

*The Hackaday Prize 2015 called for “a solution to an important problem”, an idea that has the potential to help a lot of people.*



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Open Source  
LGPL v3



# Portable Environmental Monitor

Addressing pollution @Global Scale

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# Introduction

The portable environmental monitor addresses pollution, the kind that we are unable to see but directly affects our health and can cause life threatening diseases. Airborne toxic chemicals, radioactive dust and radioactive radon are correlated with cases of pulmonary cancer, cardiovascular disease, asthma or pulmonary disease [1].

Since our biological senses can do little to warn us of such possible dangers, we plan to design the Portable environmental monitor as a first line detection and warning system.

This is not the regular detector: packed with powerful sensors capable of detecting both the chemical and the physical harmful factors, these devices are designed with Internet connectivity and will share all readings to the Global uRADMonitor network, [www.uradmonitor.com](http://www.uradmonitor.com) [2]

Online data allows us to build graph, stats and send automated notifications when certain thresholds are reached. The infrastructure has been developed for the uRADMonitor project, semifinalist of HaD 2014 [3]

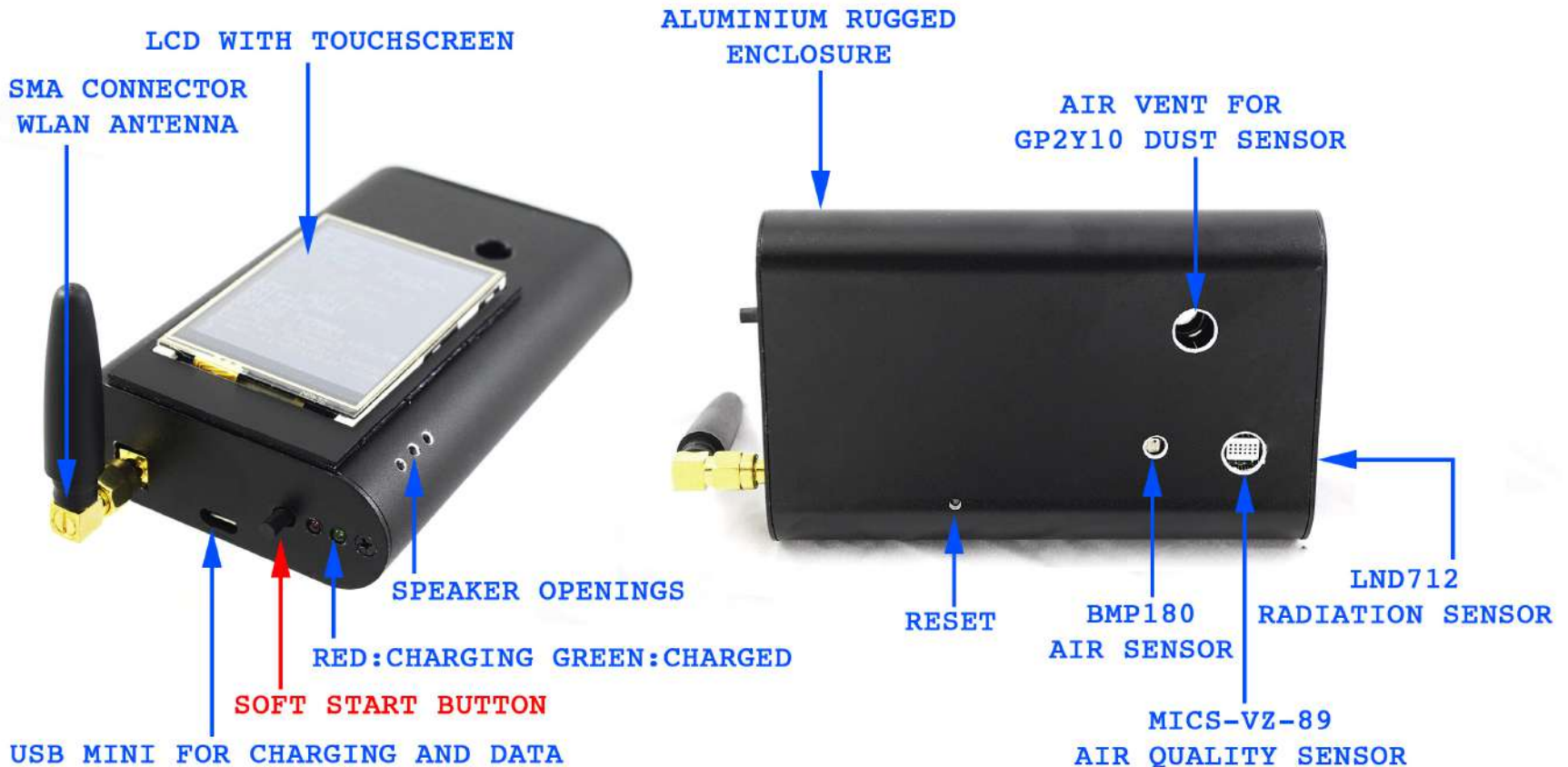
**Knowing what's around us, we have a better chance to take action!**



