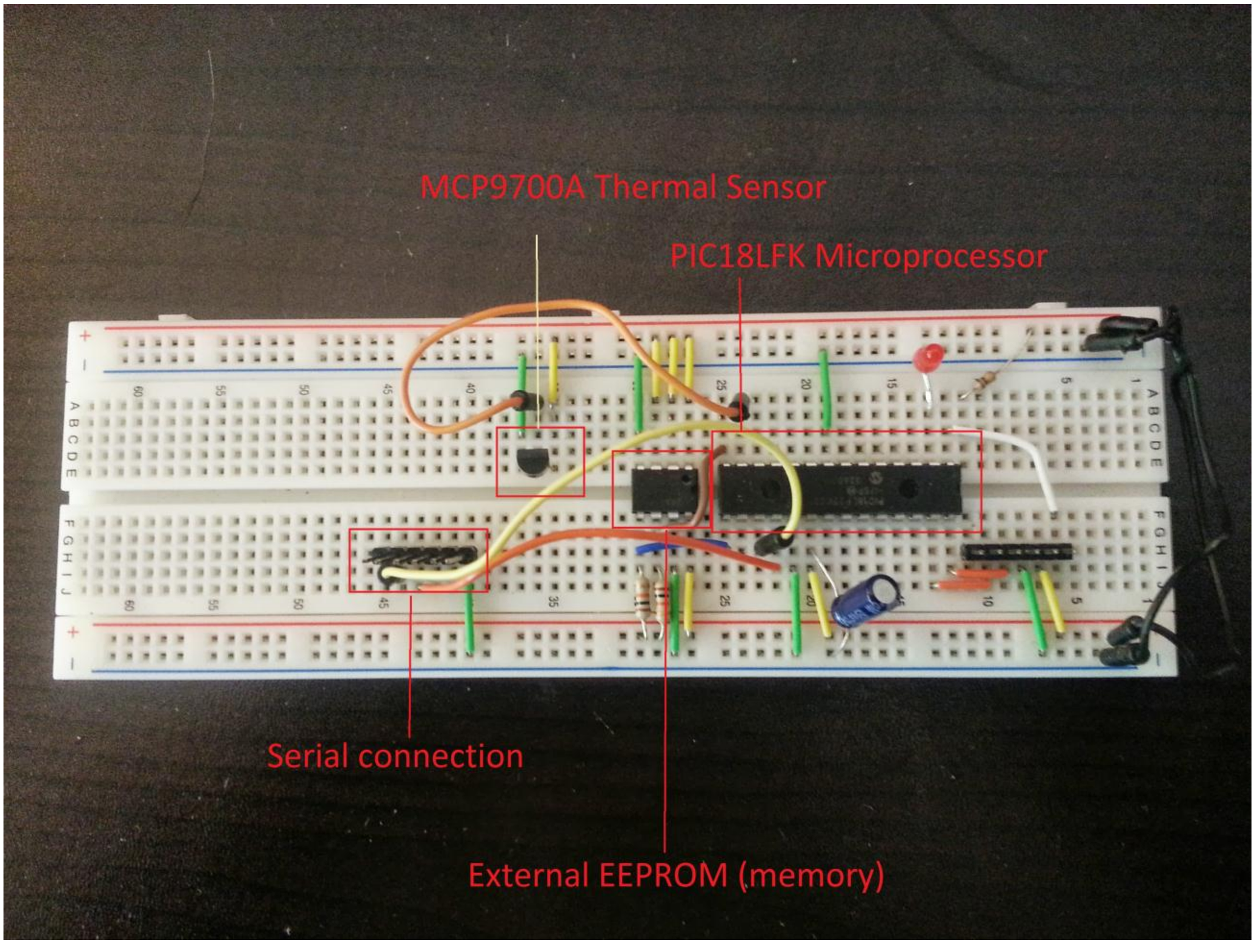
Autonomous Environmental Monitoring Stations in Oakland, CA

Prototype #1:

