OPEN SOURCE AIR PURIFIER

by ianvanmourik on May 17, 2016

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Intro: OPEN SOURCE AIR PURIFIER

Hi y'all,

I'm Ian van Mourik a Product Designer from the Netherlands. This instructable is a brain child that I just had to share with the world. Bad air quality causes various health problems and purification solutions are often complex and expensive. The solution is an open source no nonsense air purifier: the OPEN AIR!

This instructable is based on my first experimental prototype of the OPEN AIR.

It's meant to be a platform to build upon and improve. My personal goal is to test and improve the design and effectiveness. Collectively we can provide new and better solutions. The modular filter design makes it possible to change and test different kind of filters.

This Design is based on a carbon type filter in collaboration with two pressure optimized 120mm 12v PC fans. It´s controlled by an Arduino with a gas sensor and a LED panel for subtle visual feedback.

If you decide to build your own OPEN SOURCE AIR PURIFIER, be ready to roll up your sleeves, because this won't be an easy one. It will include laser cutting, 3D printing, prototyping, soldering, programming and a lot of other bits and bobs. It will be an advanced instructable. But don't let it scare you, because the reward is big, very big! Like thousands cubic meters of fresh pure clean air big.

Good luck!

Bill of materials:

1. **Housing**

- 6 sheets (700x400mm) 3 mm multi-plex
- 3 mm clear plexiglass
- About 500 gram of 3D printer filament

2. **Electronics**

- Arduino NANO v3
- 5x 3mmm LED bright white
- 2x 120 mm 12v fans (pressure optimized)
- 5x LED resistors
- Voltage controller 12v in, 5v out
- 12v power supply (1.5A+)
- MQ 135 gas and smoke sensor
- Prototyping board
- 2 pin connectors
- 5 pin connectors
- Wires

3. **Air Filter**

- Activated carbon
- Fine dust filter

Tools and extra's:

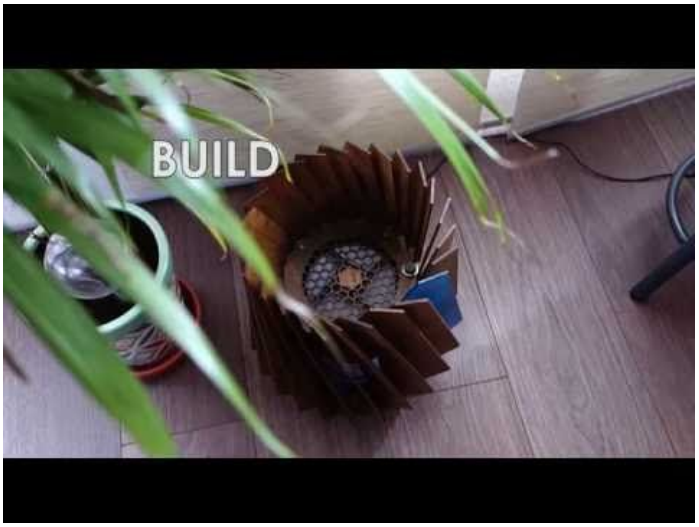
- 3D Printer
- Laser cutter
- Soldering iron and Tin

- Electrical tape
- Screw driver
- Nippers
- Brush
- Varnish or some other paint

- Multi-meter
- Sandpaper
- Wood glue
- 4x M3 x 40 bolts
- 2x M3 x 15 bolt
- Spacer
- a PC

- and a healthy brain

Total cost: 70 euro



File Downloads

OPEN AIR_1.1.rar (6 MB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'OPEN AIR_1.1.rar']

Step 1: Fabrication Frame

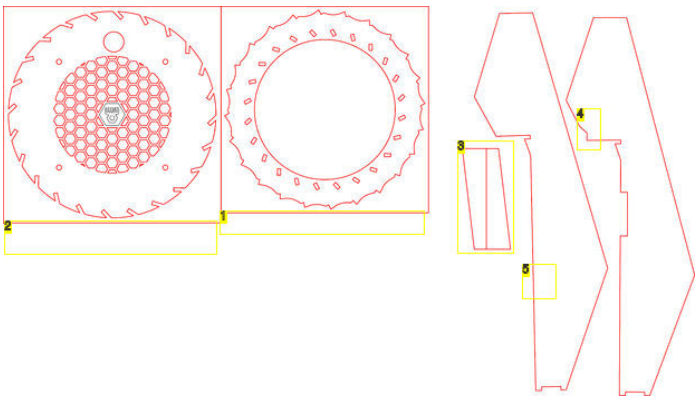
The first
step is to fabricate all the parts of the OPEN AIR, beginning with the laser cut wooden frame. I unfortunately do not own a laser cutter :(. But lucky there is a FABLAB nearby: #stadslabrotterdam.

