Indoor Air Quality Monitor

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http://blogs.citypages.com/blotter/no-smoking%255B1%255D.jpg

Client: Dr. David Van Sickle, Department of Population Health Sciences

Advisor: Mr. Peter Klomberg, Department of Biomedical Engineering

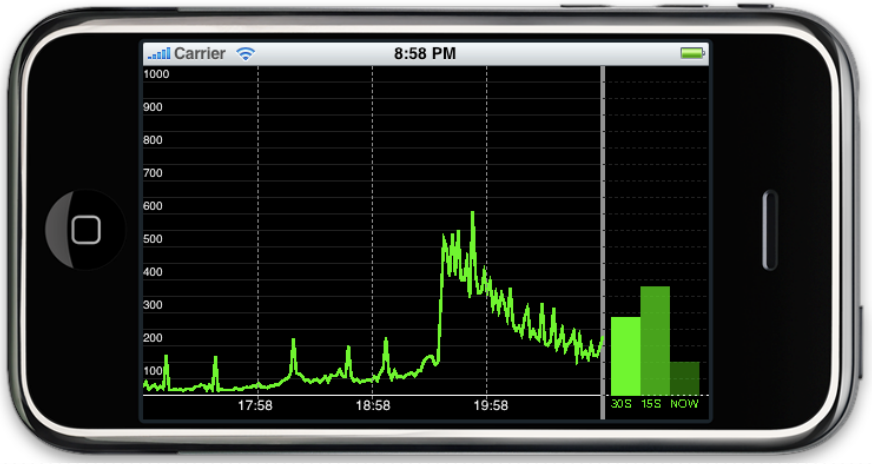
Background

- Poor air quality can lead to chronic respiratory diseases
- Client is a medical anthropologist interested in advancing global health
- **Indoor** tobacco use and biomass fuel burning in developing countries
  - 1.5-2 million deaths/year

www.treehugger.com/20091203-india-cooking.jpg

Background

- Example project: inAir tool
- Project goal: simple, effective, compatible
- Intervention/educational tool
- Implantation: projects in India and Rwanda, Project Quit Tobacco



inAir: Measuring and Visualizing Indoor Air Quality, Sunyoung Kim & Eric Paulos

Client Requirements

- The device must:
  - monitor the air quality related to tobacco smoke or biomass fuel burning
  - collect data approximately once a minute and this data should be easily downloadable
  - function for at least 1 year without breaking down or losing power

Product Design Specifications

- Operational:
  - The device will monitor particulate levels
  - Our tool will have a simple user interface making use of LEDs to indicate the air quality
  - The final product must store data and the data will be easily downloadable via USB
  - Electronic components will be powered through a wall outlet with a rechargeable battery as a “backup” power source

Product Design Specifications (Cont'd)

- Physical:
  - The final product should function between 0 and 60 °C
  - Device dimensions will be approximately 8x10x8 cm and have a mass no greater than 2 kg
  - Our instrument will be made up of various electronics components, including a programmable Arduino ® microcontroller

Product Design Specifications (Cont'd)

- Miscellaneous Specifications
  - Initially only one device (with budget of $1000)
  - The final construction cost of a typical device should be approximately $100
  - The customers will be researchers running studies on indoor air quality in India and Rwanda
  - Several similar devices exist on the market, so our device must be unique

Permanent Design Features

- Our client's specifications required a few permanent design features:
  - A sensor for particulate and other smoke related compounds
  - An Arduino ® Microcontroller
  - The power source

The Sensor

- Key Feature: detects various volatile organic compounds (VOCs) and **smoke**
- Concentration Range: 10 ppm - 300 ppm

http://www.futurlec.com/Gas_Sensors.shtml

The Microcontroller

- **Arduino ® Duemilanove**
- Key Features
  - 14 digital pins which can be used either as inputs or outputs
  - 6 analog inputs, each with 10 bits of resolution (1024 values)
  - On-board 5 V power supply (i.e. to power the sensor)
  - Can be powered either through USB/computer or externally with a battery/power adapter

