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Online supplementary to the paper

Mutual Augmentation of Spectral Sensing and Machine Learning for Non-Invasive Detection of Apple Fruit Damages

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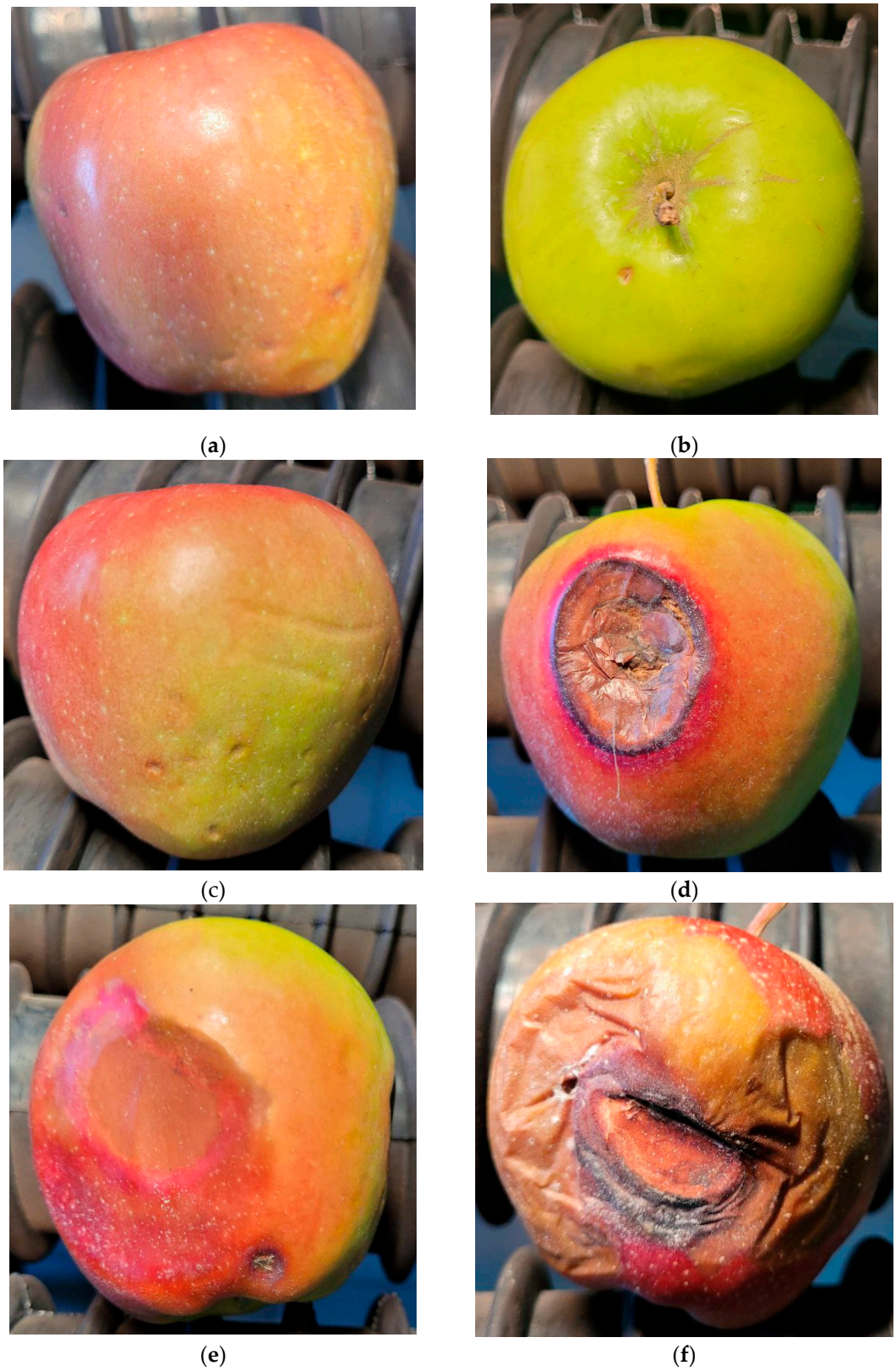

Figure S1. Representative photos of the studied apple fruits (conventional RGB images): (**a**) Healthy red apple; (**b**) Healthy yellow-green apple; (**c**) slight mechanical damages; (**d**) severe sunscald; (**e**) a heavy bruise; (**f**) fungal lesion after mechanical damage.

