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**Last Modified on Oct 31, 2014.** Please keep us updated if you adopt this model and make improvements.

By John, Tibi [add your name here](#)



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## Prototype Versions

**NOTE:** content here might be out of data  
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**This document is co-creative**

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Note: Good names are needed for each version. The current names are just temporary.

See [Applications, scenarios and properties](#) in Product Design doc.

## Important links

- [Project on SENSORICA's website](#)
- [Value accounting system](#)
- [Main doc](#)
- [General design doc](#)
- [Bill of materials](#)
- [John's Github repository](#)
- [John's original prototype](#)

See also [LED green wall project](#)

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## iPot

See [webpage](#)

See [Community Garden prototyping event](#)

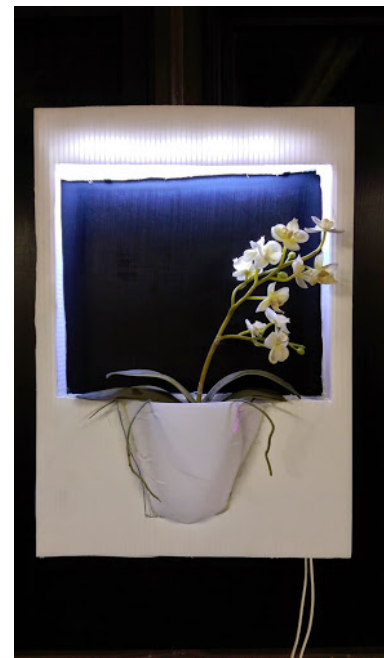
**This is a magic flower pot that you don't even need to water.  
Hang it somewhere and it will always stay green.**

The idea is to fit it with soil moisture sensor, light sensor, temperature and air humidity sensor, LED light at various wavelengths, nutrient cartridge, water generator (using a peltier cooler to condense water from the air), and temperature control.

Other similar products on the market

[Planty](#)

[Click and Grow](#)



# Rechargeable ECG Tiny

This version came out of [this meeting](#). See the Rechargeable ECG Tiny, announced by John [here](#).

See [Community Garden prototyping event](#)

A prototype circuit board of the ECG tiny which is compact enough to sit on the windowsill monitoring a small pot plant, or even hang on the side of a pot. It measures soil moisture and turns on a blue LED when the soil moisture gets below the threshold. While it's a very basic system it could be quite useful in many situations just as an indicator. Plus there are lots of things that can be added or changed such as:

- a potentiometer to change the threshold
- up to 4 LEDs - the drier it is the more turn on
- 2 soil moisture sensors each with a corresponding LED

It could also control an irrigation system but the irrigation would need its own 12v battery (or to find a lower power pump/valve). The threshold can be changed in the code and uploaded using a USBasp programmer via the ICSP header (the 6 pins at the top). But the sensitivity can also be altered by changing the depth of the soil moisture probe.



A small, simple, low power utility to assist in monitoring/managing soil moisture levels. (This is basically a matter of stripping out unnecessary features from Cesar and [John's original prototype](#) and/or using John's Tiny eCG prototype, and just using the basic functionality.)

## Goals

- Monitor soil moisture level
- Indicate using LEDs (green and red/blue) when the soil moisture level is high or low
- Trigger an irrigation system when the soil moisture level is low
- Be small, compact, and low cost

## Features

- Soil moisture sensor - Detects soil moisture and the system reacts accordingly. We can use [SENSORICA's optical soil sensor](#).
- LEDs - Green LED lights up when soil moisture is high and red/blue LED lights up when soil moisture is low.
- Output for connecting to optional irrigation circuit

#### Technical

- Microcontroller: attiny85 or arduino (nano or pro mini)
  - Battery: 18650 lithium battery (x 2 or x 4)
- 

## A simple thermometer shaped device

[Open doc](#)

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## eCG Environmental Logger and Display

A low power eCG system with environmental sensors, LCD display, and optional irrigation control.

(This would be similar to Cesar's prototype with the added sensors from [John's original prototype](#) included.)

#### Goals

- Provide local plant, soil, and environmental information that can be easily viewed on an LCD screen.
- Indicate (using LEDs) when the soil moisture level is high/low
- Activate optional irrigation system when soil moisture is low.

