

# A System for Automatically Determining Indoor Air Pollution from Pictures Taken on Mobile Phones

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Project Surya

## Introduction: Gaging the Effectiveness of Alternative Cookers Deployed in Rural Indian Homes

### Project Surya: Sustainable Cookers for India

- **Surya is a pilot program of the UN Environmental Programme**
  - The project aims to **improve health, reduce pollution, and support sustainable development**
  - Right now, Surya is focusing on **reducing black carbons (BC's)** because:
    - they have a shorter lifespan than other greenhouse gases like CO<sub>2</sub>
    - They are commonly released by biomass burned in traditional stoves in rural India

### Surya Needs to Gage the Effectiveness of Their Cookers

- A filter has already been developed
  - The filter **changes brightness proportional** to BC concentration.



The filter

- An system for accurately matching the filter brightness to a calibrated gray scale is needed

## Problem Description: Automatically Determining BC concentration using Image Analysis

•The system is subject to the following constraints: **Challenges and Constraints**

- It must be able to **continuously analyze and store data** from a **remote source**
- The filter must be **analyzed visually**
- Data must be **uploaded** onto a **database** viewable by Project Surya

•We decided the system should also have the following attributes:

- It must be almost entirely **automatic**
- **Information** about pollutions levels must be **sent back** to the people living in homes with Surya stoves

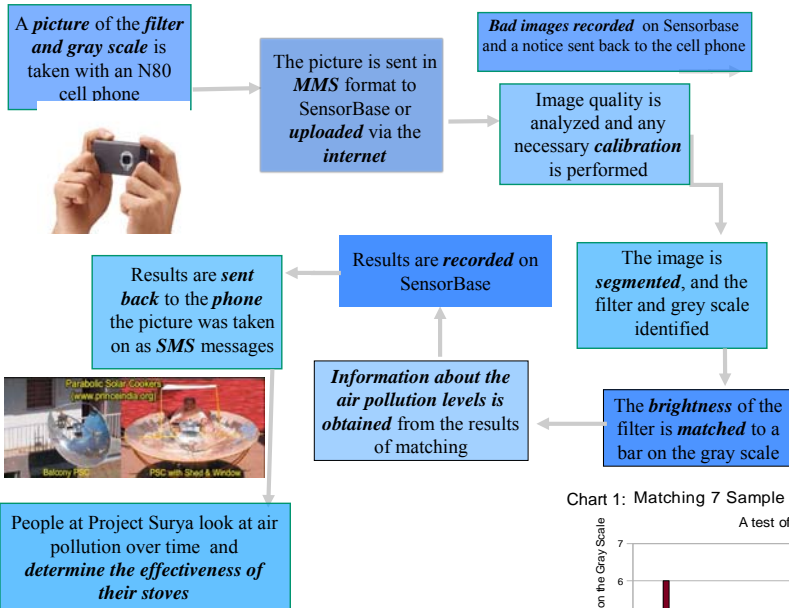
### Challenges:

- Accounting for **lighting conditions**
- **Remote** data collection
- Determining a **“base truth” metric** to use for evaluation

## Proposed Solution: Matching brightness of images captured on mobile phones on a remote server

### Our System

### Algorithms Used



– **Segmentation:** Gradient Vector Field (GVF) snake

– **Calibration:**

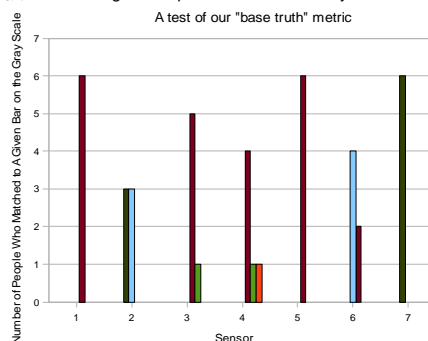
- Photographing the filter and the gray scale in the same frame eliminates unknown lighting conditions that would exist between separate images of the filter and the scale
- Regional light intensity gradient calculations, and calibration of images with a zero-gradient for a 2-pixel radius around the filter and gray scale

– **Matching:**

- Based on brightness mode of a square region of 20 pixels in the center of the filter and in the center of each bar on the gray scale

### Accuracy of Our System

Chart 1: Matching 7 Sample Filters to the Gray Scale Visually



- We found the **mode brightness** of each of the **seven filters** used in the test of our base truth metric
- **Our system matched** results from human visual analysis

We used **human visual matching** as the **base truth** to evaluate the accuracy of our system by