# Hyperspectral object detection with deep learning enhancement tested by classical methods

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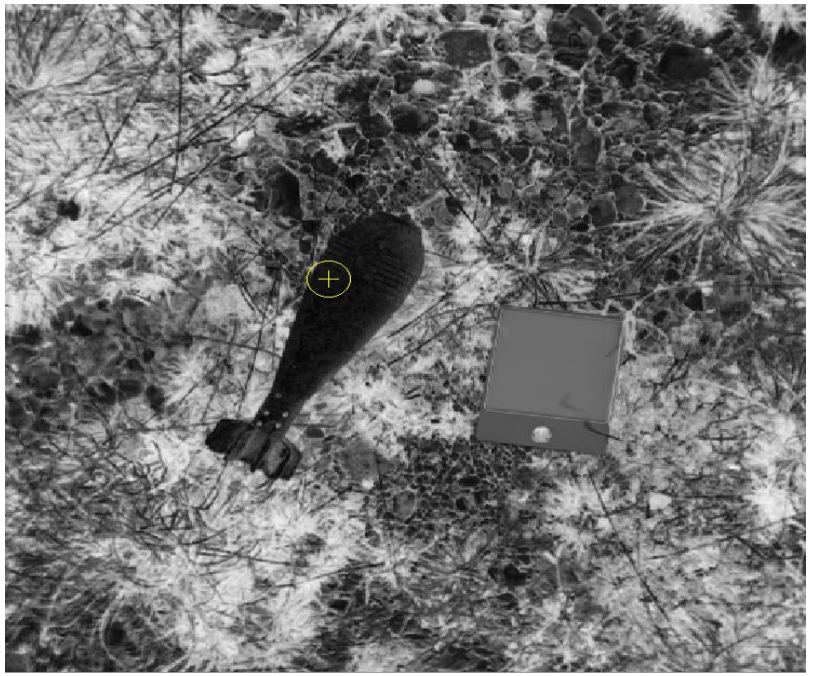
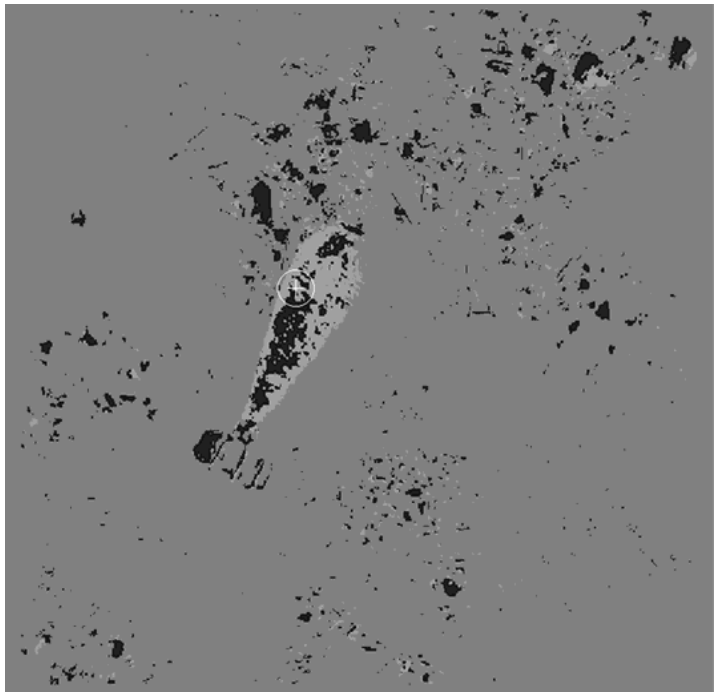
# SAM classification of an isolated target with one type of reflectance

