26/Sep/16

CHEMDUINO INITIAL PROJECT SPECS

1. OUTLINE

Modular, open source “labs-in-a-box”. Central unit based on a PC/Raspberry Pi/Android, sensor units based on the Arduino framework.

A. Possible Sensor / Data Logger Units

i. Gas Sensors
ii. Spectrometer/Colorimeter/Turbidometer (based on the same design)
iii. Temperature/pH probes
iv. Water Quality Testing
v. Integration of various other “Open” lab equipment(?)

B. User Interface Options

i. Qt based platform independent software C++ (end-user only)
ii. Web based front-end for “headless sensors” (data sharing for groups of sensors)

2. REQIREMENTS

A. Modular and Easy to Use

In order to accommodate both “plug-n-play” users and tinkerers, each sensor module should be “self contained” with the associated driver circuity built in. There should be no need to pick up a soldering iron after receiving the kit.

Example Use:

Environmental Monitoring:

Sensors:

Humidity + Temperature + Ground pH +Wireless-mesh module +Solar modules. Plugged into the Arduino core.

User Interface:

Data collected over Wi-Fi, viewed over software of choice.

B. Open Source and Cross Platform

Circuit design can be made in Fritzing or DipTrace for ease of-use while housing CAD files should be public (OnShape?) End product should not be platform dependent; sensor output should be human readable csv/txt files. Data handling can be done in R/ Python/Qt C++. A central UCL hosted data handling server would be great for viewing data over a map or from multiple sources.

Example Use:

Water monitoring:

Sensors:

Colorimeter/turbidimeter + pH + Spectrometer modules

User Interface:

Online logging of data points that can be viewed remotely as user-friendly plots. Possible data visualization solution, plot.ly?

C. Portable and Rugged

Educational hardware should be able to take a fair bit of abuse and also neglect, but modularity prevents robust and monolithic designs.

Key Design Points:

i. No in-built, enclosed, batteries, LiPo or otherwise.
ii. No high voltage sources (i.e. no Geiger Counter, which would be cool ☺)
iii. No jumper wires, instead locking/standard connectors should be used. Especially for sourcing power (i.e. there should be no need to cut the connector off a AC/DC adapter off to attach leads)
iv. Either 3D printed ABS or laser cut wood with some assembly (PLA can be flimsy).
v. Nothing sharp (i.e no razor blade slits for spectrometers)
vi. Easy to assemble, if PCB's are needed all Gerber files etc. should be available along with a bill of materials for populating after fabrication.
vii. Cheap, repairable, replaceable (parts off Amazon/EBay/RS, no specialty components)
viii. No moving parts for reliability (no fans, servos etc.)

D. Connected

Should be easy to share data, and scale the data collection from 1 to a 1000 units if need be. RF24L01 radios can be used to form a mesh network to communicate data with low power requirements. GSM shields can be used to transmit over cellular. We could also tweet i.e. pollution data as a part of community outreach. Each central unit should have the means to collect/upload/visualize data. A massive string of numbers is rarely satisfying to look at.

Example Use:

Air Quality monitoring:

Sensors:

Dust Sensor + Gas Sensors + Radio comm. + Solar (perhaps with a supercap for energy storage, 2F, 5v goes a long way)

Connectivity:

Self forming, healing mesh network that gathers data at given intervals from all sensing modules and makes them viewable–live through a single "master" module. Without requiring multiple GSM modules, expensive Wi-Fi shields etc.

RF24L01 Mesh is a great solution.

3. OUTREACH & COLLAB.

Everything with version control: Github for all files. I'll set up a separate account for the Chemduino Project or it can live under my account. Institute of Making is a great resource for fabricating parts and getting guidance, we should be in touch with them. Should also set up a blog (?) example: MIT-Build in Progress (sadly it's shutting down) Would be great to promote it through schools, hack spaces etc. as well once we have working models.

4. ISSUES

Any chance of access to laser cutters / PCB fabrication / 3D printers or do I outsource it?
Funding? Intricate sensors are not very cheap. Breadboard / perfboard prototypes would work, but they are not very reliable and hard to replicate. If one breaks it will take tons of time to re-build. Also what should be the initial scale of this? I was thinking of at least 5 of each plug-n-play sensor with 5 Arduinos, maybe 2 spectrometer/colorimeter/turbidometers but I need some guidance on this.

What is the cost for a kit of 5 arduino/5x5 sensor/1 RasPi server/power bank or solar we're aiming for?

5. PRELIMINARY PROJECT TIMETABLE

October	November	December	January	February	March
Complete the gas/dust sensor proto. Integrate with mesh network. Measure power needs of sensor + comms. Start on solar power/battery/wall power options. Start housing design for the above. Start writing software/firmware for data collection, sensor control.	Complete "minor" sensors (pH, temp,humidity, etc.) Integrate with GSM comms. Testing of mesh around UCL Complete a solar module W/O housing. Start spectrometer proto W/O housing. Module testing/calibration for gas/dust + minor sensors	PCB designs complete for proto sensors, order boards. Integrate data collection with plotly for headless operation. Housing prototypes complete. Decide on Arduino vs. bare bones MCU based on power consumption.	Alpha for lab-data software, plotting pH, temp. Firmware should be completely functional. Complete spectrometer/start calibration, software integration. Housing testing & Field testing. OpenAFM, OpenSTM integration(?)	All housings/PCB's should be complete. Reseved for debugging and further testing. Software should be release ready.	