OBI: Air Quality Sensor Hub

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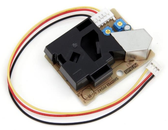
Introduction

The **Open Bike Initiative (OBI)** is a bike sharing model based on open hardware and open source software launched in 2013.
The **Air Quality Sensor Hub** is a self-contained and cost effective unit to be implemented on select OBI bicycles. It is capable of measuring a riders' exposure to air pollution by collecting real-time air quality information along the traveled paths. By combining the data, commuters can evaluate the best times to travel and ideal paths to take in order to minimize their exposure to pollutants.

Pollution

Pollutants as defined by the EPA are:
• Ozone • Nitrous Oxides • Sulfur Dioxide • Lead
• Particulate Matter • Carbon Monoxide
Sensors for Ozone, Nitrous Oxides, Sulfur Dioxide, and Lead are very expensive. In order to keep the system cost effective **CO** and **Particulate Matter (PM)** are the main focus.



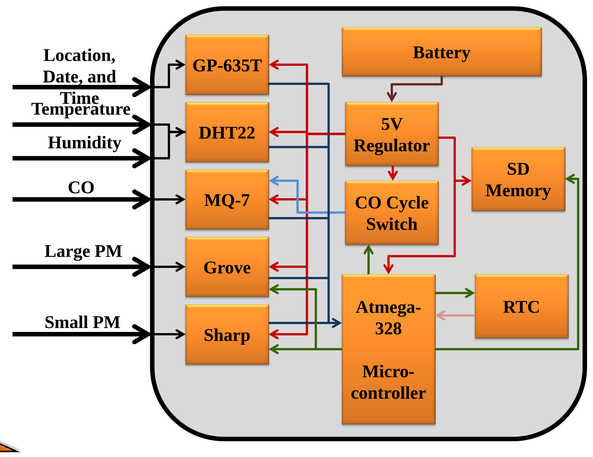
Grove (Large PM)

MQ-7 (CO)

Sharp (Small PM)

DHT22 (Temp + Humidity)

GP-635T (GPS)

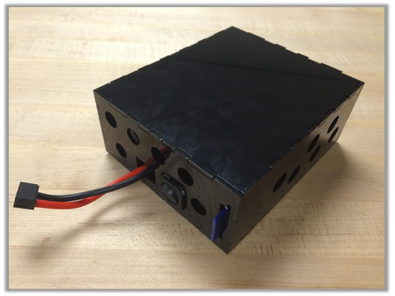


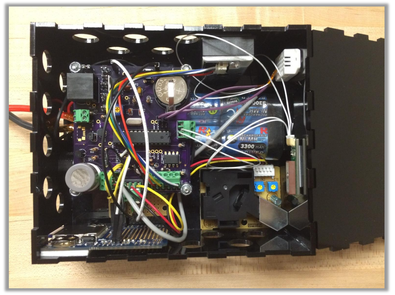
System Design

- The **Arduino** based system uses an **Atmega 328 microcontroller**.
- The rechargeable **7.2V Ni-MH battery** pack is connected to a **5V** linear regulator through a switch. The regulated 5V line powers all the components of the system including all sensors and can supply approximately **9 hours** of power before needing to be charged.
- Approximately 90 seconds after power on, the **GP-635T** GPS begins sending the location, date, and time to the microcontroller.
- The **DHT22** sensor begins sending the temperature and humidity values to the microcontroller as soon as the system is powered on.
- The **MQ-7** cycles through a 60 second burn off (cleaning) phase after which it begins reporting relative CO levels to the microcontroller for 90 seconds. The cycle repeats continuously.
- The **Grove** sensor reports the relative concentrations of larger PM particles while the **Sharp** sensor reports the relative concentrations of smaller PM particles in the air.
- The **Real-Time Clock (RTC)** is set using the time reported by the GPS and is used to track the time for each record.
- Every **2 seconds** the microcontroller records a new line of sensor data onto a text file saved on the **SD** memory card.

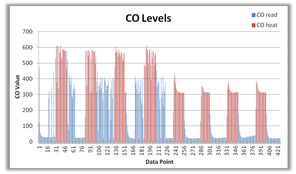
Future Plans

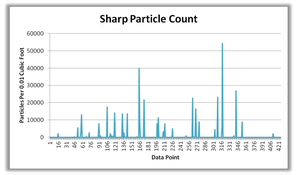
Future models of the OBI systems are expected to have an improved **"Smart Lock"** capable of **wireless**, **cellular,** and **RS232** communication via **RJ45**.
In anticipation of the upgrades, our system is designed with its own RJ45 connector in order to:
• Receive commands
• Send data for cloud storage and analysis
• Transmit power from a dynamo hub