One target of uniform reflectivity in the camera's field of view

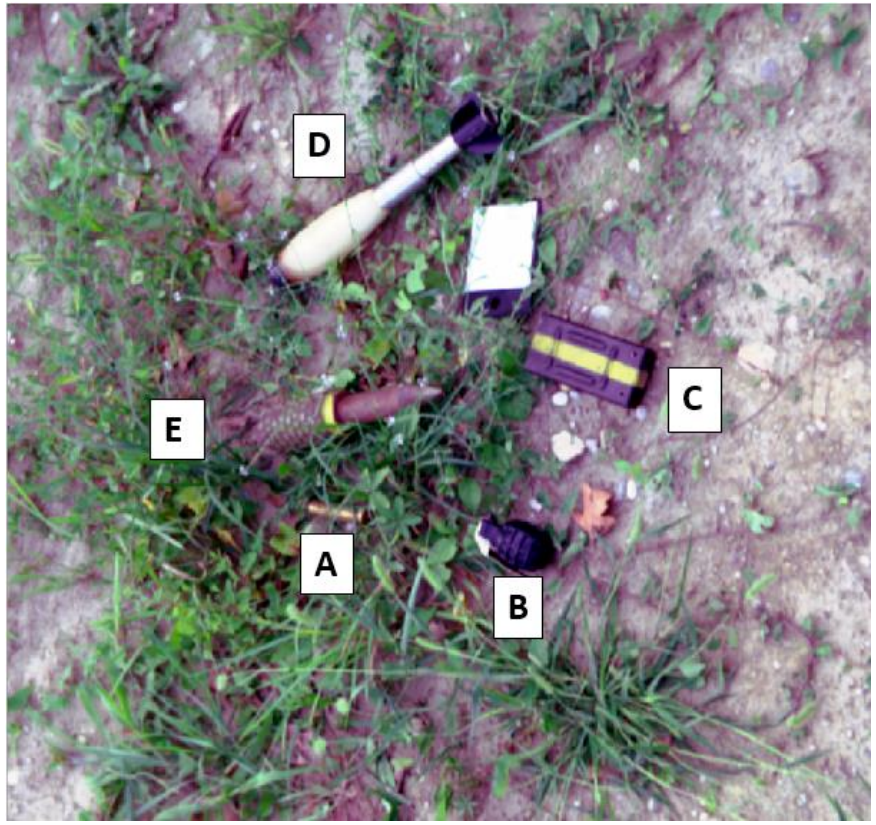


The spectral angle raster (black) outlines the shape of the target and also of the white calibration plate.



Based on just two samples of the target spectrum, SAM detects the target

# Extraction of individual targets from groups that have different multiple reflectance spectra




Target/number of types of reflectance: A - bullet/1, B - hand grenade/2, C - plastic pressure plate/2, D - trombone/3, E - anti-personnel landmine/3

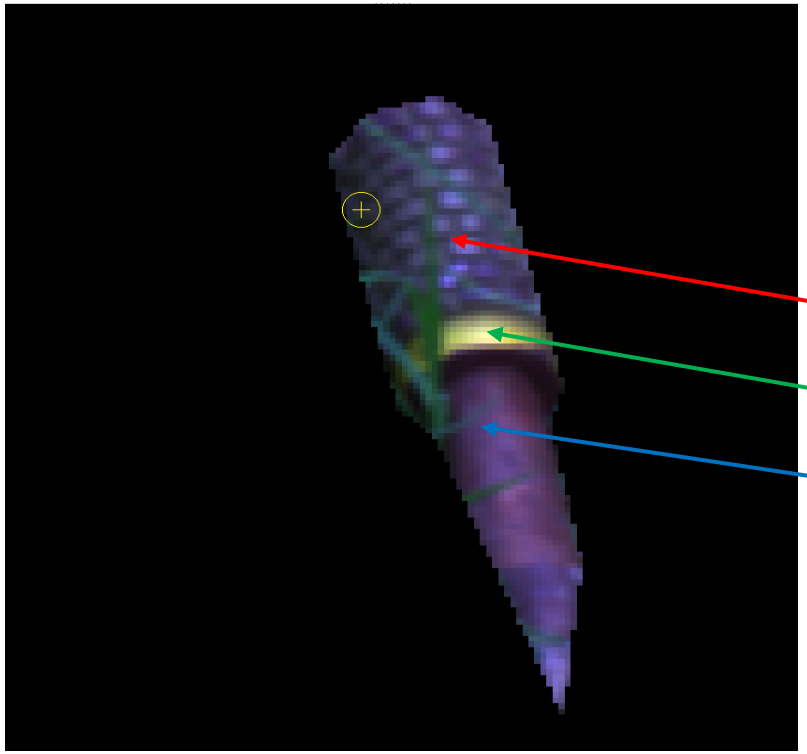
Ground truth mask - separation of each target by shape from a group of targets that have different multiple reflectance spectra