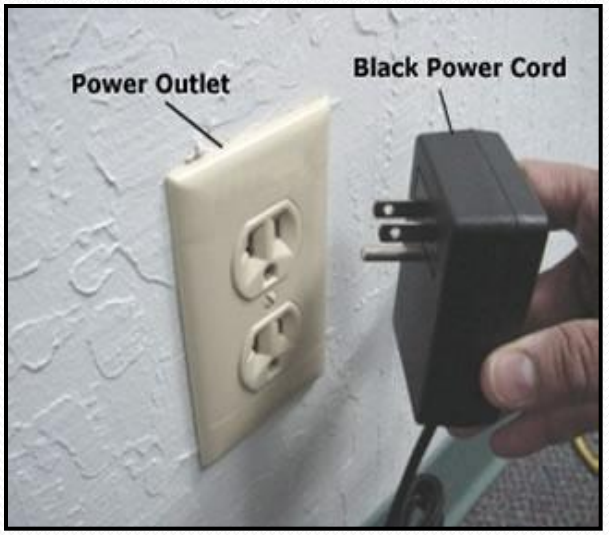
http://www.inmotion.pt/store/product_info.php?cPath=10&products_id=56

The Microcontroller: Code

```
// Digital LED Output to Analog Sensor Input
//
//  Setup:
//   - Potentiometer (i.e. 'sensor") with Outer Leads to '5V' and (Analog/Power) 'Ground', and Wiper to 'Analog In 0'
//   - Red LED connected from 'Digital Pin 5' to (Digital) 'Ground' (resistor side to Ground)
//   - Yellow LED connected from 'Digital Pin 6' to (Digital) 'Ground' (resistor side to Ground)
//   - Green LED connected from 'Digital Pin 7' to (Digital) 'Ground' (resistor side to Ground)
//
// by: Indoor Air Quality Monitor Team (BME 301)

int sensor  =  0;// analog pin 0 used to connect the sensor
int   sensor_val;// variable to read the value from analog pin 0

int LEDpinR  =  5;// digital output 1 (red)
int LEDpinY  =  6;// digital output 2 (yellow)
int LEDpinG  =  7;// digital output 3 (green)

void setup()
{
 pinMode(0, INPUT);   // sets sensor as an input
 pinMode(5, OUTPUT);  // sets red LED as an output
 pinMode(6, OUTPUT);  // sets yellow LED as an output
 pinMode(7, OUTPUT);  // sets green LED as an output
}

void loop()
{
   sensor_val =analogRead(sensor);          // reads the value from the sensor input (i.e. value between 0 and 1023, if using 5V input)
  if (sensor_val >= 0 && sensor_val < 341)// green LED lights up for values 0 to 340 (from analog sensor input)
  {
    digitalWrite(LEDpinG, HIGH);
    digitalWrite(LEDpinY, LOW);
    digitalWrite(LEDpinR, LOW);
  }
  else if     (sensor_val       <       682)//  yellow  LED  lights  up  for  values  341  to  681  (from  analog  sensor  input)
  {
    digitalWrite(LEDpinG, LOW);
    digitalWrite(LEDpinY, HIGH);
    digitalWrite(LEDpinR, LOW);
  }
  else                                      // red LED lights up for values 682 to 1023 (from analog sensor input)
  {
    digitalWrite(LEDpinG, LOW);
    digitalWrite(LEDpinY, LOW);
    digitalWrite(LEDpinR, HIGH);
  }
}
```