#### Features

**todo**

#### Addons

- LCD display (via embedded computer board)
- Web broadcasting (via embedded computer board)

#### Technical

- Embedded computer board: RPi, Odroid, etc.
  - Microcontroller: arduino (nano or pro mini)
-

# eCG Environmental Broadcaster

A full featured eCG system with environmental sensors, LCD display, irrigation control, and internet publishing.

(This would be similar to John's prototype with the added LCD, etc. from Cesar's prototype.)

## Goals

- Provide remote and local plant, soil, and environmental information that can be viewed locally on an LCD screen as well as broadcast online to be viewed anywhere in the world.
- Indicate (using LEDs) when the soil moisture level is high/low.
- Activate optional irrigation system when soil moisture is low.

## Features

todo

## Technical

- Microcontroller: arduino (nano, pro mini, uno, or leonardo)
  - Battery: 12v SLA battery
- 

# Environmental Monitor (“Watcher”)

Monitors environmental and soil data.

## Nano “Watcher”

### Features

- Temperature
- Humidity
- Soil moisture x 4
- Light
- Water flow rate

### Addons

- LED Lighting
- Micro SD card module for logging.
- Real Time Clock module
- Embedded computer
- LCD Display
- WiFi hotspot
- Web application

## Irrigator (“Rain”)

Monitors soil moisture levels and controls irrigation.

### Nano “Rain”

Monitors soil moisture levels in 1 to 7 locations and controls 1 to 7 irrigation systems.

#### Features

- Microcontroller: Arduino Nano
- Soil moisture sensor (up to 7)
- Irrigation system and pump/valve (up to 7)

#### Addons

- Up to 7 soil moisture sensors
- Up to 7 irrigation systems (pumps/valves)
- LED Lighting
- Embedded computer (and related)
- Micro SD card logging

#### Notes

- The Arduino Nano is more expensive and larger than the attiny85 (see below) but provides more functionality and addons.
- 

## attiny85 “Rain”

Monitors soil moisture levels in 1 to 2 locations and controls 1 to 2 irrigation systems.

#### Features

- Microcontroller: attiny85
- Soil moisture sensor (1 or 2)
- Irrigation system and pump/valve (1 or 2)

#### Addons

- Many addons are not available with the attiny85 version.

#### Notes

- The attiny85 chip is a cheap, low cost, and small option but doesn't support many addons such as the embedded computer.
- 

## Hydroponics/Aquaponics Manager (“Hydro”)

Monitors and controls hydroponics/aquaponics systems.

## Nano “Hydro”

To do...

### Features

- Microcontroller: arduino nano
- Water level sensors (monitoring water level in tank and grow bed)
- Water flow sensors (monitoring flow from tank to grow bed, and from grow bed to tank)

### Addons

- LED Lighting
- Micro SD card module for logging.
- Real Time Clock module
- Embedded computer
- LCD Display
- WiFi hotspot
- Web application

# Urban gardening version

*[Proposed by Tibi]*

Montreal has a lot of back alleys, as you can see [HERE](#). People make small gardens in the back of their house and people move quite a bit on the back alleys. One idea is to package the garden manager into a nice box, with a glass window, with the electronics visible and the SENSORICA logo and OSHW logo on it.



This design allows those who pass by to see the system. Moreover, the box can also give an option for those who pass by to connect to it via bluetooth and access public data about the garden and about environmental conditions. For example, the box can tell them when it was raining, how much sun there was over the summer, etc. In other words, the box provides public info about the local environment. Moreover, a QR code on the box can give the public access to the project page on SENSORICA's website, where they can find out more. Access to a hub with more data from other boxes can also be accessed.

[Added by John]

Currently if I connect the monitoring system via USB to a Raspberry Pi running the website (alternatively a BeagleBone or similar could be used... or Arduino Tre) anyone can log directly into the Pi via WiFi (the Pi itself acts as a wireless hotspot), and view the web page.

The box could quite easily contain the WiFi details so people walking past can connect with their phone, as well as a public URL they can use to connect when they're not nearby.

The Pi setup is fairly simple and not very expensive. But I would probably try to have a single Raspberry Pi (or equivalent) which can host a bunch of monitoring systems. That way you don't need any more than one Pi in each garden.

