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# TRAINING-FREE MULTIL-MODAL ALIGNMENT FOR FINE-GRAINED COUNTERFEIT FRUIT DETECTION

**Dat Tran-Anh[1], Quynh Nguyen Huu[2], Ngoc Anh Nguyen Thi[2], Thieu Huy Nguyen[1], Nguyen Huu Gia Bach[3]**

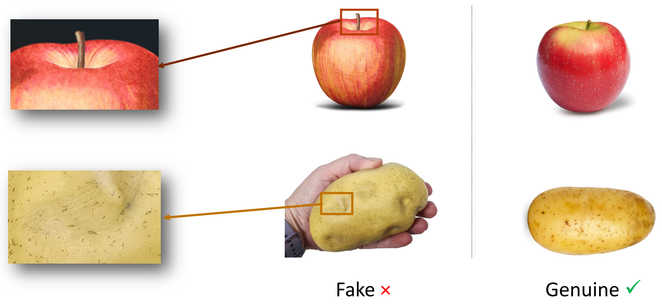
[1] Faculty of Information Technology, Thuyloi University, Hanoi, Vietnam Email: dat.trananh@tlu.edu.vn [2] CMC University, Hanoi, Vietnam

[3]Yen Hoa High School, Hanoi, Vietnam

## PROBLEM DEFINITION AND CONTRIBUTION

**Goal:**

Detect fine-grained counterfeit fruits in a training-free and incrementally expandable manner.




Fine-grained differences between authentic and fake fruits (texture, gloss, micro-patterns)

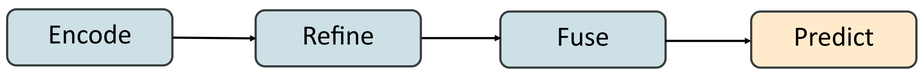
**Contributions:**

- a training-free framework for fine-grained counterfeit fruit detection.
- enriched semantics to capture subtle visual differences.
- stabilized few-shot visual features using base knowledge.

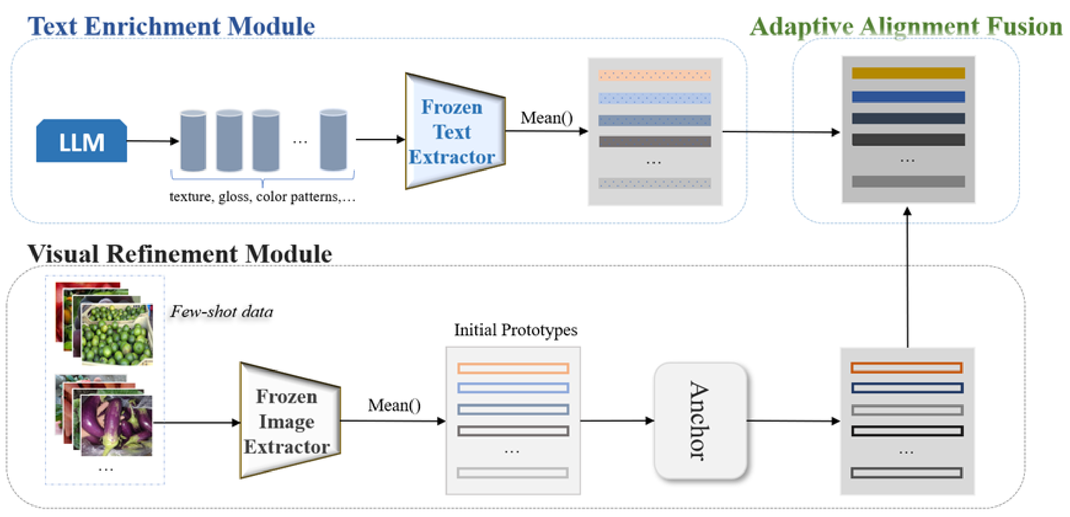
## METHODOLOGY

**Assumption:** access to a frozen vision–language model and a small number of support images per new class. No fine-tuning or retraining is allowed in any session.

**Process:**




**Model Architecture:** Images and enriched texts are encoded with frozen backbones, refined using base knowledge, and fused adaptively to produce stable, training-free fine-grained predictions.




## EXPERIMENTATION

**Dataset:** evaluate on four FSCIL benchmarks: MiniImageNet, CUB-200 (fine-grained birds), EuroSAT (remote sensing), and FG-Fruit (authentic vs. counterfeit fruits). This set-up covers both generic and highly fine-grained scenarios.

