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

Tiancheng Zhi, Bernardo R. Pires, Martial Hebert, Srinivasa G. Narasimhan
Carnegie Mellon University

Motivation
Powders in the World

Applications for Powder Recognition

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

#2 Thin Powder on Background Appearance
Thin
Thick

Method
Capture Multispectral Powder and Background Images

Render Powder on Background Images

Machine Learning

Solving Challenge #1
Solving Challenge #2

RGNB-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 Appearance

The Beer-Lambert Blending Model

\[ I_c = (1 - \alpha_c) I_b + \alpha_c I_T \]

Channel Index

\[ \alpha_c = e^{-K_c x} \]
Attenuation Parameter

Thickness

RGNB-SWIR Powder Recognition Database

Images

Top-N Retrieval
100-Class Accuracy (%)

1 64.0
3 86.0
5 88.5
7 92.5

Recognition with Known Powder Location

Recognition with Unknown Powder Mask

Detection on Human

References

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Swir Hyperspectral Camera

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