# Each target produces false alarms to others unless masked

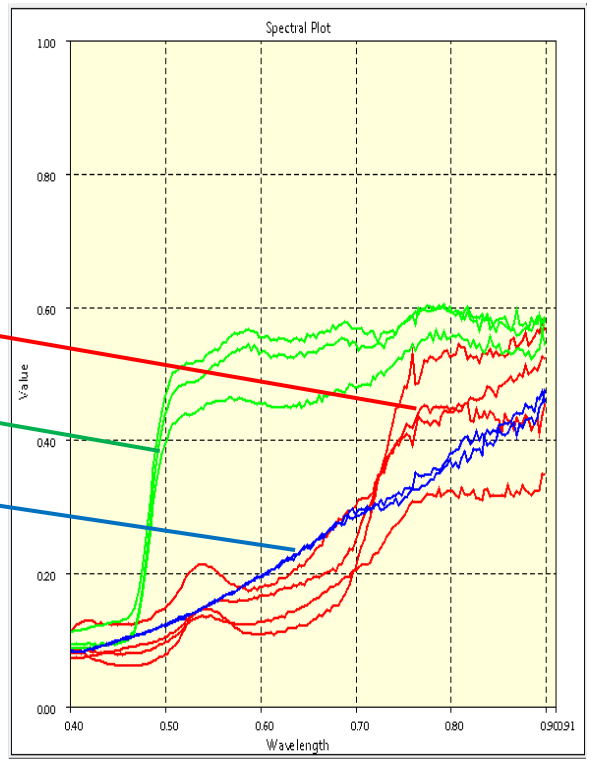
Four reflectance samples from target E for SAM angle 4 create false alarms on other targets

Four reflectance samples from target E for SAM angle 5 create false alarms on other targets