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# Device Overview

Press the soft start button for 3 seconds to start the device



# The Problem we Solve



Studies have shown the negative effects of primary air pollutants on health [1]

Having a portable monitoring tool, people become more aware of the possible danger, and are able to take preventive actions.

Showing a global scale map of pollution, we're able to pin point the most affected areas, raising more community interest for solving the problem [2]

The Monitor is equipped with powerful sensors making it capable of instantly identifying some of the most aggressive air pollutants (VOCs, CO<sub>2</sub>, Dust, Radon / radioactive dust).



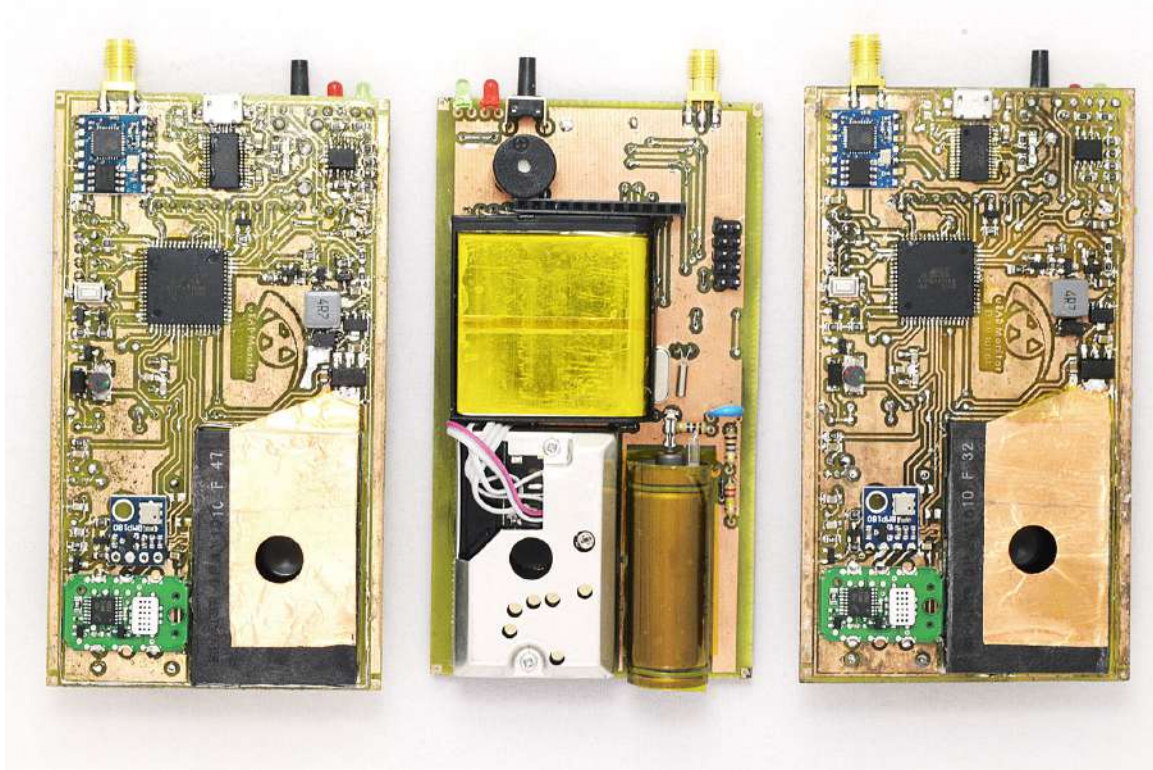
Image credit: <http://www.ctvnews.ca/health/10-million-canadians-at-risk-from-exposure-to-traffic-pollution-researchers-1.1506719>