I used 3mm triplex birch wood sheets, birch wood is ideal for laser cutting because it is very soft, and it's cheap witch is always good. Speed and power settings for the laser cutter are depended on the type of wood and machine you are using. Ask the FABLAB crew for help if you are not sure.

You will need one top and one bottom piece, 22 regular ribs, 1 wooden rib with the cutouts for the gas sensor, 1 Plexiglas rib for the LED and a couple of assembly tools.

For the LED rib I used 3mm clear blue Plexiglas which I roughly sanding in a vertical direction. Roughing up clear Plexiglas diffuses the light causing it to light up. Feel free to experiment!

After cutting check everything with a quick test fit, NO GLUE! I would highly recommend cover the wood with some kind of varnish or paint to prevent the wood from warping over time. So sand it down and do whatever you desire. I used heavy duty varnish for a old and kind of dirty finish.



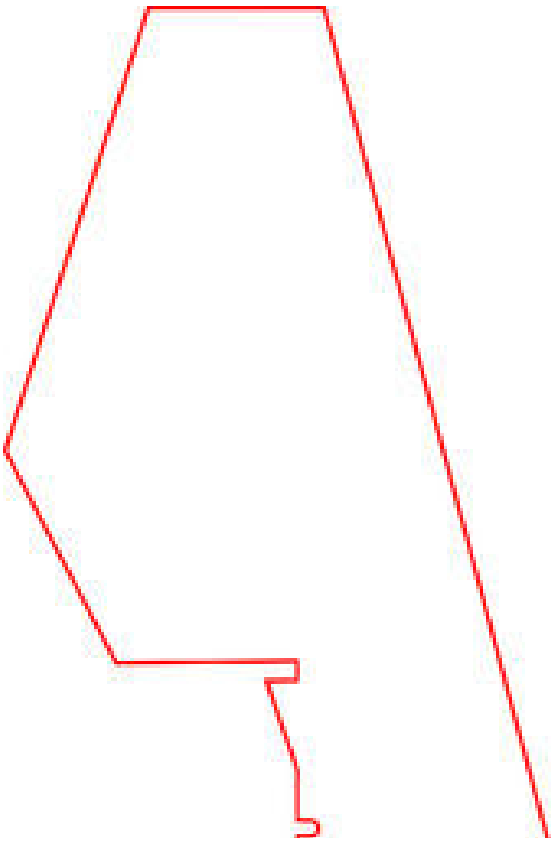


Image Notes
1. bottom piece
2. top piece
3. assembly tool
4. The special one with cutout for gas sensor and fan wires
5. normal rib. you need 22 of tese