# Selecting a single target for SAM classification within its masking surface, example landmine E

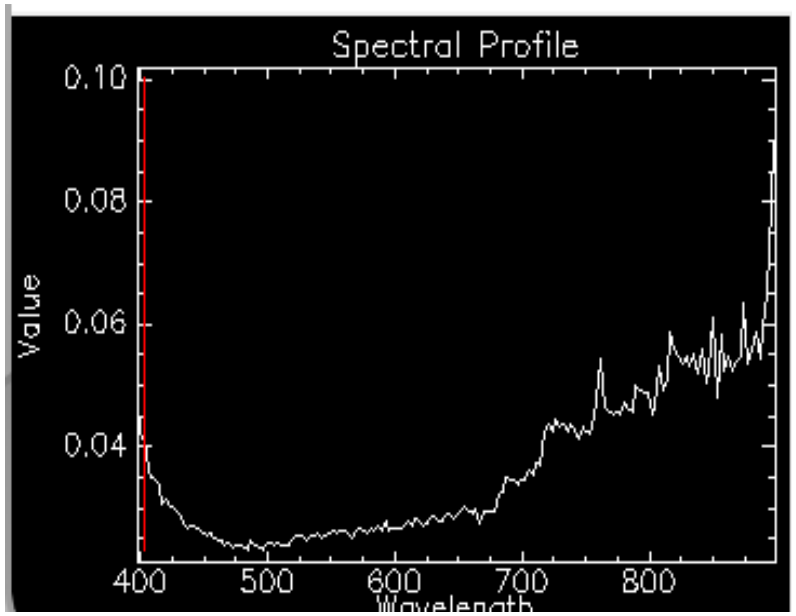


Color (RGB) display of landmine E, R=657 nm, G=551 nm, B=451 nm

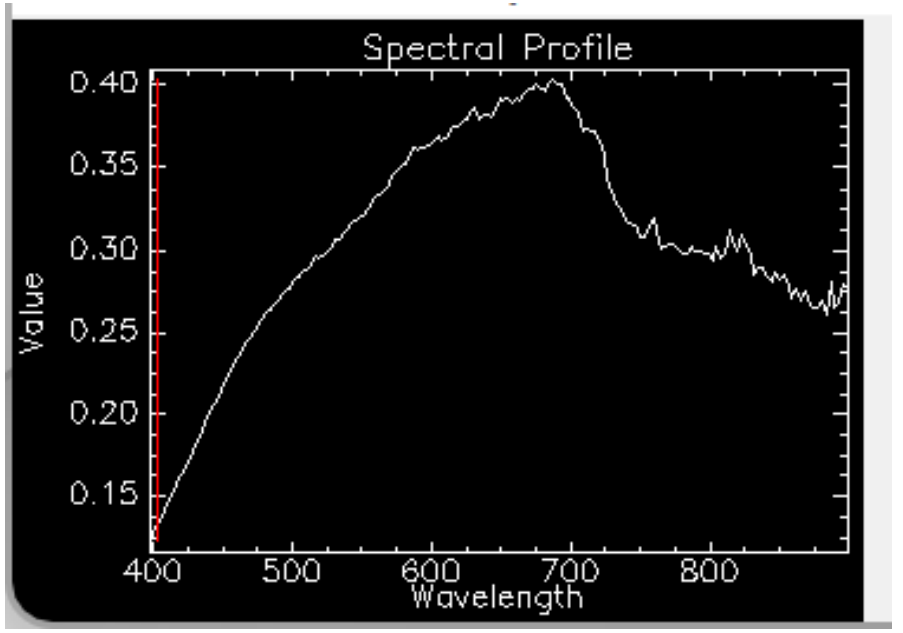



Several spectral samples of landmine E: red - mine body, green - yellow mark, blue - wooden spike