The Pi should run off the 18650 battery pack as well. (Note: I would recommend a larger SLA battery instead.)

The Pi can transmit the data to a web site which collects data from many locations and provides it to the public.

An open source web application could allow anyone to host the data on live web servers, and present it to the public. This way each group can be independent of any centralised system, while still being able to connect with others.

The application could be designed to allow data sharing, so you specify the URLs of other instances of the application and it automatically exchanges all public data.

People can submit their data (via automated tools) to any of the websites that display it, and if it's public, know that data will be shared among all connected sites.

During the exchange between web sites containing the data they could also swap the list of other sites. This would mean if you set up a new installation and add just one other website which already exists, it can populate your entire website using data from all other sites on the network.

Another possibility is to bundle the data up into torrents, and have a system which downloads all available data torrents and compiles the data into a single local database (regularly downloading updates as well), then displays it. This would be tricky but would be the ultimate in decentralised and distributed data. With torrents as the data source it would be virtually impossible to take the whole system offline (which is good).

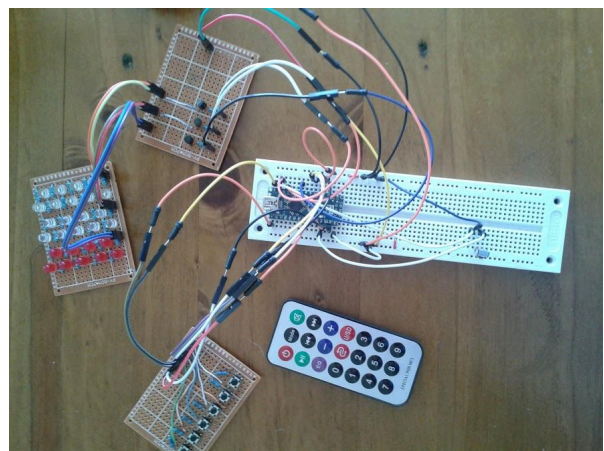
## Addons

### LED Lighting

Multi channel LED lighting can be used to provide and/or supplement light to plants.

Main idea, is to monitor light on 3 basic wavelengths that the plant needs, and use that as feedback mechanism to supplement the needed wavelength for the development period of the plant.

See [John's LED system](#).



## Basic design proposed

Tibi is going to work on the feedback, 3 photodiodes covered with film bandpass filters. These filters can be purchased in sheets, cut into small pieces and fixed on top of the photodiode.

## Micro SD Card Logging

Arduino based systems can have data logged to a micro SD card. This does use up 3 digital pins and therefore may reduce the number of other components available.

## Real Time Clock Module

A real time clock module can be added so that data includes a date and time. This is particularly useful when using other addons such as the web application.

## Embedded Computer

Boards such as Raspberry Pi, Odroid, etc. can be connected to the microcontroller to provide additional functionality.

### Related addons

The following addons are available when an embedded computer is added to the system.

- LCD display
- Touch screen LCD display
- WiFi Hotspot
- Web Application

## LCD Display

Connected via the embedded computer, an LCD display can show live data/graphs, via the web application.

by [John](#)

I've just overhauled the entire eCG system with some very significant improvements.

The interface is now designed specifically for touch screens (but can still be used as a standard web application from any PC, etc.).

A small touch screen interface hanging on a wall would be a convenient way to access the eCG system. The new UI is reasonably intuitive and it should be fairly easy for new users to figure out how to navigate. When viewing the full graph it's now possible to view the data for today, yesterday, this week, this month, and this year. It defaults to showing today's data.

Here's a video of the new version running on a touch screen:

[https://drive.google.com/file/d/0B\\_8QvsLqRy5qTGI2NXFteVhZY2c/view?usp=sharing](https://drive.google.com/file/d/0B_8QvsLqRy5qTGI2NXFteVhZY2c/view?usp=sharing)

(Excuse the shaky camera work and flickering screen effect caused by the phone camera.)

It would be good to get a designer to improve the look and design of the UI but it's already much better than the previous prototype. I've pushed the code to github and I'll try to get some photos and schematics for the electronics published soon.

See also [here](#)

## Touch Screen LCD Display

Connected via the embedded computer, a touch screen LCD display can show live and interactive data/graphs and provide a way to interact with the system, via the web application.