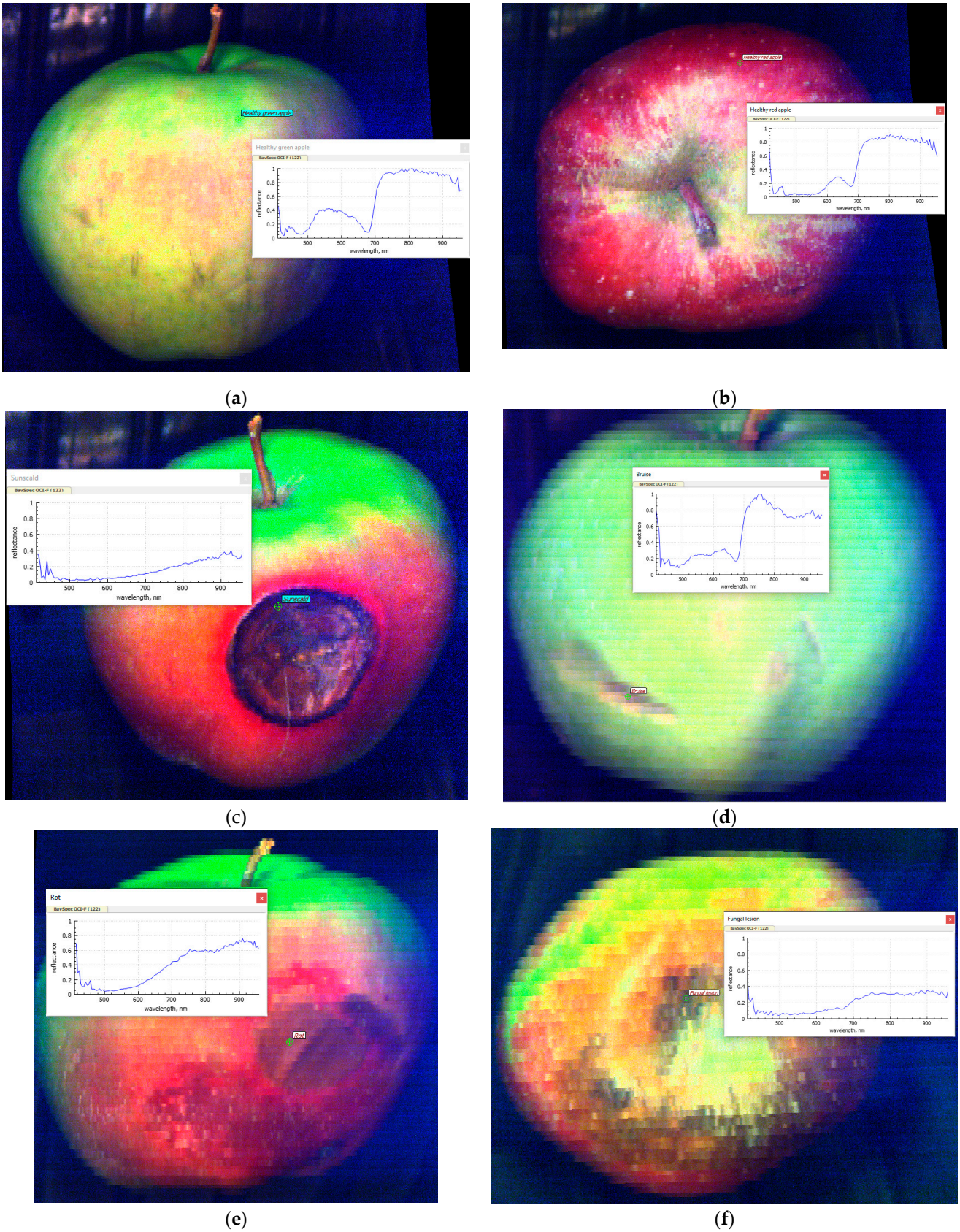

Figure S2. Representative RGB images of the studied apple fruits (composed from their hyperspectral images) with a typical reflectance spectrum (shown in overlay) of the damaged area (sampling point is marked on the image): (**a**) Healthy green-red apple; (**b**) Healthy red apple; (**c**) severe sunscald; (**d**) bruise; (**e**) rot after mechanical damage; (**f**) fungal lesion.

Table S1. Per-pixel classification results, inference on the test set only.

Feature set used		Accuracy, %	Cohen's kappa	F_2 score
Baseline (agreement between the human experts)		98.4±1.2	0.949±0.029	0.386±0.353
Reflectances with spectral downsampling	1	98.8±1.6	0.956±0.064	0.106±0.232
	2	98.8±1.6	0.956±0.065	0.104±0.233
	4	98.7±1.6	0.956±0.065	0.102±0.233
	8	98.7±1.6	0.955±0.065	0.096±0.229
	16	98.5±1.6	0.948±0.065	0.063±0.200
	32	98.5±1.5	0.946±0.064	0.087±0.217
Reflectances with no downsampling + LBP		98.8±1.6	0.956±0.064	**0.142±0.263**
Reflectances + LBP + weighting		96.6±3.2	0.896±0.075	0.093±0.147
LBP only		91.2±3.4	0.667±0.095	0.000±0.000
VI only		98.7±1.2	0.955±0.048	0.122±0.245
VI + LBP		**98.9±1.4**	**0.962±0.057**	0.096±0.238
VI + LBP + weighting		98.8±1.5	0.959±0.061	0.090±0.228

Table S2. Per-pixel classification results using annotations from human expert #2.

Feature set used		Accuracy, %	Cohen's kappa	F_2 score