The Power Source

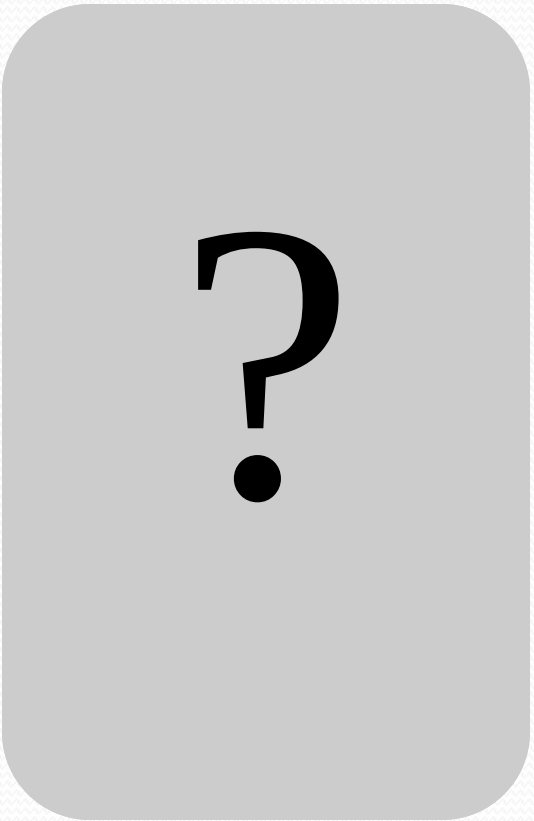
- The power source will consist of two main components:
  - A plug will connect the device to a wall socket power supply
  - An internal rechargeable battery will act as the “back-up” power source during power outages
  - Similar to set-up used in clock-radio



http://www.it.utah.edu/services/helpDesk/connectedhelp/actiontec/images/PlugWall.jpg

