DIGITAL IMAGE PROCESSING PROJECT

Paneer Contamination Detection Using Hyperspectral Imaging and Deep Learning

Presented By

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Motivation

- Food contamination is a major issue in the dairy industry, especially in perishable products like paneer.
- Traditional contamination detection relies on manual inspection or chemical testing, which is slow and destructive.
- There is a need for non-destructive, automated methods to monitor food safety and quality in real time.

Base Paper Summary

“Bread Contamination Detection using Deep Learning and Thermal Imaging”

- Used thermal imaging to detect contaminated regions on bread.
- Applied YOLO-based deep learning for classification and detection.
- Achieved high accuracy in identifying contaminated zones through temperature variations.

Our Adaptation

Original Study:

- Food Type: Bread
- Camera Used: Thermal Camera
- Feature Extracted: Temperature Patterns
- Model Used: YOLOv11n

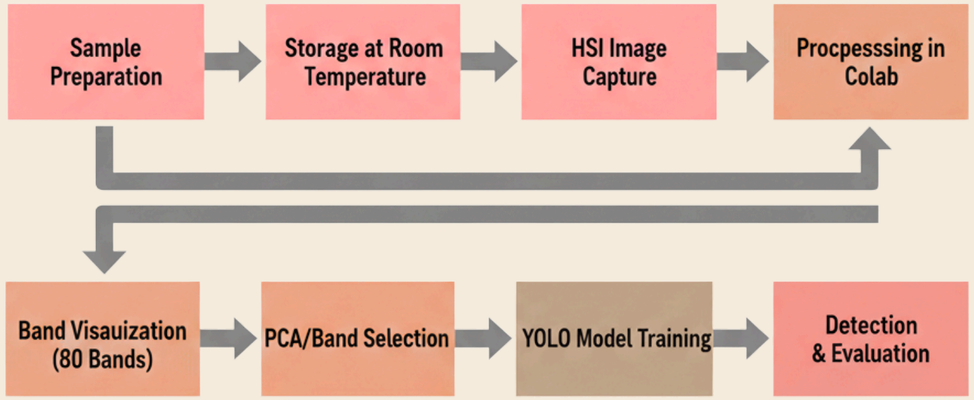
Our Project:

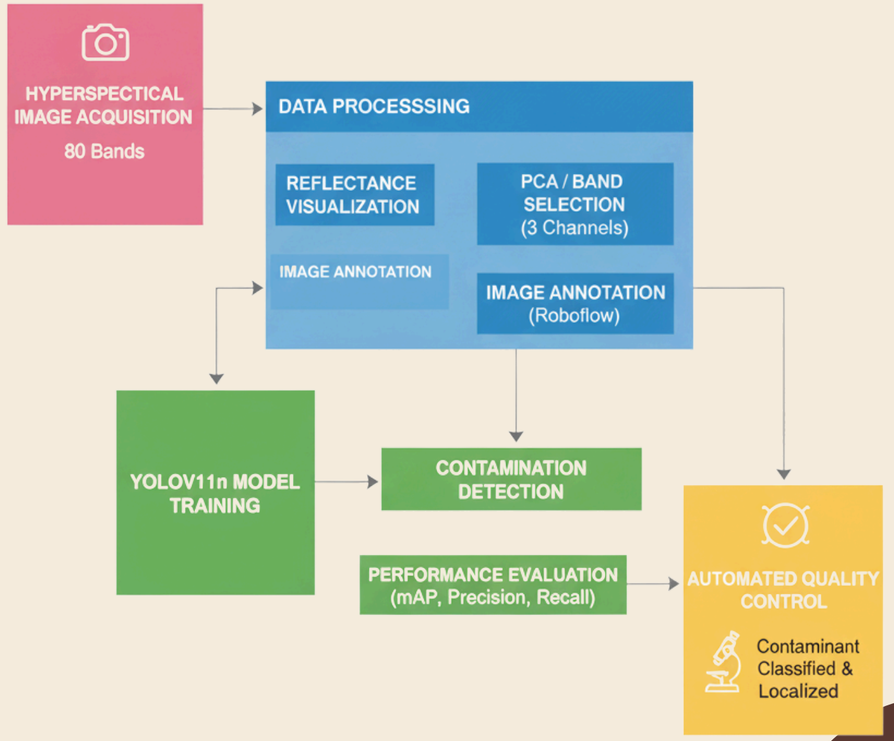
- Food Type: Paneer
- Camera Used: Hyperspectral Camera (80 Bands)
- Feature Extracted: Spectral Reflectance
- Model Used: YOLOv11n (Same as Original Study)

Methodology

Steps Followed:

1. Prepared 3 paneer types – Milkymist, Malai, Tofu.
2. Applied 5 treatments: normal, acetic acid (3 & 6 drops), hydrogen peroxide (3 & 6 drops).
3. Captured 140 HSI images (80 bands each).
4. Processed images using spectral library in Google Colab.
5. Visualized reflectance and pseudo-RGB images.