## Web Application

The web application runs on an embedded computer board and can broadcast data/graphs via the web or via a local network such as WiFi.

## WiFi

The embedded computer board can act as a WiFi access point allowing wireless devices to log in and view/interact with the system, such as via the web application.

### nrf24l01 module

by [John](#) remixed by Tibi

Sensor nodes can wirelessly transmitting data to a base hub using nrf24l01 modules. This allows many sensor modules to all transmit data from different locations and have it accessible from a single UI. Using the nrf modules makes the sensor nodes quite small and cheap (possibly \$10-\$20 each depending on how it's configured) so it should be feasible to have a whole bunch of them scattered throughout a garden or house. Each node has a 3 number ID which could be used to represent their coordinates in 3D space (ideal for a sensor farm spread throughout a food farm), or simply used for custom IDs. The data is now stored in redis (a type of database) making it faster than the previous prototype. Although there is still room for improving performance further.

A simple nrf24l01 wireless module [wiring diagram](#). The header shown in the diagram is where the module plugs in. You can tell which way it goes by the red (3.3v) and black (gnd) wires. Just match them up to the vcc and gnd on the module. This is where I got most of the info for it:

<https://arduino-info.wikispaces.com/Nrf24L01-2.4GHz-HowTo>

Here's a video on it: <https://www.youtube.com/watch?v=w1huO82IZjQ>

See also the [nRF Wireless eCommunity Garden System](#)

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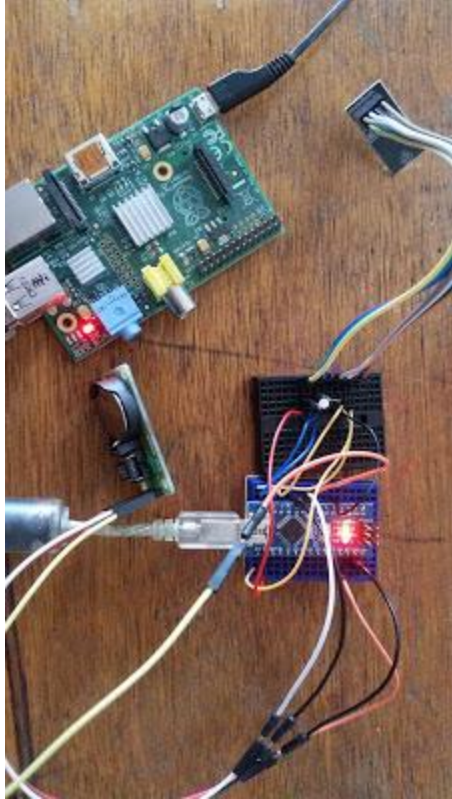
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By John, Tibi [add your name here](#)

## Prototyping

by [John](#), remixed by Tibi

This is the central hub. It receives the wireless transmissions and feeds them to the RPi to be displayed in the UI ([open pic in original location](#))