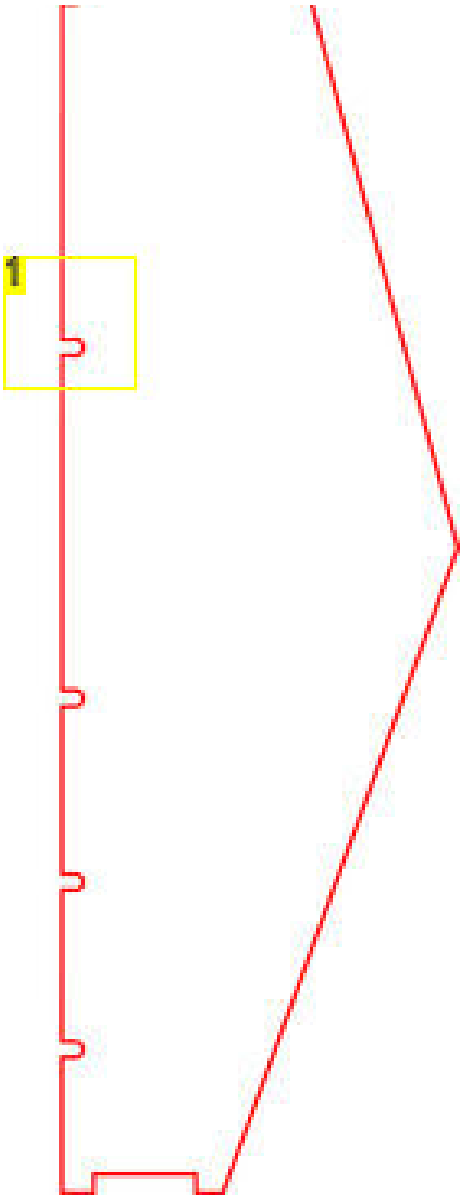


Image Notes
1. Plexiglas with cutouts for 3mm LED

Image Notes
1. Turbo sanding

Step 2: Fabrication 3D printed parts

There are 4 printed parts totaling roughly 24 hours of printing time.

The coupler for the 120mm fans, the coupler for the filer and the filter itself are all printed in the same direction with the same settings. Depending on the printer, the tolerances on the tread can be a bit too tight and may require some sanding to make it fit. All the holes for the M3 bolts should be self-tapping.

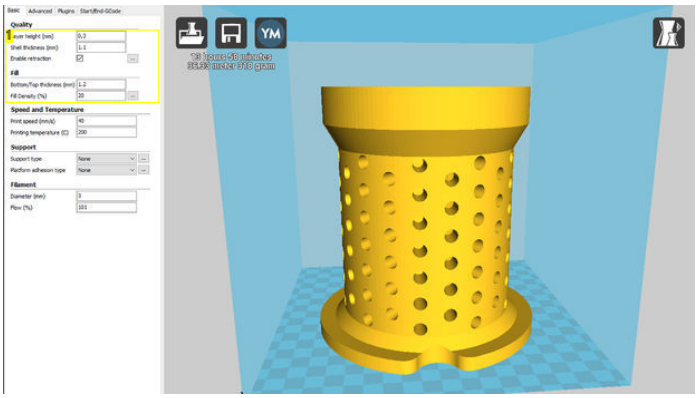


Image Notes
1. CURA 14.12.1 settings

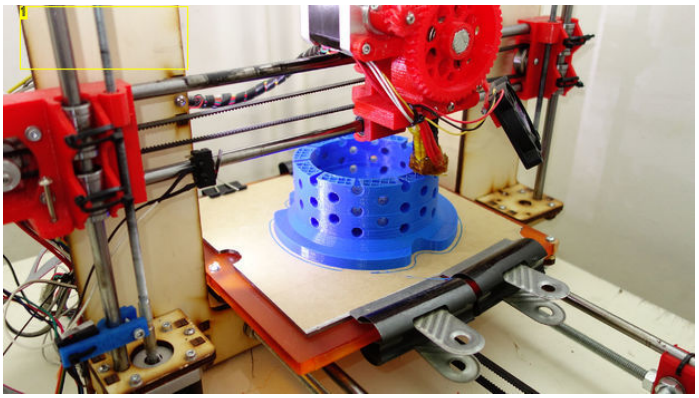


Image Notes
1. REPRAP Prusra I3.3

Step 3: Electonics

The open air is made to be
completely autonomous. It has a gas sensor to measure the air quality and a LED panel for visual feedback. My PCB and code is made so there are 3 options:

Clean air: fans and LED are off.

Dirty air: The fans spin near client (speed can be adjusted with a 1K ohm variable resistor) and the LED's breaths slowly in an upwards motion.

Gross air: Fans speed up to maximum and the LED's breaths fast in an upwards motion.

The basic setup of the PCB is made with two relays for the 2 fan speeds. One is direct 12v for full speed and the other is guided though variable resistor.

To provide the Aruino with 5v while using a 12v power supply I used a couple of voltage regulators. This creates a 5v rail for the Arduino and sensor, a 12v rail for the fans and a common ground rail.

The 5 3mm LED's can be glued inside of the cutouts in the Plexiglas. All LED's have the same ground wire, and the positive anode sides will be connected to the Arduino PWM output ports.