Baseline (agreement between the human experts)		98.4±1.2	0.949±0.029	0.386±0.353
Random Forest classifiers				
Reflectances with spectral downsampling	1	97.2±2.7	0.917±0.064	0.147±0.271
	2	97.2±2.8	0.916±0.066	0.140±0.267
	4	97.2±2.8	0.915±0.066	0.137±0.264
	8	97.2±2.9	0.914±0.067	0.125±0.253
	16	96.9±3.0	0.906±0.072	0.090±0.212
	32	96.9±3.1	0.905±0.072	0.112±0.223
Reflectances with no downsampling + LBP		97.2±2.8	0.916±0.066	0.158±0.270
Reflectances + LBP + weighting		95.4±4.1	0.867±0.080	**0.192±0.238**
LBP only		89.6±4.9	0.639±0.100	0.000±0.000
VI only		97.1±2.6	0.913±0.061	0.143±0.256
VI + LBP		**97.3±2.7**	**0.921±0.063**	0.164±0.277
VI + LBP + weighting		**97.3±2.6**	0.920±0.062	0.174±0.279
Support Vector classifiers				
Reflectances with spectral downsampling	1	**97.0±3.0**	0.909±0.071	0.132±0.239
	2	96.9±3.1	0.907±0.074	0.101±0.210
	4	96.9±3.1	0.905±0.074	0.088±0.199
	8	96.8±3.2	0.904±0.075	0.079±0.193
	16	96.6±3.2	0.895±0.076	0.035±0.128
	32	96.6±3.2	0.893±0.077	0.019±0.080
Reflectances with no downsampling + LBP		**97.0±3.0**	**0.910±0.070**	0.131±0.237

Reflectances + LBP + weighting	94.9±2.5	0.843±0.055	**0.203±0.270**
LBP only	39.1±3.8	-0.106±0.026	0.015±0.021
VI only	96.6±3.2	0.896±0.077	0.006±0.036
VI + LBP	95.8±3.6	0.876±0.080	0.029±0.048
VI + LBP + weighting	93.8±3.5	0.811±0.064	0.098±0.129