Design Aspect: User Interface

- Options:
  - Stoplight
  - 5 pt. scale
  - 10 pt. scale



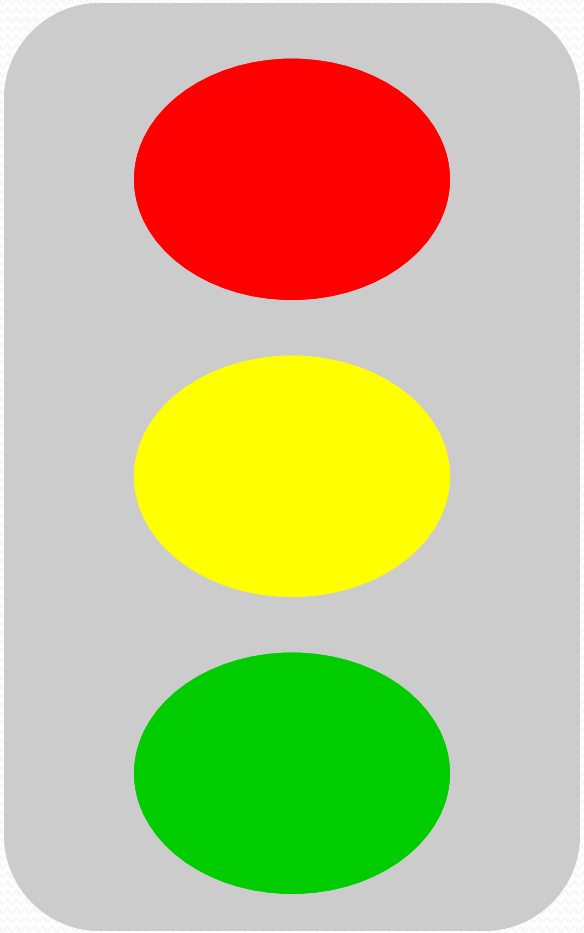
Stoplight

-Simple

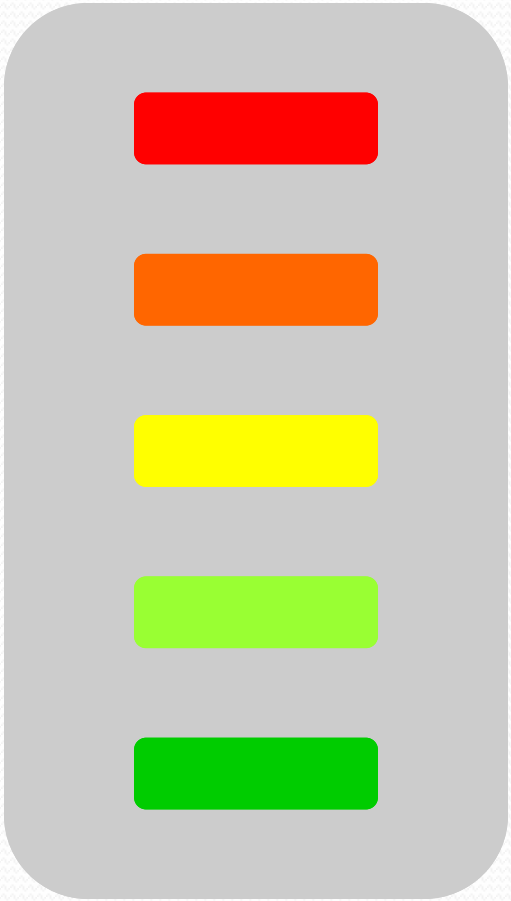
-Red signifies poor air quality

-Yellow signifies air of moderate contamination

-Green signifies the relative absence of contaminants



5-Point Scale



-Intermediate colors allow for more levels of air quality portrayal

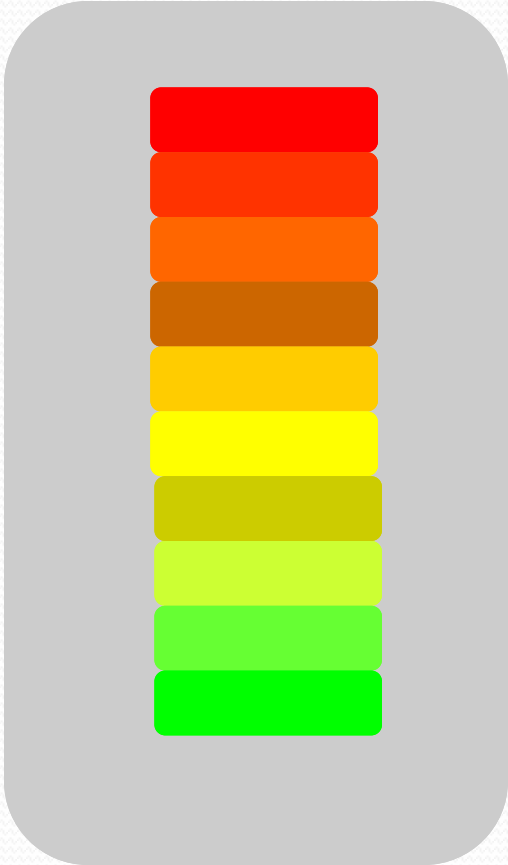
-Based on the same color scheme as the stoplight (Red<Yellow<Green)

10 Point Scale

-Most complex design

-Most accurate portrayal of air quality

-The abundance of leds in different areas might lead to higher incidence of failure



Design Matrix-Display

Design	Complexity	Accuracy	Ease of Construction	Total
Stoplight	10	4	8	22
5-Point Scale	8	7	6	21
10-Point Scale	2	10	2	14

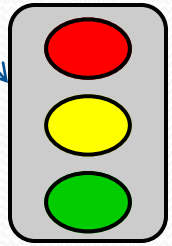
Ethical Considerations

- Intended for education
- Global engineering
- “Outreach project”
- Aim: Present a clear description of “Air Quality”

Final Design

- Stoplight Led Display
- Particulate Sensor
- Arduino® Microcontroller
- Power Source
- Various circuit components:
  - Breadboard
  - Black, red, & green solid 22 gauge wire
  - Case box
  - Resistors
  - Toggle switch

http://tuberose.com/Cigarette_Smoking.html



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Questions?