LED to Arduino pin connections with resistors. From top to bottom.

- pin 3 - 100 ohm
- pin 6 - 340 ohm
- pin 9 - 220 ohm
- pin 10 - 100 ohm
- pin 11 - 100 ohm

The resistance varies depending on the thickness of the Plexiglas that the LED has to shine trough.

For maximum ease and customizability everything external is connected with connectors.

Calibration

The MQ sensors are not all the same and needs to be calibrated. Put the sensor near fresh air or ideally outside and wait until the minimum value is reached. This is the value of clean air and you can change the values in the code accordingly. The code is filled with instruction to make it easy to understand where to change the settings.

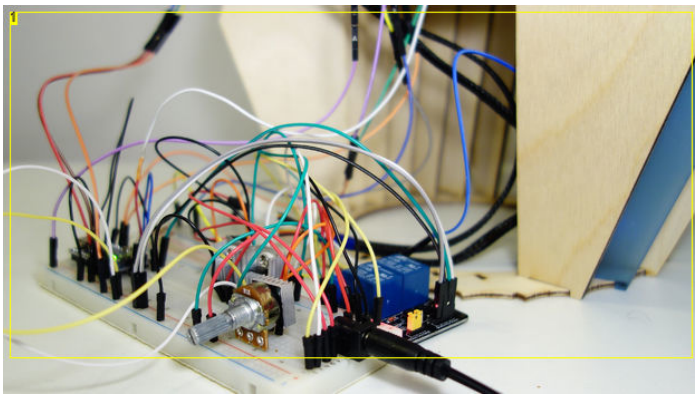


Image Notes

Image Notes

1. Testing...

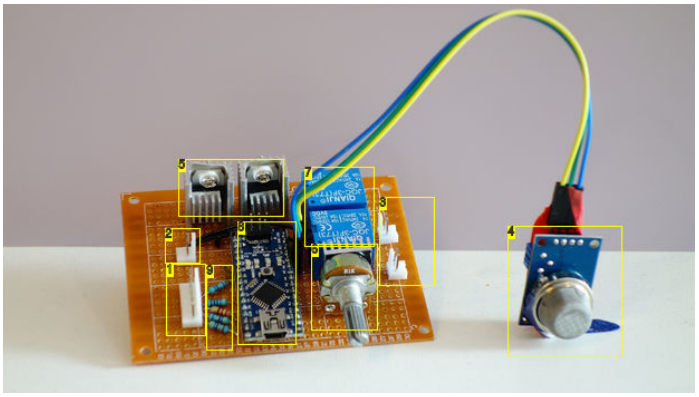


Image Notes
1. LED connector
2. 12v in
3. 12v FAN out
4. MQ 135 gas sensor
5. 12 to 5 v power regulator + heatsink
6. 1K ohm pod meter
7. DC / DC realais
8. Arduino nano V3
9. LED resisors

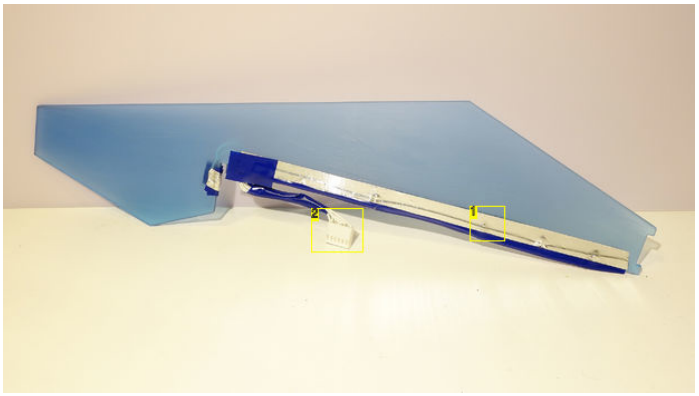
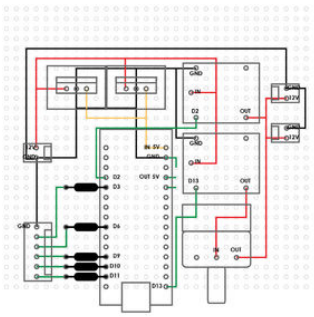
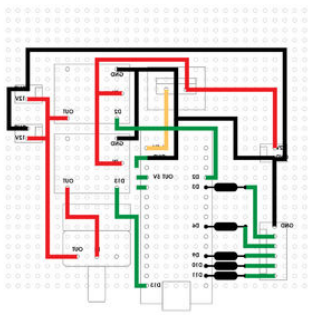