# Spectral signature of hand granade

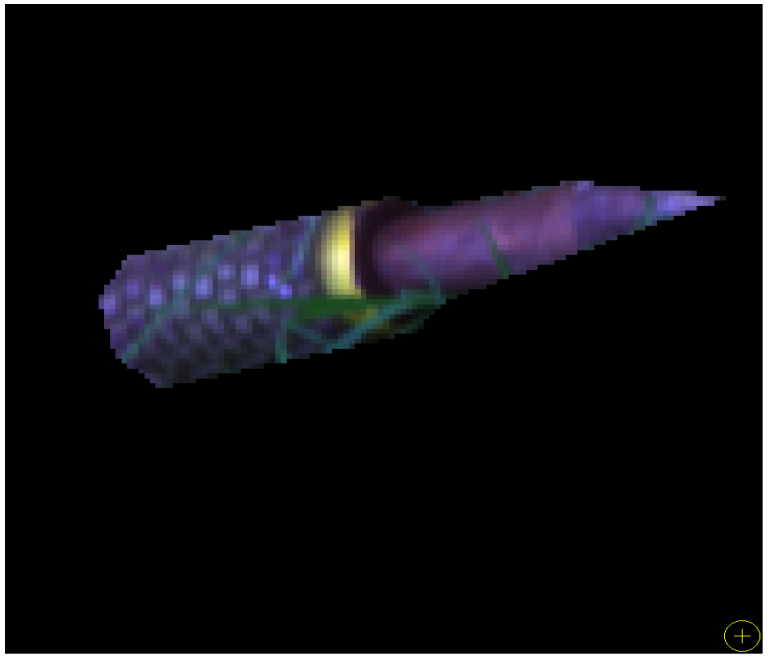



Reflectance spectra of a hand grenade, rubber black part

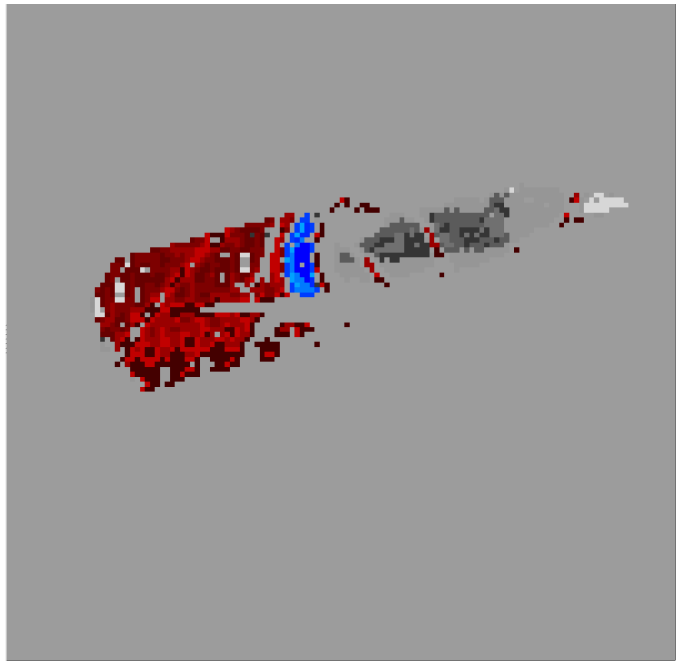



Reflectance spectra of a hand grenade, the metal trigger.

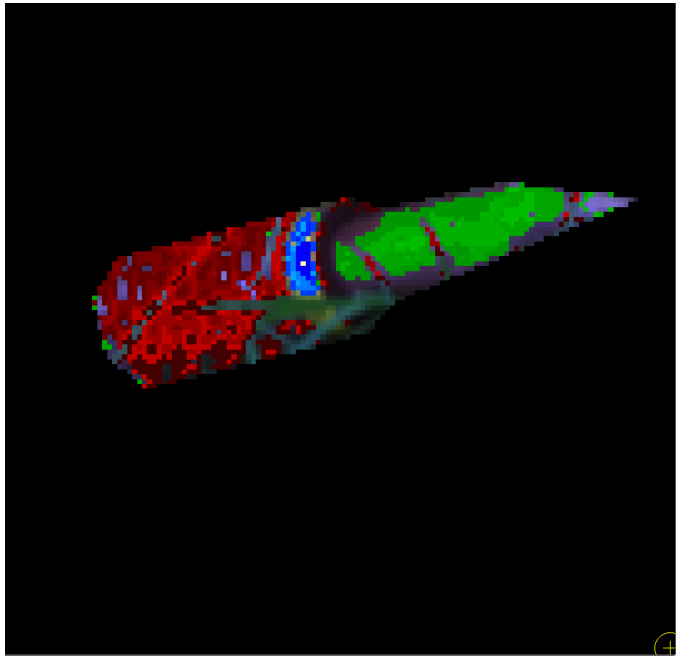
# SAM classification of isolated (masked) landmine E



Visualized RGB image of target E



Result of SAM classification by parts with different reflections of an isolated masked target E