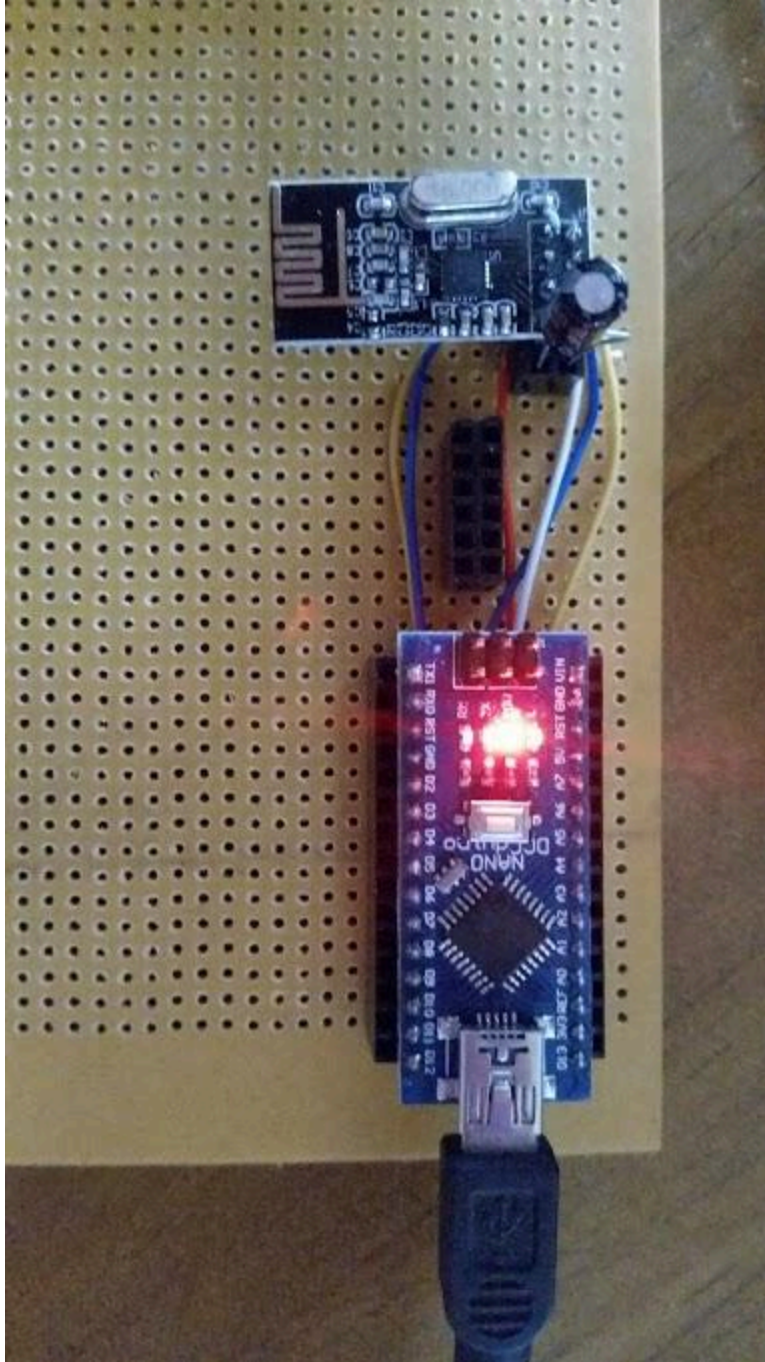


The hub has an nrf wireless module and a real time clock so it add the date/time of the transmission to the data. This is a barebones development sensor node without any sensors, running on an arduino nano clone ([open pic](#)).

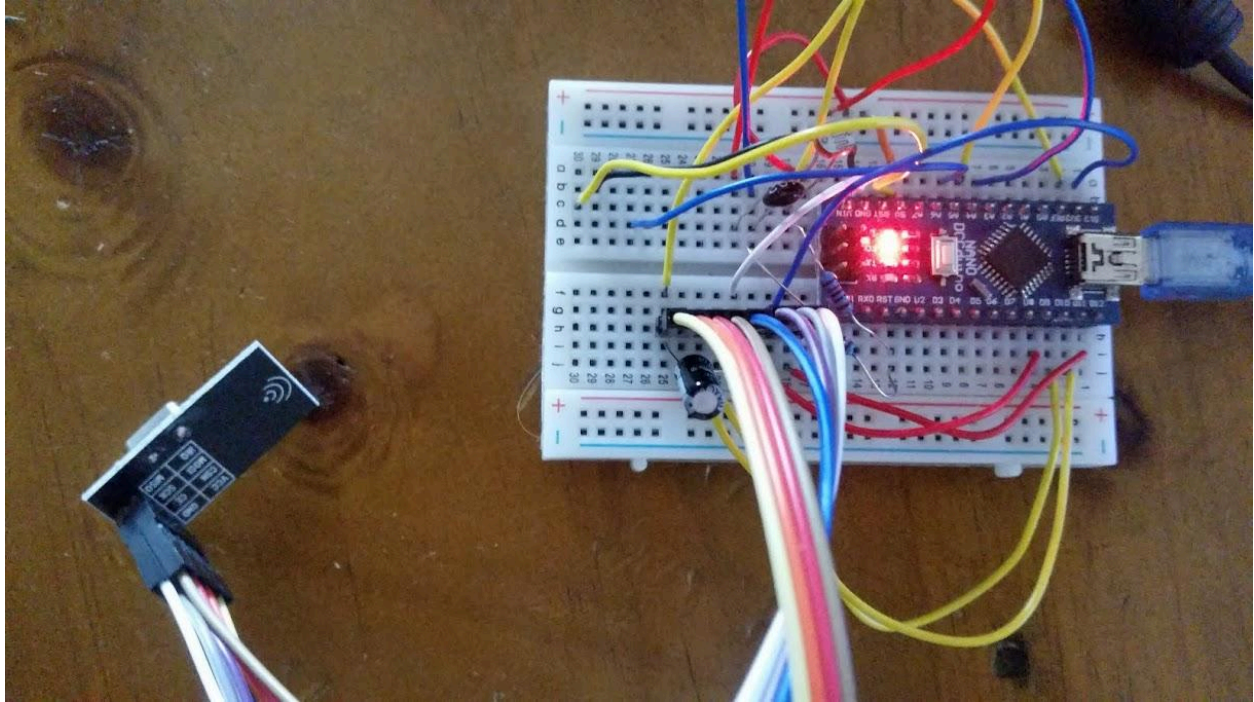
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By John, Tibi [add your name here](#)