Image Notes
1. isolating tape layer with a reflective aluminum tape layer
2. 6pin female connector.
one common ground for all 5 LED´s

1. polarity indication power supply



Front



Back

Step 4: Assembly part I

The assembly is split in to 2 parts because of to many pictures. Before you start the assembly make sure you have all the parts fabricated, painted and ready to go!

Assembly step 1: Fans

First you should build up the fan assembly with the 2 120mm fans, the wooden top piece, dual fan connector, fan to filter connector and the filter housing. Double check the direction of flow of the fans, they need to blow the air upward. 8 M4 40mm bolts is all you need and the bolts can be crewed direly in to the plastic.

Because 3D prints are never completely flat cause of material shrinkage you may need to tighten the bolts quite a bit, remaining gaps between the fans and the printed parts can be covered with tape.

Assembly step 2: lining up

The height of the wooden top piece on top of complete fan assembly is already set. All you need to do is align the bottom piece by putting in 3 ribs and check the angle of the ribs with the assembly tool. If you want to be sure you can put a couple more ribs in and check the whole shape but do NOT glue it all together just jet.

Assembly step 3: The ribs

Important is to leave at least 9 slot open where the sensor hole is located for easy installation of the electronics. And put the one special rib with the sensor cutout and the Plexiglas rib to the side for now.

Start off with 3 ribs in a triangular form like the previous step and triple check the alignment of the bottom piece and the angle of these 3 ribs with the assembly tool before touching any glue. I would recommend to temporarily secure these 3 ribs with tape and then start to work your way around, gluing ribs in place with wood glue.

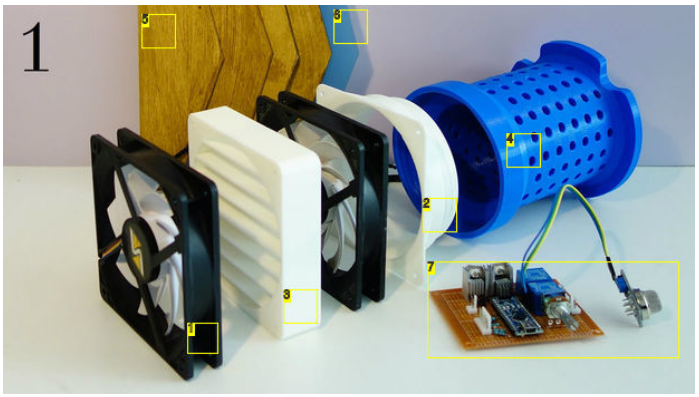


Image Notes
1. 12V fan from Swift tech H220 CPU cooler
2. Fan to filter connector
3. Dual fan connector
4. Carbon filter housing
5. wooden pieces
6. plexiglass LED panel
7. Custom PCB