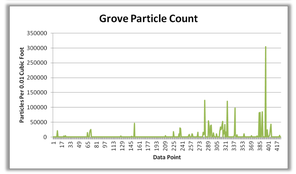


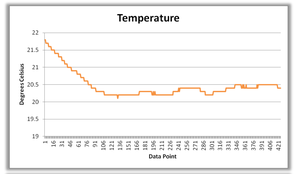


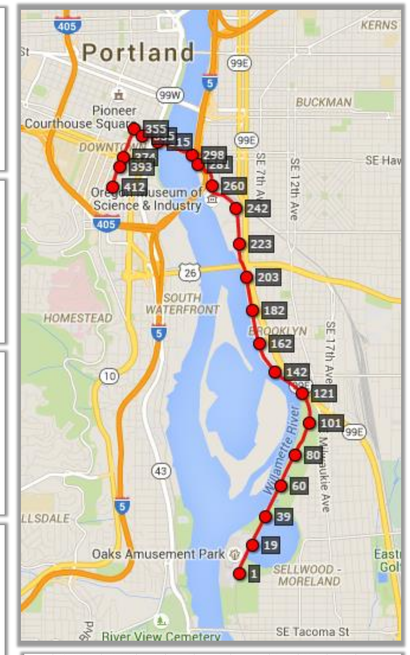
Sample Data

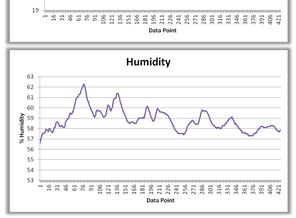


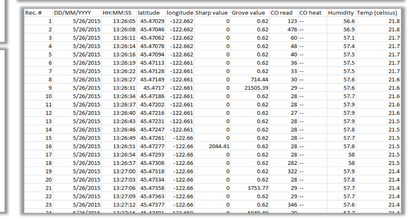












Rec. #	DD/MM/YYYY	HH:MM:SS	latitude	longitude	Sharp value	Grove value	CO read	CO heat	Humidity	Temp (celsius)
1	5/26/2015	13:26:05	45.47029	-122.662	0	0.62	123	--	56.6	21.8
2	5/26/2015	13:26:08	45.47046	-122.662	0	0.62	476	--	56.9	21.8
3	5/26/2015	13:26:11	45.47062	-122.662	0	0.62	60	--	57.1	21.7
4	5/26/2015	13:26:14	45.47078	-122.662	0	0.62	48	--	57.4	21.7
5	5/26/2015	13:26:16	45.47094	-122.662	0	0.62	40	--	57.5	21.7
6	5/26/2015	13:26:19	45.47113	-122.661	0	0.62	36	--	57.5	21.7
7	5/26/2015	13:26:22	45.47128	-122.661	0	0.62	33	--	57.5	21.7
8	5/26/2015	13:26:27	45.47149	-122.661	0	714.44	30	--	57.6	21.6
9	5/26/2015	13:26:31	45.4717	-122.661	0	21505.39	29	--	57.6	21.6
10	5/26/2015	13:26:34	45.47186	-122.661	0	0.62	28	--	57.7	21.6
11	5/26/2015	13:26:37	45.47202	-122.661	0	0.62	28	--	57.9	21.6
12	5/26/2015	13:26:40	45.47216	-122.661	0	0.62	27	--	57.9	21.6
13	5/26/2015	13:26:43	45.47231	-122.661	0	0.62	28	--	57.9	21.5
14	5/26/2015	13:26:46	45.47247	-122.661	0	0.62	28	--	57.8	21.5
15	5/26/2015	13:26:49	45.47261	-122.66	0	0.62	28	--	57.7	21.5
16	5/26/2015	13:26:51	45.47277	-122.66	2044.41	0.62	28	--	57.8	21.5
17	5/26/2015	13:26:54	45.47293	-122.66	0	0.62	28	--	58	21.5
18	5/26/2015	13:26:57	45.47308	-122.66	0	0.62	282	--	58	21.5
19	5/26/2015	13:27:00	45.47318	-122.66	0	0.62	322	--	57.9	21.4
20	5/26/2015	13:27:03	45.47334	-122.66	0	0.62	28	--	57.8	21.4
21	5/26/2015	13:27:06	45.47358	-122.66	0	3753.77	29	--	57.7	21.4
22	5/26/2015	13:27:09	45.47363	-122.66	0	0.62	29	--	57.7	21.4
23	5/26/2015	13:27:12	45.47377	-122.66	0	0.62	346	--	57.6	21.4

Conclusion

The system was able to successfully meet the following necessary requirements:
• Cost Effective
• Portable
• Self Contained
• Measure relative pollutant levels
• Correlate data to GPS location
• Evaluate environmental factors
• Able to adjust to future OBI models

In the future, improvements could be made to reduce the size, improve efficiency, and expand on types of detectable pollutants.