*miniImageNet. 100 classes*

*CUB-200. 200 classes*

*FG-Fruit. 50 classes*

### Visual Backbones

- ResNet-50/101
- ViT-B/16, ViT-B/32, ViT-L/14

### LLM for Semantic Prompts

- Attribute-based descriptions
- Capture subtle cues (texture, gloss, micro-patterns)

## QUANTIATIVE RESULTS

| Method | MiniImageNet | | CUB-200 | | EuroSAT | | FG-Fruit | |
|---|---|---|---|---|---|---|---|---|
| | $Acc_{avg}$ (%) | Drop (%) | $Acc_{avg}$ (%) | Drop (%) | $Acc_{avg}$ (%) | Drop (%) | $Acc_{avg}$ (%) | Drop (%) |
| CLIP-Zero | 84.4 | **-0.24** | 87.0 | -0.30 | 86.7 | **-0.41** | 87.0 | **-0.29** |
| CoOp | 86.8 | -0.11 | 89.3 | -0.13 | 88.6 | 0.14 | 89.3 | 0.22 |
| CoCoOP | 87.4 | 0.021 | 89.5 | **-0.41** | 88.8 | 0.21 | 88.9 | -0.16 |
| FSIL-VL | 86.1 | -0.15 | 89.0 | 0.12 | 89.1 | -0.18 | 88.4 | 0.26 |
| **Ours** | **87.9** | -0.11 | **90.6** | 0.20 | **89.6** | -0.12 | **90.2** | 0.13 |

*Performance comparison across four FSCIL datasets in the 5-shot setting*

### Overall Performance

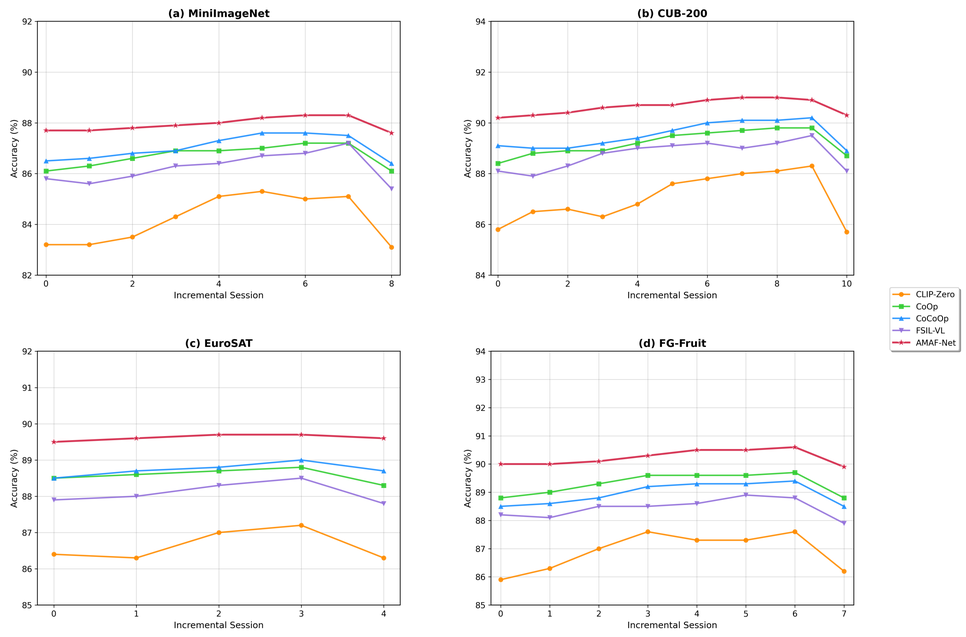
- Highest accuracy across all four FSCIL benchmarks
- Stable performance in training-free condition

### Fine-Grained Ability

- 90.2% on FG-Fruit
- 90.6% on CUB-200
- Strong at capturing subtle visual differences

## ANALYSIS & DISCUSSION

**Analysis of quantitative results:** achieves the highest average accuracy across all four benchmarks, outperforming all training-free and VLM-based baselines.




### Consistent Across All Sessions:

- AMAF-Net consistently outperforms baselines
- Prototype refinement slows accuracy degradation
- Stable across all incremental sessions

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