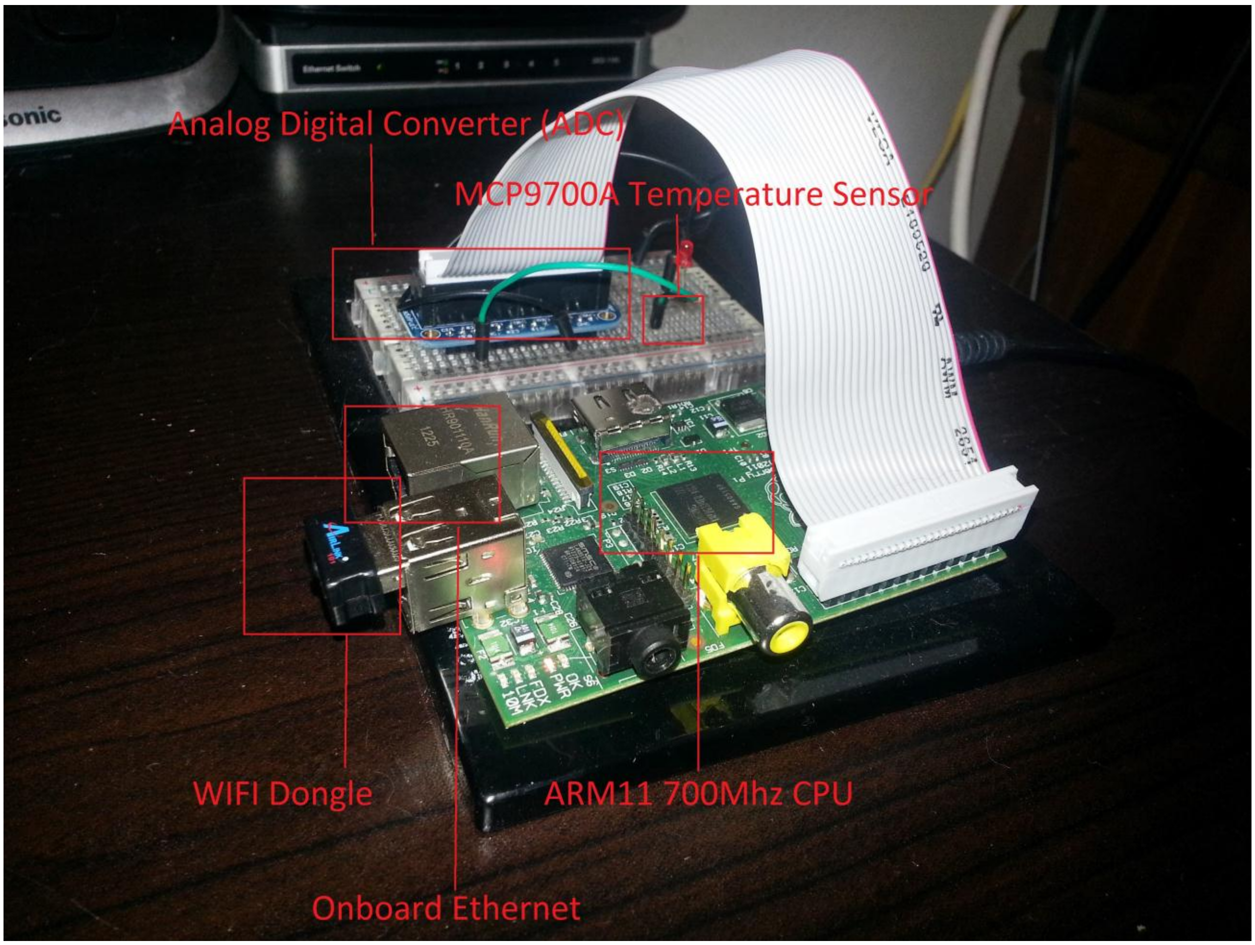
Prototype #1 represents the most rudimentary approach for developing an environmental monitoring station. While it uses barebones components and represents the lowest cost solution/platform, it is technically the most challenging as it requires a substantial amount of low level design and programming.

This prototype uses the PIC18LF25K microprocessor, which retails for about $3/each in volume. Temperature sensing is done using a MCP9700A Thermal Sensor, which retails for around 30 cents. Data is stored on an external EEPROM and downloaded via a physical serial connector. The PIC microprocessor has about 32K of RAM on chip and the external EEPROM holds 64K of data. All told, the parts cost under $5.



