

SUPPLEMENTARY MATERIAL

Efficient and explainable attention-based multitask learning for fruit type, ripeness, and disease classification

Rida El Chall,^{1,2} Sarah Alayan,¹ Abed Ellatif Samhat¹

¹Scientific Research Center in Engineering (CRSI), Faculty of Engineering, Lebanese University (LU), Beirut

²School of Engineering, Computer and Communications Department, Lebanese International University (LIU), Beirut, Lebanon

Corresponding author: Rida El Chall, Scientific Research Center in Engineering (CRSI), Faculty of Engineering, Lebanese University (LU), Beirut, Lebanon. E-mail: rida.chall@ul.edu.lb

 ©The Author(s), 2026
Licensee [PAGEPress](#), Italy

Table S1. Summary of accuracy: Multitask vs. Single-task models using MobileNetV2 backbone and 1 shared CBAM module.

Model	Fruit				Ripeness				Disease			
MobileNetV2	Prec	Rec	F1	Acc	Prec	Rec	F1	Acc	Prec	Rec	F1	Acc
Single Task	98.07	98.06	98.07	98.05	96.04	96.11	96.06	96.06	99.57	99.57	99.57	99.56
MTL 1-CBAM	99.29	99.43	99.36	99.39	96.33	96.38	96.34	96.35	99.70	99.70	99.69	99.69
K-fold (K=5) Evaluation												
Single Task	97.76	97.76	97.75	97.72	96.03	96.06	96.04	96.05	99.27	99.29	99.27	99.26
MTL 1-CBAM	98.33	98.31	98.31	98.28	96.35	96.34	96.33	96.34	99.64	99.63	99.63	99.63
Standard deviations (F1/Acc) for Train/Test split: Single Task: Fruit ($\pm 0.26/\pm 0.30$), Ripe ($\pm 0.18/\pm 0.18$), Disease ($\pm 0.09/\pm 0.12$); MTL 1-CBAM: Fruit ($\pm 0.06/\pm 0.05$), Ripe ($\pm 0.19/\pm 0.18$), Disease ($\pm 0.09/\pm 0.09$).												

Table S2. Per-Source Evaluation (MobileNetV2, 1-CBAM, Separate optimizers, trained on full dataset).

Dataset	Fruit		Ripe		Disease	
	F1	Acc	F1	Acc	F1	Acc
NewPlant	99.98	99.98	—	—	99.93	99.93
PlantDoc	89.89	89.47	—	—	79.24	78.36
Fruit Ripeness Level	99.32	99.3	99.25	99.25	—	—
Fruit Image (22 Classes)	93.35	93.54	85.62	85.64	—	—

Table S3. Cross-Dataset Generalization (MobileNetV2, 1-CBAM, Separate optimizers, trained on NewPlant + Fruit Ripeness Level only).

Dataset	Fruit		Ripe		Disease	
	F1	Acc	F1	Acc	F1	Acc
NewPlant	99.97	99.96	—	—	99.81	99.81
PlantDoc	77.94	77.78	—	—	59.68	56.72
Fruit Ripeness Level	99.29	99.35	99.20	99.20	—	—
Fruit Image (22 Classes)	98.26	98.51	83.93	84.05	—	—

Table S4. Summary of performance across Tasks and CBAM configurations using k-fold (K=5) Cross-Validation (MobileNetV2) using Separate Optimizers.

Backbone	Fruit		Ripe		Disease	
	F1	Acc	F1	Acc	F1	Acc
MobileNetV2 No-CBAM,	97.94±0.45	97.90±0.47	96.33±0.37	96.33±0.38	99.48±0.08	99.47±0.08
MobileNetV2 1-CBAM,	98.31±0.47	98.28±0.48	96.33±0.42	96.34±0.43	99.63±0.07	99.63±0.07
MobileNetV2 3-CBAM	98.21±0.36	98.17±0.37	96.55±0.48	96.56±0.47	99.57±0.12	99.57±0.12