The result of SAM classification shown over the image of target E

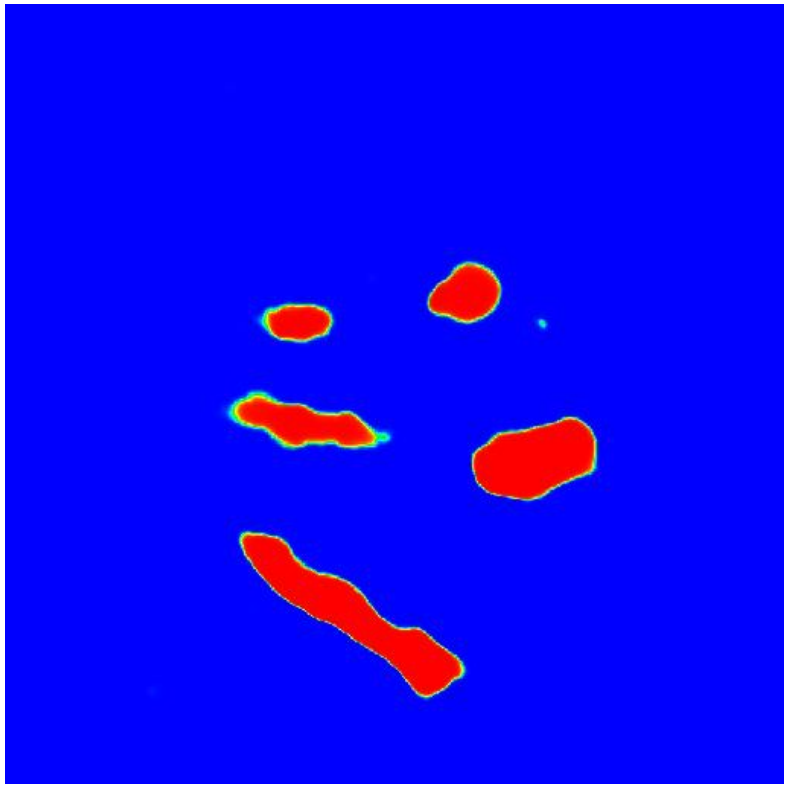
# Deep learning

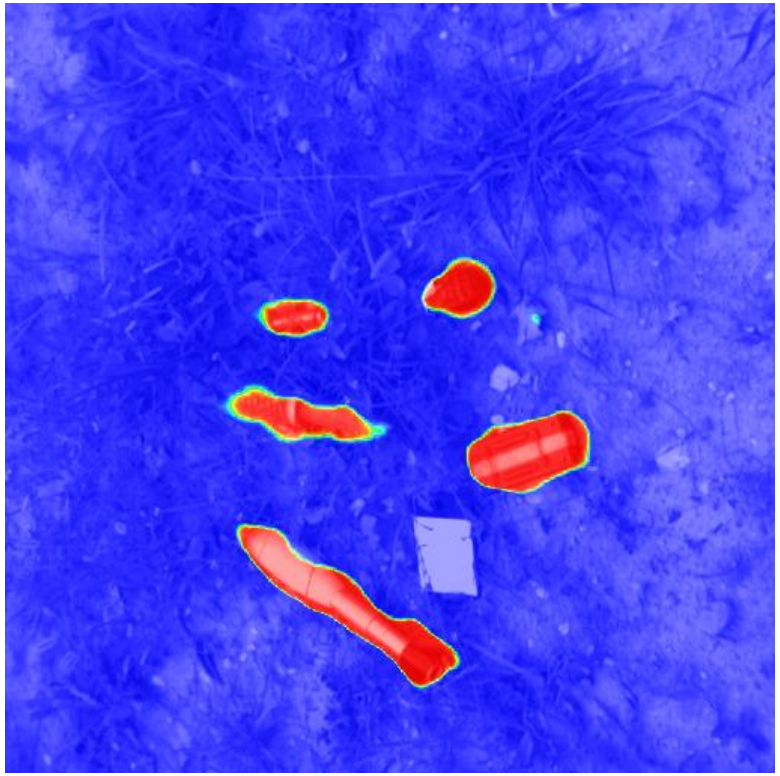
12 images training, 3 validation
5 targets with 13 spectral reflectance areas, some have multiple reflection areas
1 class approach

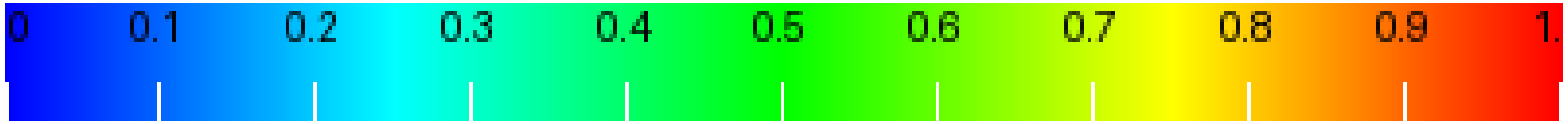
**Recall** measures the percentage of **actual positives** that were **correctly predicted**.
**Precision** measures the **accuracy of predicting positives**.
**F1** is the harmonic mean of Precision and Recall; it balances both.
**IoU** measures the overlap between the predicted area and the actual (ground truth) area.

Recall - 0.87
Precision - 0.59
F1 - 0.70
IoU - 0.54

# Prediction of model best case







# Discussion

- Targets that have at least 5 to 10 pixels are considered
- If only one target is in the field of view of a hyperspectral camera, it can be successfully detected using SAM classification if the target’s surface has one type of reflectivity
- If the target has two or more surfaces of different reflectivity, then the SAM must be applied separately for each of them
- If there are multiple targets in the camera's field of view, some or all of which have multiple surfaces of different reflectivity, then SAM must be applied separately for each
- In deep learning methods, false alarm control is very complex but manageable
- Using the classic SAM remote sensing method as an example, an approach to solving sub-target spectral diversity is tested via the Deep Learning method.