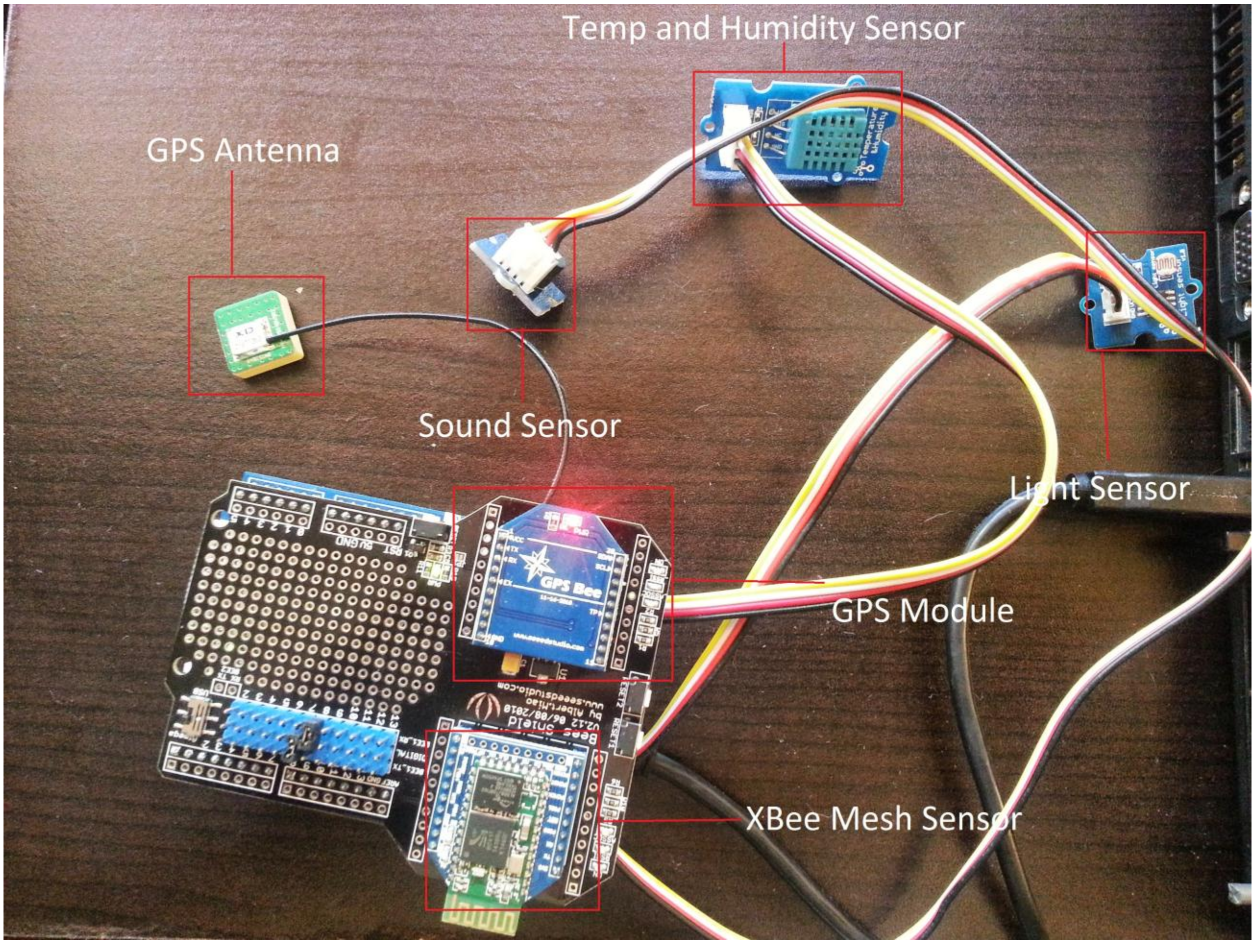
Prototype #2:

Protype #2 represents the most powerful, high level approach to developing environmental sensors. This approach uses a [Raspberry Pi Microcontroller](), which retails for $25. Communication is over wifi, which connects to the Raspberry Pi via USB and retails for about $8. Included in the project is an analog to digital converter which reads data from the analog temperature sensor. The Raspberry Pi comes with 512M of RAM and stores its data on SD cards, which can hold up to 32GB of data. Since the Raspberry Pi is internet enabled and uses high level APIs, it can easily post environmental data to Internet of Things sites such as Pachube/Xively.