# The Hardware



Atmega128 microcontroller, 2.4" touchscreen color LCD, 1500mAh battery with charge and temperature control, FT232 USB interface, ESP8266 WLAN interface, LND712 Geiger tube, GP2Y10 dust sensor, MiCS-VZ-89 air quality sensor, BMP180/BME280 air sensors, speaker.



# The Enclosure



Rugged aluminium for durable construction, small enough to comfortably fit the palm of your hand, while allowing easy access to the touchscreen. Air vents for sensors on the sides. LED indicators for battery charger. Convenient placement of Geiger tube at the top end to allow probing.





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# The Software

Modern UI with finger friendly buttons and data shown in charts. Driver implementation for all hardware components separately. Complex software with approx. 3000 C++ code lines in Beta only, not counting the server side. Real time user input handling and information display, correlated to sensor readings. No Arduino nor operating system used.

```
30:00:43 87% 00:01:25 87% 00:03:31 79%
```

MEASURE

MONITOR

SETTINGS

SHUTDOWN

BACK

36.40°C

1002hPa

90.39m

0.00mgm<sup>3</sup>

400.00ppm

873.36ppb

0CPMM

MEASURE

Are you sure?

YES NO

SHUTDOWN

```
p 33
}
// handle regular buttons
switch (uiResult) {
case ID_BUTTON_SHUTDOWN: {
uint16_t result = gui.showYesNoPopup("Are you s
if (result == ID_YES)
shutdown();
else if (result == ID_NO) {
uiResult = 0;
gui.drawPage(PAGE_MAIN);
}
} break;
case ID_BUTTON_MEASURE: {
uiResult = 0;
gui.drawPage(PAGE_MEASURE);
} break;
case ID_BUTTON_MONITOR: {
uiResult = 0;
gui.drawPage(PAGE_MONITOR);
} break;
case ID_BUTTON_SETTINGS: {
uiResult = 0;
gui.drawPage(PAGE_SETTINGS);
} break;
case ID_BUTTON_BACK: {
uiResult = 0;
gui.drawPage(PAGE_MAIN);
} break;
case ID_BUTTON_MUTE: {
isMuted = !isMuted;
if (!isMuted) beep(); // test beep that sound i
uiResult = 0;
} break;
}
```

# The Infrastructure



Global centralized infrastructure currently handling close to 300 uRADMonitor-A devices all across the globe, sending in measurements with 1 minute resolution, totaling 57 million DB entries and counting. The Portable Environmental Monitor is able to contribute with pollution readings for a global scale picture thanks to its built in USB+WLAN connectivity. All data collected is open source / FREE PUBLIC DOMAIN .