It's currently just transmitting empty values but it's working. You can see the header rails there so I can connect sensors. This is a fully functional (albeit messy) sensor module with a light sensor, temperature sensor, and soil moisture sensor (although the soil moisture sensor isn't plugged in, in the [photo](#)):



I haven't added a DHT11 (humidity/temperature) sensor yet because I want to see how small I can get the sensor nodes. The DHT11 sensor is quite large compared to a thermistor, but it is possible to add it. In the video I posted you can see 2 devices listed. Those two devices are the sensor nodes shown above. If more nodes are added they'll automatically show up on the UI and it can be given a name by the user so it's easier to identify.

One of the next steps is to make a few sensor nodes from atmega or attiny chips, then it'll possible to shrink the size and cost of each node even further.

I'm going to make some to run off rechargeable batteries that can be charged via USB.

Then I'll look at adding a small solar panel so it can be sealed up in a waterproof box and used outside in the garden.

If anyone wants to replicate this let me know.

## ESP8266 WiFi module

by [John](#)

The previous eCG prototypes are WiFi enabled but they do that via a Raspberry Pi.

While that approach works well the RPi is the most expensive component in the system, and pushes up the overall price.

I just created a simple WiFi prototype that uses a \$3-4 ESP8266 WiFi module, which greatly reduces the cost.

It doesn't support the graphs, etc. because these modules aren't really powerful enough for that (at least not easily), but it does show the latest sensor values.

The module can be configured as a WiFi access point or it can connect to an existing WiFi network. If this system was set up in a community garden or something the access point name and password could be displayed so anyone can connect and view it from their phone.

It's also possible to configure the router to make the output page accessible from the WWW.

Here's a photo of the circuit, without the sensors attached:

[https://drive.google.com/file/d/0B\\_8QvsLqRy5qU2syUVVTSE1KZkU/view?usp=sharing](https://drive.google.com/file/d/0B_8QvsLqRy5qU2syUVVTSE1KZkU/view?usp=sharing)

The two wires going off the screen are attached to a 3.3v power supply (because the arduino can't provide enough current for the module), but that can be included on the board itself in later versions.

Here's a screenshot of the output:

[https://drive.google.com/file/d/0B\\_8QvsLqRy5qU2syUVVTSE1KZkU/view?usp=sharing](https://drive.google.com/file/d/0B_8QvsLqRy5qU2syUVVTSE1KZkU/view?usp=sharing)

The output is crude but it does the job of displaying sensor values.

Ideally I think the system should have an interface built to run on android or whatever device is used to access it, which can be made to look much nicer than the crude HTML output of the ESP module.

That interface then connects to the basic interface shown above to grab the latest data to display it in a nicer, more user friendly way.

If anyone wants to have a go at replicating this let **John** know and I'll give you the necessary info, code, etc.

See also [here](#)

## 12v SLA Battery

todo

## 12v Solar Panel and Charging Manager

todo

## Composition of light

(cheap and easy way to measure )

<http://www.cs.cmu.edu/~zhuxj/astro/html/spectrometer.html>

See also [here](#)

## Spectrometer on the cheap

A nice idea for a practical system for a spectrometer on the cheap

<http://forum.arduino.cc/index.php/topic,17429.0.html>

See also [here](#)