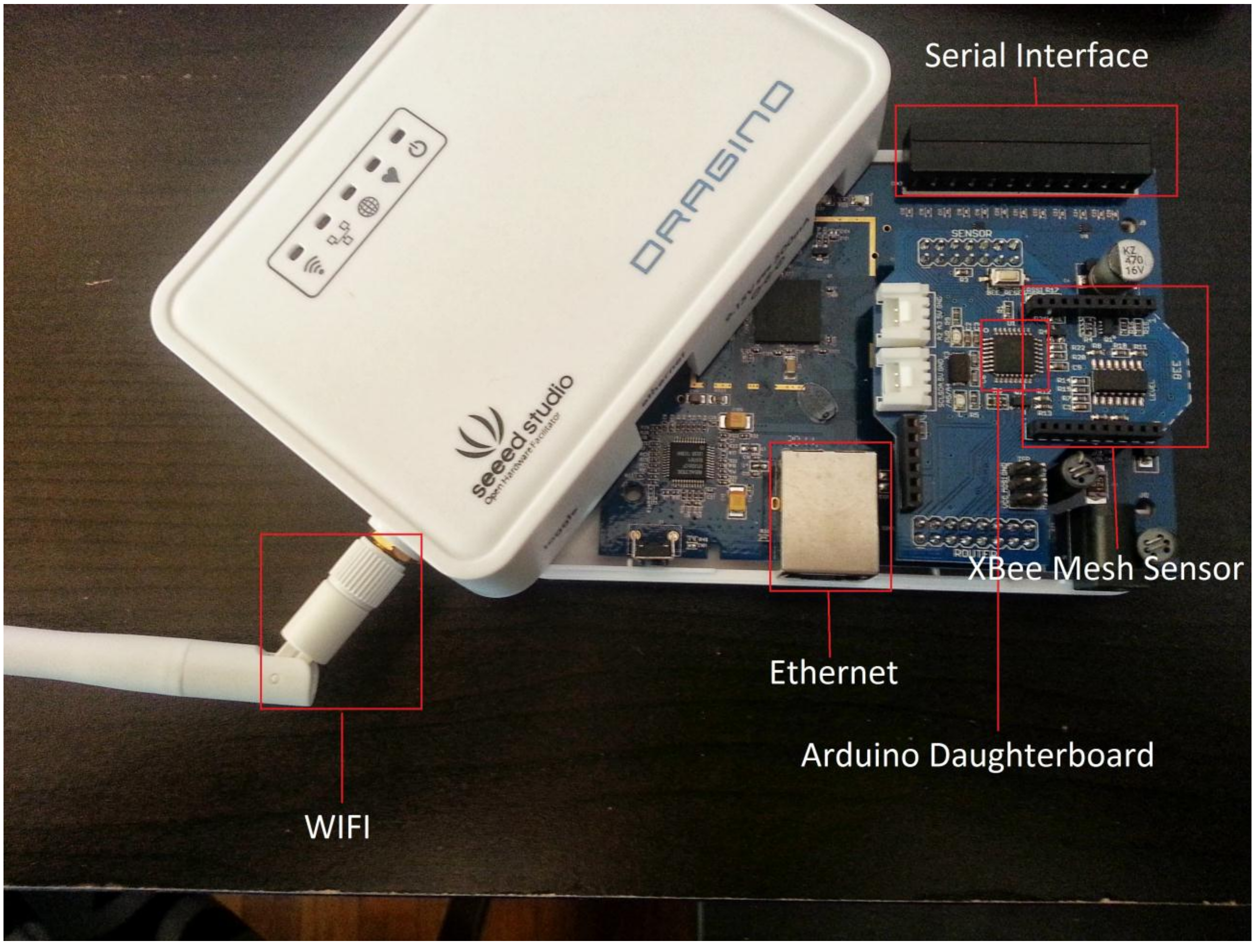


Prototype #3:

Prototype #3 uses an 8-bit ATMEL Arduino microprocessor and falls in cost and complexity in between the PIC and PI solutions. The Arduino contains an 8-bit processor running at 16MHz, with 32K of flash memory. The Arduino retails for around $30 each, though low cost versions exist that retail for around $10. For purposes of this prototype, Grove plug and play components were used to ease connecting new components and sensors. The prototype used the Grove DHT 11 temperature and humidity sensor, a grove sound sensor to measure noise pollution, and a grove light sensor to measure sunlight. Location data is collected using the Grove GPS module, and communicated back to a base station using XBee wireless mesh networking.



The base station consists of a Dragino Dragove WIFI router that includes an embedded Arduino and XBee module. All of the monitoring stations communicate over the XBee protocol to the nearest Dragove base station, which is connected to the internet and uploads sensor data to a backend database.



Next Steps:

For purposes of the prototype, sensor data was logged only to a local PC. In phase 2 of the project, sensor data will be pushed over XBee/WIFI to Pachube/Xively.

The total cost of the Arduino based solution, including Grove sensor components, was about $200. Additional cost cutting measures such as sourcing bare components, as well as using homemade Arduino motherboards based on AVR/ATMEL processors, will be explored. Such measures should cut the cost of each environmental sensor in half.