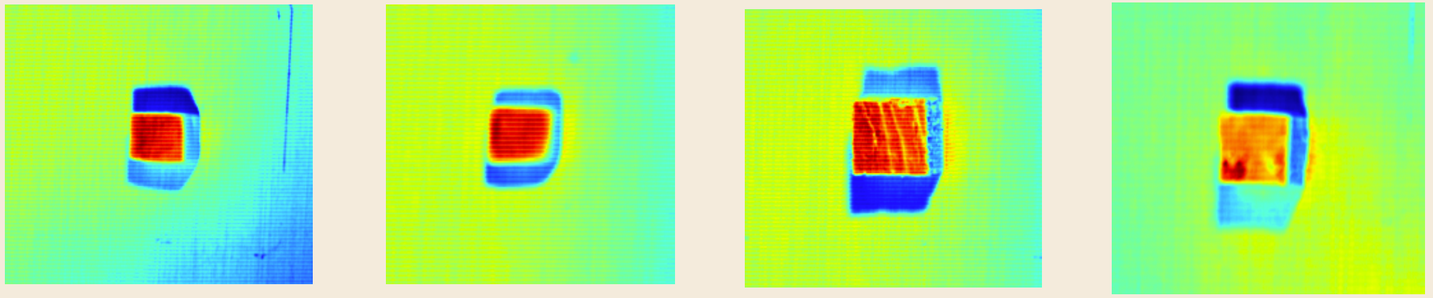


Results – Visualization & Findings

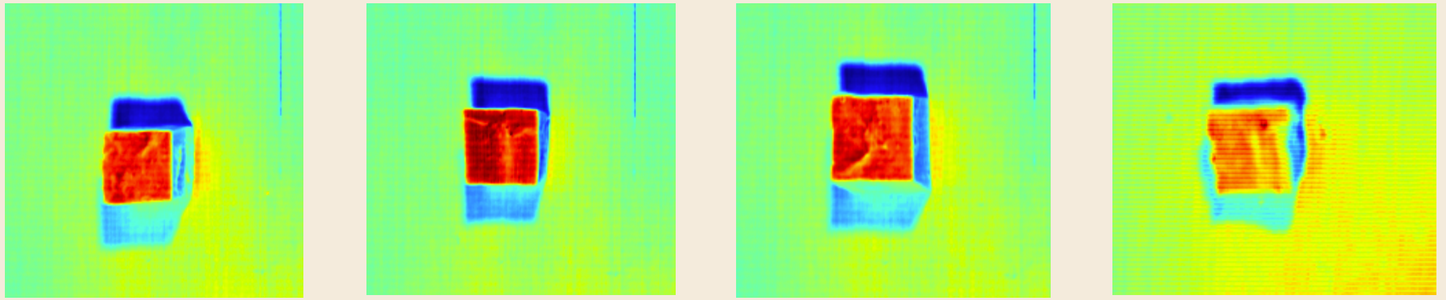
Treatment	**Observation**	**Spectral Behavior**
Normal	Stable intensity	Uniform reflectance
Acetic Acid	Dull surface	Reduced reflectance
Hydrogen Peroxide	Brightened surface	Increased reflectance

- Successfully visualized 140 hyperspectral images in Colab (25-Malai Paneer, 29-Tofu Paneer, 29-Natural Paneer)
- Observed clear differences between normal and treated samples.
- Bands 40–60 showed the strongest reflectance variation.
- Acid-treated cubes: darker spectral regions (lower reflectance).
- Peroxide-treated cubes: brighter spectral zones (higher reflectance).

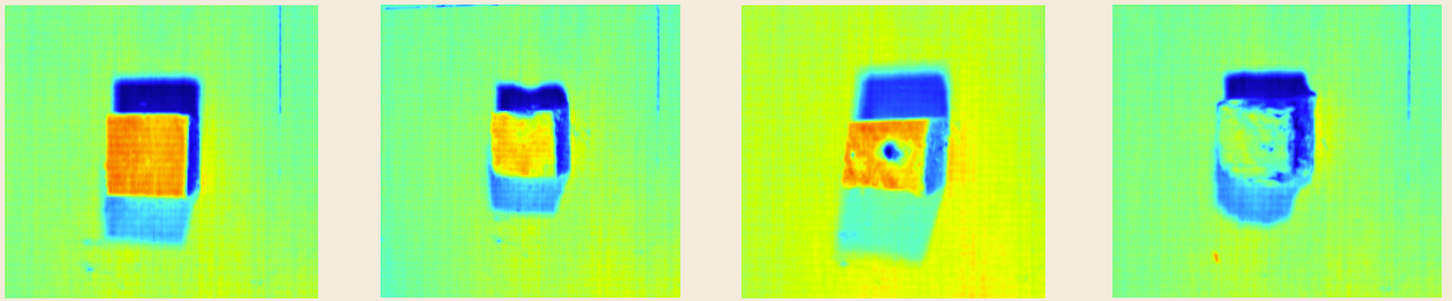
Natural Paneer



Malai Paneer



Tofu Paneer



RESULT IMAGES
https://drive.google.com/drive/folders/1J8_2B4R58m_Ac6yTE5FEuSctlXSK0IcV?usp=sharing

Key Findings

- Hyperspectral Imaging (HSI) effectively captures chemical and physical changes in paneer.
- Reflectance variations correspond to contamination or treatment intensity.
- Data structure and preprocessing pipeline are complete for deep learning integration.
- The method is non-destructive and more sensitive than thermal imaging.
- Established dataset and metadata ready for YOLOv11n model training.

Future Enhancements

Planned Next Steps:

- Apply PCA or band selection to compress 80 bands into 3-channel pseudo-RGB images.
- Annotate images using Roboflow for contamination labeling.
- Train the YOLOv11n model on the preprocessed dataset.
- Evaluate using *Precision, Recall, and mAP metrics.
- Extend dataset from 140 to 540 images for higher accuracy.

Future Scope

Real-time paneer quality monitoring in dairy production.

Integration with IoT sensors for smart food safety systems.

Expansion to other dairy products and imaging modalities.

Thank You