Cell Phones as a Distributed Platform for Black Carbon Data Collection

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Project Surya - http://www.projectsurya.org/

**Introduction:** Black carbon production is a large issue in developing nations

**Issues with black carbon:**
- **Health concerns**
  Black carbon, a chief component of soot and a part of diesel emissions, is linked with respiratory illnesses.
- **Global warming**
  Black carbon, following carbon dioxide, is the second largest contributor to global warming. However it exists in the atmosphere for a shorter period of time therefore any changes will bring quicker results.

**Production of black carbon:**
- **Diesel Emissions**
- **Incomplete burning of fossil fuels and biomass**
- Outdated or primitive cooking methods using wood and dung as fuel
- Fires starved of oxygen (a disproportionate amount of fuel to oxygen) which results in an incomplete burn
- Diesel engines (reduced effect by particulate traps)

**Problem Description:** Developing a new low cost cell phone based sensor

**Cell Phone Camera**
- **Black Carbon Sensor**
  - Low cost pump

**Calibration Chart**
- **Reference Template**
  - Spatial Locator

**Cell Phone Audio Jack**
- **Temperature Sensor**
  - Data
  - Minutes
  - or
  - Txt messages
  - Headset Jack
  - Temperature Sensor

**Proposed Solution:**

**Calibration**
- Create filters with known BC Loading (ug/cm²)
- Scan filters with high quality photo scanner
- Extract Red value from scan
- Fit Red value vs. BC Loading
- Select 10 Red values for chart
- Print chart on profiled printer

**Extracting BC Concentration**
- Photo
- **Color to BC Loading**
  - Extract Red values from filter and reference template
  - Use known BC Loading to create color vs. BC Loading conversion

**BC Loading to BC Concentration**
- $BC_{conc} \ [\text{ug/m}^3] = \frac{BC_r \ [\text{ug/cm}^2] \times A \ [\text{cm}^2]}{V_f \ [\text{m}^3]}$
- $V_f = F \ [\text{m}^3/\text{min}] \times D \ [\text{min}]$
- Combine BC Loading, flow rate, exposure duration and filter size to obtain BC Concentration

**Future Deployments - 2011**
- Khairaptur, India - 50 sensors
- Los Angeles, CA - 40 sensors
- Jet Propulsion Lab, CA - 2 sensors
- Environmental Protection Agency, DC - 1 sensor

**Results**
- Measurements collected in Indian and California
- Validated using two accepted standards
- Measurements with cell phone within 10% of standard methods

**Credit:** Adam Ferguson

**Photo**
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**Calibration Curve:**
- Recorded PCM peak value vs. Temperature