Multispectral Imaging for Fine-Grained Recognition of Powders on Complex Backgrounds

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Motivation

Powders in the World


Food Additives [1]

Makeup [2]


Drugs [3]


Explosives [4]

Applications for Powder Recognition

Cooking Robot | Criminal Identification | Drug Control | Security Check

Challenges

#1 Lack Useful Information (Shape, Context, Texture, Color)

#2 Thin Powder on Background Appearance

Method

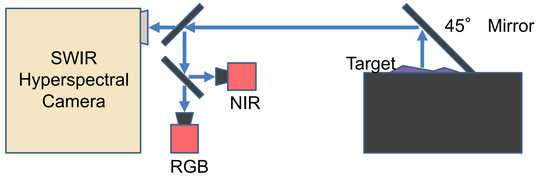
Capture Multispectral Powder and Background Images → Render Powder on Background Images → Machine Learning

Solving Challenge #1 | Solving Challenge #2

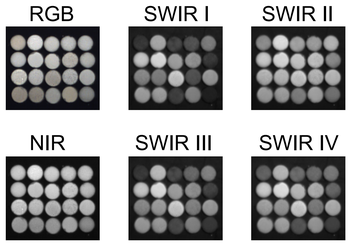
RGBN-SWIR Multispectral Imaging

Visible Light (RGB) 400-700nm	Near Infrared (NIR) 700-1000nm	Short-wave Infrared (SWIR) 1000-1700nm

Image Acquisition System



20 Powders in Different Spectra



Rendering Thin Powder on Background Images

The Beer-Lambert Blending Model

Thin Powder | "Thick" Powder | Background

$$I_c = (1 - \alpha_c) A_c + \alpha_c B_c$$

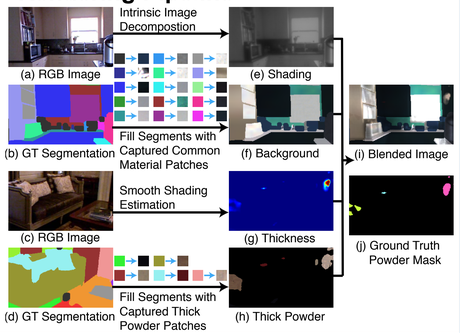
Channel Index

$$\alpha_c = e^{-\kappa_c x}$$

Thickness

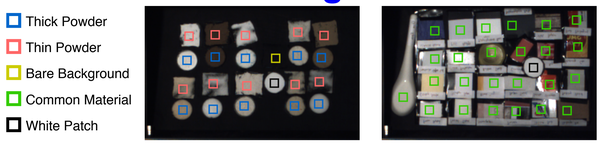
Attenuation Parameter

Rendering Pipeline



RGBN-SWIR Powder Recognition Database

Patches

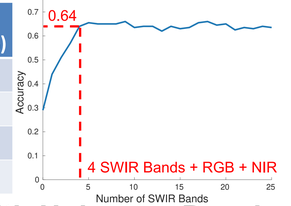


Scenes

Experiments

Recognition with Known Powder Location

Top-N Retrieval	100-Class Accuracy (%)
1	64.0
3	86.0
5	88.5
7	92.5



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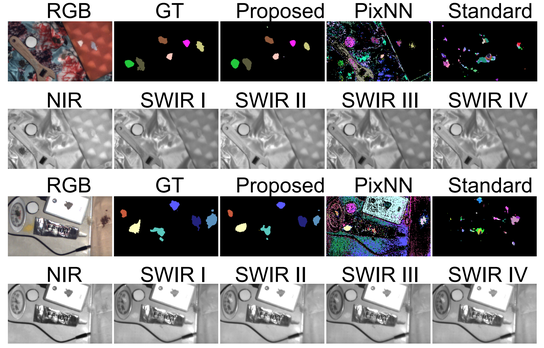
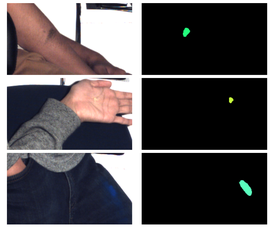
Recognition with Unknown Powder Mask



Detection on Human



References
[1] https://xapfoods.com/product/dark-roasted-curry-powder/
[2] https://www.makeupforever.com/ca/en-ca/make-up/face/powder/super-matte-loose-powder
[3] http://www.witf.org/news/2015/12/dea-launches-pilot-program-to-cut-drug-overdoses-in-pittsburgh.php
[4] http://www.ksla.com/story/24477722/epa-looking-at-options-to-burn-15-million-pounds-of-explosive-powder/