Creative Uses of Custom Electronics for Environmental Monitoring at the Christina River Basin CZO

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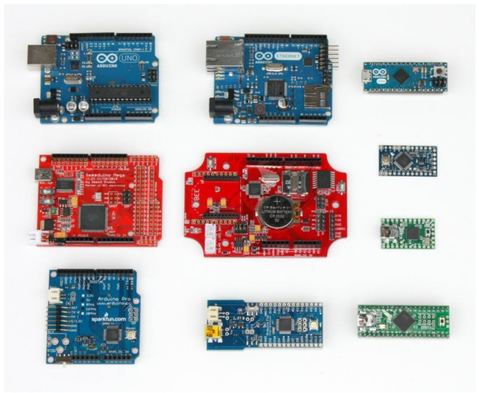
Introduction

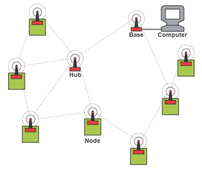
The **Christina River Basin CZO** is currently operating dozens of homemade dataloggers that are connected to different types of environmental sensors, and all the loggers were built using Arduino-based microprocessor boards. We have also created a variety of helpful devices to perform functions that would have been too expensive or impossible to implement with standard methods and commercial hardware. The ability to design and build custom electronic devices specifically suited to a unique task has gotten easier and cheaper, thanks to the recent popularity of open source electronics platforms like Arduino.



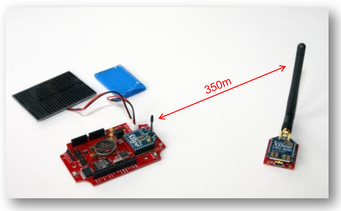
Arduino boards are available in a variety of sizes and configurations. Some have additional features like Xbee radio sockets, Ethernet ports and memory card slots. All of the boards shown here contain the same type of processor and are programmed the same, but the smaller boards are easier to fit into finished projects. Our dataloggers use a custom sensor interface board to easily connect various devices to the main board.

An interface board with memory card and clock creates a basic datalogger.

Xbee radio modules in the same network can use different power levels and configurations.



The Xbee radios form a self-healing mesh network to transmit the data back to the coordinator.



A solar powered logger with Xbee has a range of 350m to the base station, or 100m between logger nodes.

Some of the commercial sensors that can easily connect to Arduino loggers: soil moisture, conductivity, redox, CO_2 probes, pressure transducers, and oxygen sensors.

Observations

- Temperature extremes cause batteries to fail or have significantly shorter lifespans. Live data networks help with logger maintenance.
- Solar panels mounted inside a clear enclosure cause excessive heat buildup on sunny days in the summer. External solar panels cost more but keep the circuitry and battery cooler.
- Humidity and condensation inside the enclosures can cause board failure. A conformal coating should be applied to the circuit boards before deployment.
- Xbee radio range is highly dependent on terrain, vegetation, and antenna gain. Sleep routines are needed to preserve battery life.
- Management of the live streaming data is a very complicated process.
- Our loggers are currently collecting over 30,000 datapoints each day.

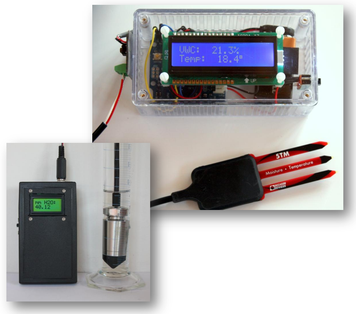
Practical Implementations of Arduino Hardware

6-channel soil moisture probe logger

A quick and inexpensive ($60) way to measure soil conditions.

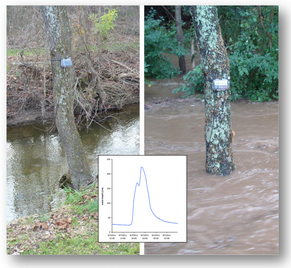
Power Usage Monitor and Logger

Measures power consumption by using non-invasive current transformers. It can be used on single circuits or a whole house. Also measures air temperature and humidity and stores all data to a memory card.



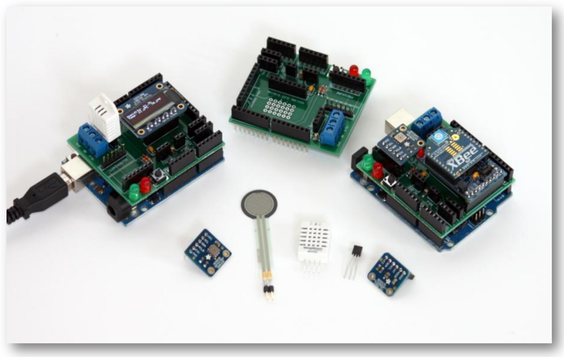
Pressure Transducer Readout & Portable Soil Moisture Probe Tester

Useful for testing probes during deployment.



Radio Reporting Streamgage

An Arduino logger with Xbee radio sends live stream depth data to a base station that posts it to a web page.



Educational Sensor Integration Kit

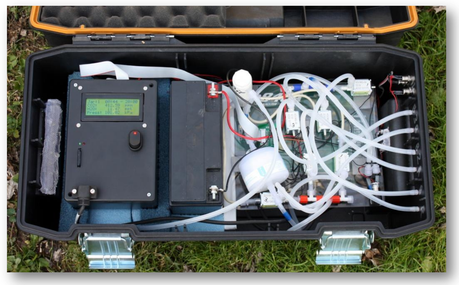
A custom PC board allows students to easily experiment with a variety of basic sensors and then display the data on an LCD or transmit it via Xbee radio to a PC or other logger. The collected data can be submitted to an interactive data visualization system that maps and graphs the students' data alongside live streaming data from scientific stations operated by the USGS, NOAA, CZO, and others.

Remote Streamwater Sampling System

(Also known as Dial-a-Pump) Researchers can remotely trigger a pump by calling the prepaid phone and then following the interactive voice menus to select pump options and hear live sensor value readouts. The pump system can also be adapted to be controlled via the internet or Xbee radio network.

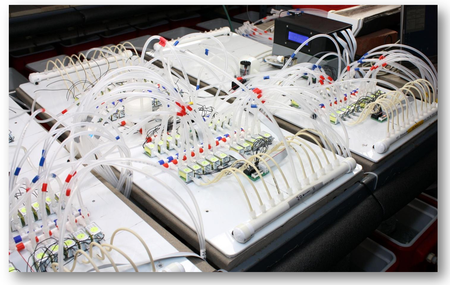
Solar powered well depth logger

Measures water depth in 4 wells, stores data to memory card and transmits via Xbee mesh network.



Portable 3-chamber Soil Respirometer

The Arduino circuit displays live data from a LICOR CO_2 analyzer, logs the data, and operates solenoid valves and pumps to control the flow of air through custom respiration chambers.



60-chamber Respirometer Controller

Similar to the portable unit (left), this Arduino logger controls a LI-COR analyzer, pumps, and 120 separate solenoid valves that sample the rate of respiration in 60 jars of soil samples.

The **Dial-a-Pump** controller operates a bank of large solenoid valves that can fill multiple barrels for sampling the stream water during different parts of a storm.

For more information, visit the CRB-CZO Arduino Project webpage where we will share details of our projects, schematics, and source code:
http://www.stroudcenter.org/research/projects/czo/arduino.shtm

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