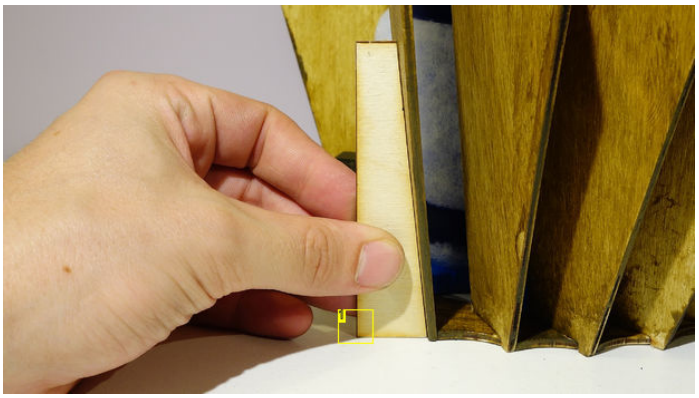


Image Notes
1. Check tool for the correct angle

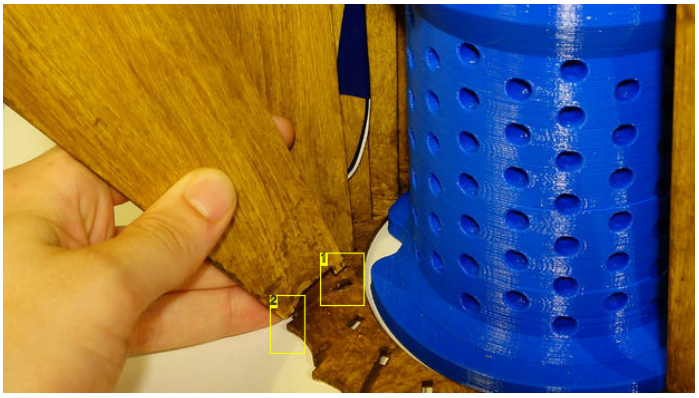


Image Notes
1. slot for glue
2. slot for glue

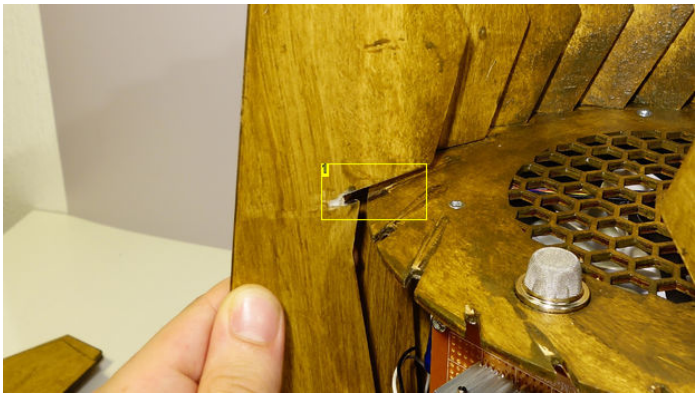
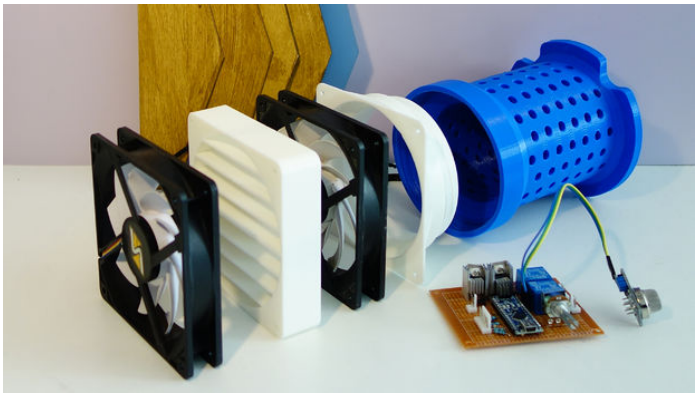


Image Notes
1. slot for glue

Image Notes



1. leave at least 9 slots open for easy installation of the electronics

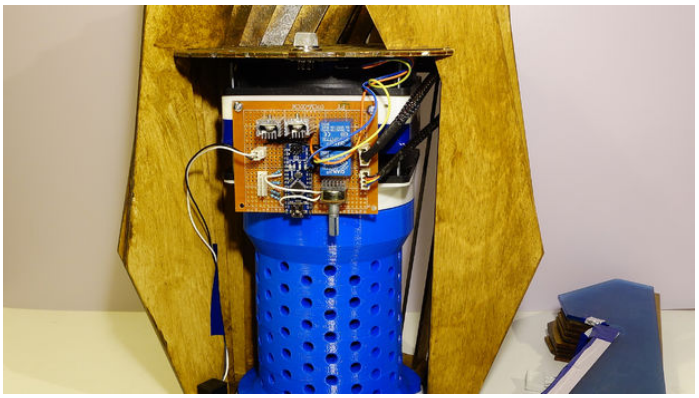
Step 5: Assembly part II

Assembly step 4: Electronics board.