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# Improving the Beta



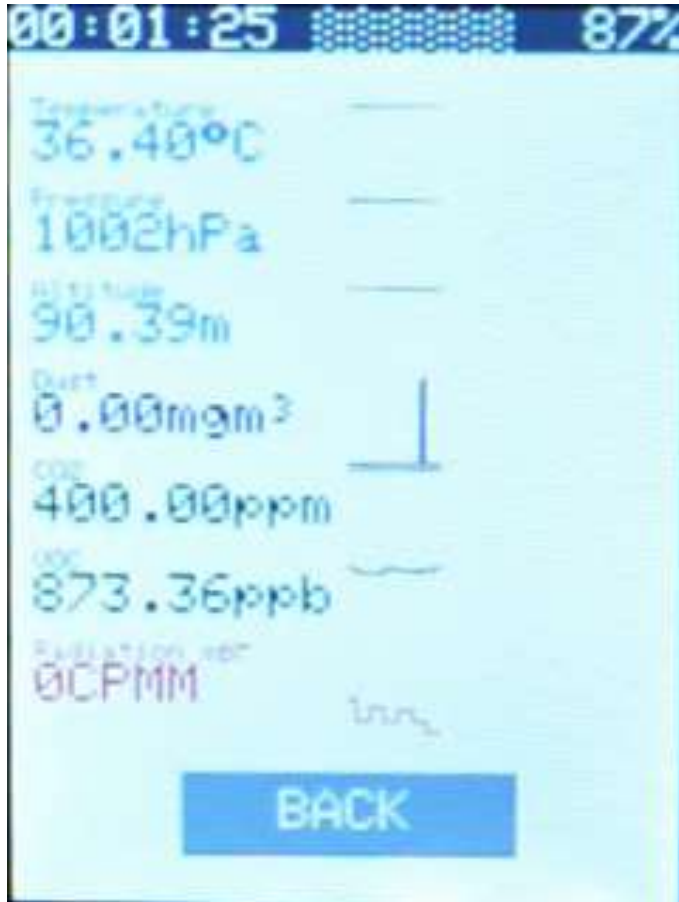
It would be more appropriate to call the software Beta while the hardware is a little further developed. The beta hardware needs a few changes, like better energy management, renouncing to the 5V boost converter and changing the high voltage inverter to a multiplier topology so it can run from 3.3V, and changing the 3.3V LDO regulator to a more efficient energy management, most likely something based on a LTC IC (eg. LTC3440). Also the LCD connector needs to be standardized, as at this moment it is custom and a bit hard to assemble / disassemble. The ISP connector must be moved closer to front, and changed to a 6pin type, that's enough for ISP programming. ESP8266 ESP04 changed to ESP08 for some extra RF interference protection. A micro-sd would be a nice add-on to collect data while offline.

**But these are all just optional improvements.**

# Improving the software



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The beta SW will be further improved:

- Finalize Wifi code to have all data reported to [www.uradmonitor.com](http://www.uradmonitor.com)
- Add a software keyboard (SIP) to allow entering the WLAN key or any other user parameters
- Add configurable thresholds for alarms for all parameters monitored
- **Additional graphics for quick indications: green gfx / health fresh air , red/polluted air and so on**

# Beta troubleshooting



- If the device doesn't start, connect the USB charger and try again. Keep the start button pressed for 3-5 seconds.
- If the device doesn't turn off, press reset. If still on, just press it several times, while also keeping it down for a few seconds.
- In case of any unexpected behavior or screen corruption, reset the device
- WLAN in this Beta is for Open Aps only but WLAN might not work at all.



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# References

- [1] The Influence of Primary Air Pollutants on Human Health Related Risk , *Sule, Tunde Usman Nurudeen, Alhasan, Abubakar, Z., Abdulasisi Titi Umoru*,  
<http://www.iiste.org/Journals/index.php/JEES/article/view/6764/6876>
- [2] Global Radiation Monitoring Network,  
<http://www.uradmonitor.com> and <http://dev.uradmonitor.com>
- [3] uRADMonitor-A HaD Semifinalist 2014,  
<https://hackaday.io/project/1662-global-radiation-monitoring-network>
- [4] Portable Environmental Monitor construction log,  
<http://www.pocketmagic.net/portable-environmental-monitor/>
- [5] Portable Environmental Monitor on Hackaday,  
<https://hackaday.io/project/4977-portable-environmental-monitor>



# Thank you



**This was a one man show. Thanks for watching!**

Radu Motisan , [radu.motisan@gmail.com](mailto:radu.motisan@gmail.com) , August 2015