQ28/ref=sr_1_1?crd=2JNY3R237W2DK&keywords=pi+camera+cable+16cm&qid=1675506822&sprefix=picamera+cable+16cm%2Caps%2C154&sr=8-1	5	

Q. ty	Part	link to the shop I used	Cost (€)	Notes
1	Mini PiTFT - 135x240 TFT 1.14inches display	https://www.amazon.com/Mini-PiTFT-135x240-Add-Raspberry/dp/B09Q1SRJ6H/ref=sr_1_4?crid=1BU461Z72K12M&keywords=mini+Pi+TFT+1.14&qid=1675506942&sprefix=mini+pi+tft+1.14%2Caps%2C156&sr=8-4	19 (7€ Aliexpress)	
1	USB MICRO-B BREAKOUT BOARD	https://www.adafruit.com/product/1833	2	
~120g	Filament 1.75mm		~2.5	Suggested PETG, yet other materials will do the job

Note: all components are also available from AliExpress

Electronic and electrical small parts:

Q. ty	Part	Notes
1	White LED	To illuminate the cube
1	Prototype board	To connect all the parts
1	14pin (2x7) or 12pin (2x6) GPIO female header (Plastic body height ca 8 to 8.5mm)	To connect the Connections board to Raspberry Pi Zero
1	1x8 Male Headers 90deg	To connect the servos and LED.
1	40pin (2x20) GPIO male header	In case you could not get the WH version of Raspberry Pi
1	Heat-sink for Raspberry Pi	Not really needed

Screw types:

Quantity (indicative)	Dimension	Head type
3	M3x12	Conical
10	M3x8	Conical
12	M2.5x8	Cylindrical
12	M2.5x4	Cylindrical

Power supply:

If micro-USB: 2A phone charger with micro-USB cable.

Because of the small amount of power consumed by the servos, a 5V power bank for phone works well too; See next page for a suggested version.

Of course some other common materials are needed (wires, solder and solder device, tire wraps, self-adhesive rubber feet, etc.).

The suggested cube

GAN 330 Keychain is the cube I have built the robot around.



In theory every 30mm Rubik's cube will work, but this GAN 330 keychain is extremely recommended.

The rationale to suggest this model:

1. Very low rotation friction
2. Cut corners mechanism.
3. Adjustable friction.
4. Robust construction.

As reference, a couple of shops (AliExpress and Amazon.com)

- https://www.aliexpress.com/item/4001038623950.html?pdp_npi=2%40dis%21EUR%21%E2%82%AC%2014%2C05%21%E2%82%AC%208%2C01%21%21%21%21%402103222716761077538436432e8bef%2112000032064721934%21bt&t=pvid:faade393-c22d-4858-b04e-ad8bc281ef12&afTraceInfo=4001038623950_pc_pcBridgePPC_xxxxxx_1676107754&spm=a2g0o.ppclist.product.mainProduct
- https://www.amazon.com/GAN-Speed-Cube-Ring-Keychains/dp/B086V59NTF/ref=sr_1_1_sspa?crd=17YELTO4BF1KB&keywords=gan+330&qid=1676107792&srefix=gan+330%2Caps%2C189&sr=8-1-spons&psc=1&spLa=ZW5jcjlnldGVkUXVhbGlmaWVyPUFvZzBsdDkzNko5RVYmZW5jcjlnldGVkSWQ9QTAYMTU3MTMxS1FBSjFIQ0RRNUiBJmVuY3J5cHRIZEFkSWQ9QTA3Mjc2MDUyVWhQUkIxS1JXVEpMJndpZGdldE5hbWU9c3BfYXRmJmFidGlvbj1jbGlja1JlZGlyZWNOJmRvTm90TG9nQ2xpY2s9dHJlZQ==

Notes:

1. The blue logo on the white center facelet alters the color recognition: refer to the troubleshooting section for some info on how to remove that logo, to improve the cube status readability.
2. I'm neither affiliated with Amazon nor with GAN; I'm just sharing my positive experience with this cube 😊.
3. The Amazon link is just used as reference, to find further information.

Alternative/optional components

Raspberry Pi ZeroW (instead of Zero2W)

In case Raspberry Pi Zero2W will suffer gain for severe chip shortage, then Raspberry Pi ZeroW board is a valid alternative for this project:

Pro:

1. In 2022 and 2023 it had better availability than Zero2W, see notes below.
2. Hardware and Software compatibility.
3. Size.
4. Price.

Cons:

1. Performances:
 - a. The Boot with script loading takes about 120secs, roughly double the time of Zero2W.
 - b. Cube status detection takes about 10 seconds more than Zero2W.
 - c. Solving time takes about 5% more than Zero2W.On average the cube status detection and solving takes 90 seconds vs 70 seconds of a Zero2W.

Purchasing a Raspberry pi Zero (Info valid at the moment of writing, 15 January 2024)

Both Raspberry Pi ZeroW and Zero2W are back in stock, notably in Amazon and AliExpress.

The Raspberry Pi official site (<https://www.raspberrypi.com/products/raspberry-pi-zero-w/>) displays the availability of the products through the official dealers in various countries. Select *Buy now*, enter your Country and check one by one the proposed shops for availability.

Notes:

- In some Countries / shops restrictions are applied: In the Netherland, where I live and placed my order, it has been periods in which orders were restricted (only one board per person per month).
- On December 2022 I spent 18.6€ (+ 3€ for shipment) and I got my first ZeroW in a couple of days. Yes, this is not the 'old' price, but competitors aren't cheap either....
- On February 2023 I spent 20.8€ (+ 10€ for shipment, ordered abroad) and I got my second ZeroW in a couple of days.
- On March 2023 I spent 21€ (included shipment) and I got my third ZeroW in a couple of days.
- On July 2023 I spent 22€ (+ 2.5€ for shipment) and I got a Zero2W from an official dealer in The Netherlands.
- In December 2023, a Raspberry Pi Zero2W without headers was 27,50€ through AliExpress, shipping included.

Power bank

Because of the small servos used and the low overall power budget, I searched for a power bank having small footprint. Other parameters considered were large capacity, fast charging, high R&R and limited cost 😊

The one I bought claims to be 10000mAh; I don't know whether it really has that capacity, yet it lasts very long.

The shape is perhaps a bit too thick and round, but I don't care much.

The black version is cheaper than the other colors, therefore I'll re-print the Baseplate in a different color to highlight the separation between robot and power bank:



Power bank Intenso Powerbank XS10000

I got this power bank for 15€, from Amazon.nl:

https://www.amazon.nl/dp/B07Z8DF4DG?ref=ppx_yo2ov_d_t_b_product_details&th=1

This **USB – microUSB** cable is on the high-cost side. Reasons for choosing this model relate to the right-angle terminals, and short cable length.

The cable length description was for 10cm, while I got a cable with almost 20cm, which is good. My initial intention was to keep the charge indicator upside, yet it would stay under the bot.

I got this cable for 9€ from Amazon.nl:

<https://www.amazon.nl/dp/B01FPOXKQG?psc=1&ref=ppx>