The electronics board can be mounted in the holes already printed in the fan connector. If you want to you should use the smallest spacers that you can find because the tolerances with the ribs are pretty tight. PRO tip: if the holes in the electronics board won't align with the holes in the printed part, like what append to me.. Get a small screwdriver and a lighter, heat up the screwdriver until it's nice and hot, and then keep rotating the screwdriver while slowly pressing into the printed part. And voila a perfect hole to put a bolt in. keep in mind to not go completely trough the printed part, and you should use 10mm M3 bolts.

Assembly step 5: Finishing up

First let's finish all the wiring. The fans can be connected and the power plug print can be glued in place after you welded the wires and connector on it. Now is the time to do a last final test to check if the complete system and all the electronics work. If all is well you can start gluing the last ribs in place. I would suggest starting by connecting the LED rib and putting it in place, next I should place the special wooden rib with the cutout for the sensor and the fan wires. Next up is put the remaining 7 ribs in place and BOOM. The main assembly is done!!



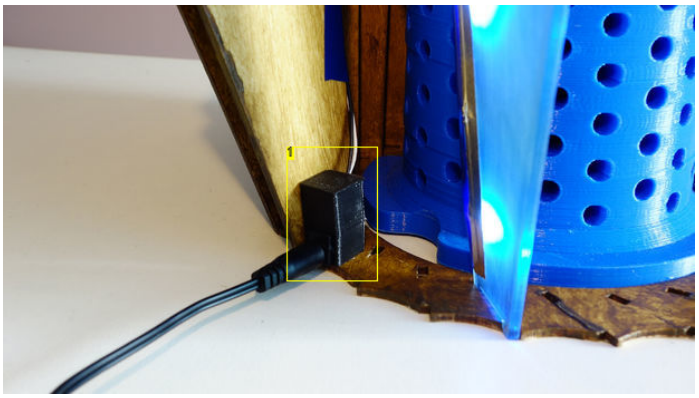


Image Notes
1. small print for power connector. super glue is king!

Image Notes
1. connect the LED´s

Step 6: The Filter

After the assembly the filter housing can be unscrewed from the bottom of the OPEN AIR.

The trick with using 12v PC fans is to not restrict the air to much by making the filter to dense. Do not overdo it otherwise there would not be enough airflow to have a significant effect on the air quality.

The air will pass through 3 types of media designed to remove dust and toxins from the air

1. Fine dust filter

The fine dust filter on the outer side of the housing is the first filter the air encounters and it will remove dust particles from the air. These filters can usually be bought at large stores in the household sections.

2. Course activated carbon grid

Activated carbon comes in many shapes and forms and it can be a weird item to find. The simple solution is activated carbon for fish tanks! It's cheap, easy to find and it will work very well as an air purifier. So go to the nearest pet store or go online and search for the biggest grains of activated carbon. The larger the grain the better the airflow!

3. Activated carbon sponge

The Activated carbon sponge is also a product made for fish tanks that works great as an air filter medium. The best thing about these sponges is that they are nice and

firm and thus can be used as cover, so the activated carbon grid won't fall out the filter housing. Look for a square sponge at least 8 by 8 centimeters and cut is roughly round so it will fit snugly inside of the filter housing.

A good baseline is the layer design like I illustrated. But feel free to build up your own filter.

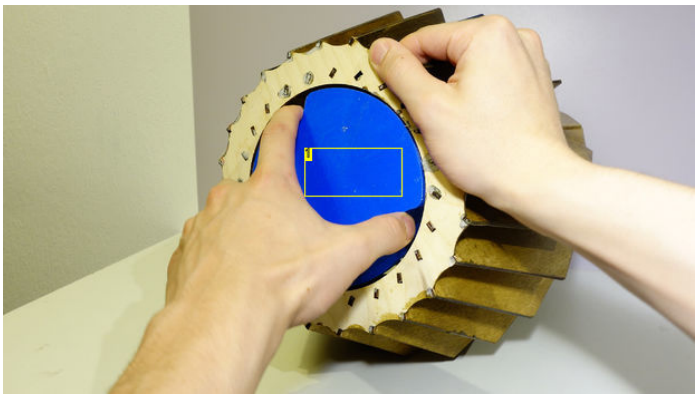


Image Notes
1. removable filter
righty tighty lefty loosey

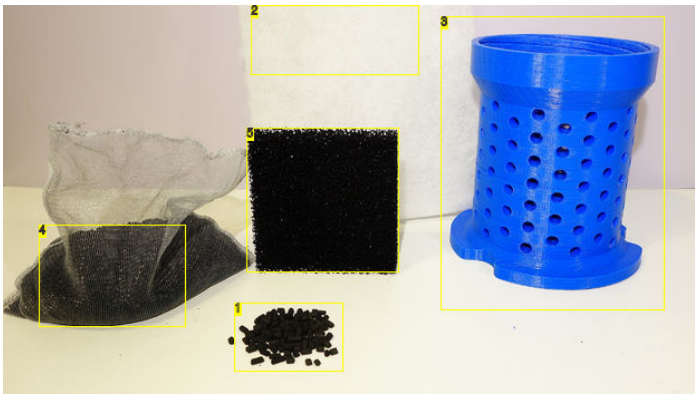
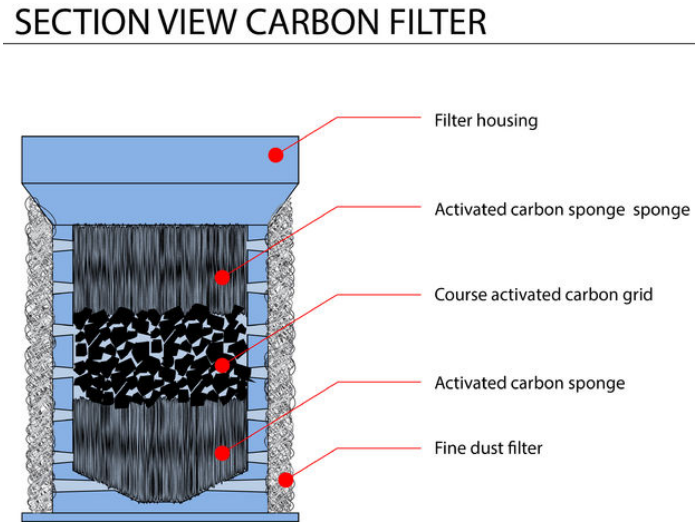


Image Notes
1. Course activated carbon grid
2. Fine dust filer
3. Housing for carbon type filter
4. Course activated carbon grid
5. Activated carbon sponge



Step 7: USE > IMPROVE > SHARE

USE

Great job if you came this far and congratulations on your own OPEN AIR! I hope you did enjoy the build and that you learned some new things along the way.

The open air fits best in a small to medium room like office spaces, bed rooms and living rooms. I would say all the rooms up to a maximum of 35 square meters, otherwise it will be to must of a volume to clean on a constant basis. For use in big rooms the open air can be put on its side to blow a lovely breeze of fresh clean air toward you.

The OPEN AIR with the activated carbon filter will significantly improve the air quality and removes all unwanted odors and toxins from the air. However the activated carbon works like a sponge and will become saturated over time. Meaning that you should replace the activated carbon every once in a while, like every couple of months. Check step 5 for instructions on replacing the filter.

IMPROVE

There are always improvements to be made and this project is no exception. Because the lack of skills and time I could not implement the following improvement:

PWM fan controlled by the gas sensor values.Small control panel for manual override buttons.Overall size of the electronics. Better sensor placement. NOCTUA NF-F12 fans.Different filter designs like: vertex dust chambers, UV sterilization, dehumidifiers, HEPA filers and more

If all goes well in the next time frame, I am going to test the effectiveness of this carbon filter versus a previous UV filter design. Result will be shared of course!

SHARE

I really appreciate all the time and effort that you put in reading, making or improving this instructable! And I really hope you guys are now more aware of the problem of indoor air quality and that you are now a small part of the solution. So share this insturctable and your results and improvements. Together we can make a change!

Related Instructables

CLEANit : Plant Powered Air Purifying System by Ganesh Varma Vegesna

Creating Activated Carbon From Food Waste (CCC Carbon Method) by nocureforcrazy

Open Source Air Purifier :Air B Development Timeline : Made in Shanghai by aaaiiirrr

Activated Carbon Air Filter by Hatty

How to refill a "disposable" Brita brand water pitcher filter with activated carbon. by IAMSatisfied

Open Source 3D Printed Water Filter by makerboat

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