Closing The Loop On Precision Spraying

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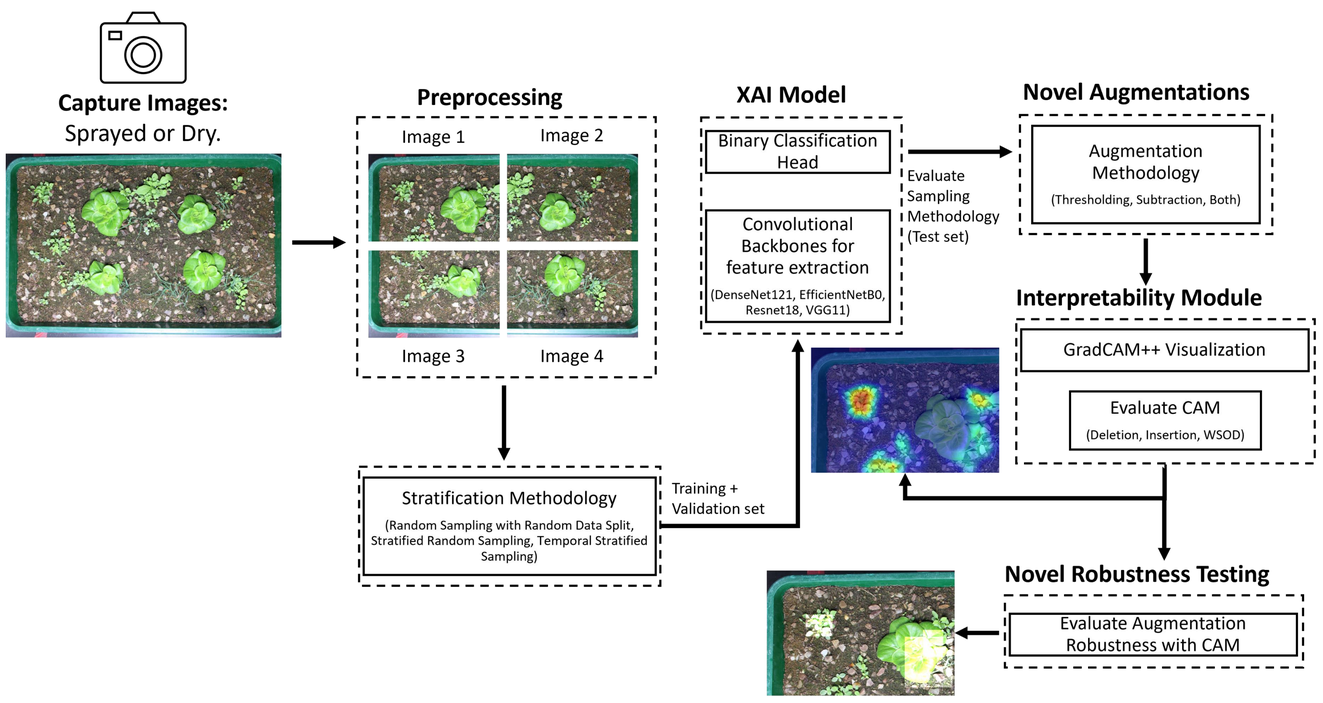
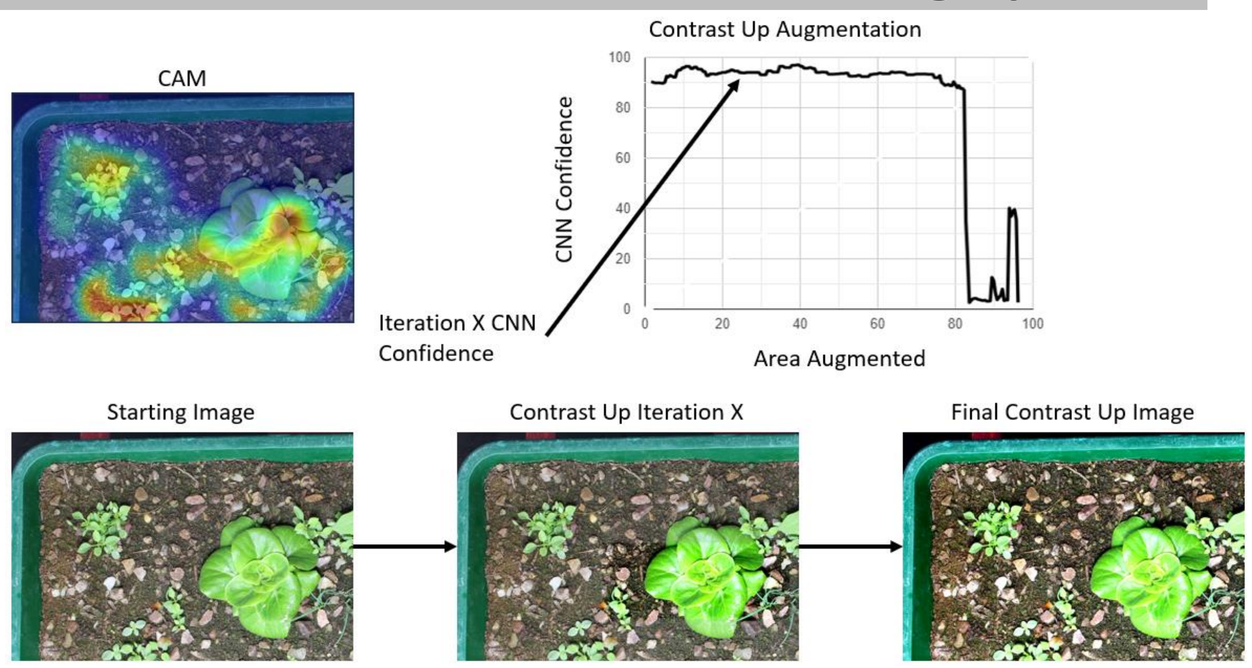
Introduction

Precision agriculture requires optimised spraying for sustainable chemical use. Current evaluation methods, however, are manual and limited. To address this, we integrated Convolutional Neural Networks and eXplainable AI to develop an automated vision system that identifies spray deposits. Our dataset, enables binary classification and Weakly Supervised Object Localisation.

eXplainable AI Pipeline



Novel Robustness Testing Pipeline



Classification/Robustness Results

Architecture	Augmentation	F1 Score	AUROC	WSOL
DenseNet121	None	**95.16 (+1.46)**	**95.16 (+1.46)**	**35.44**
	Thresholding	93.51	93.55	27.71
	Subtraction	**95.16 (+1.46)**	**95.16 (+1.46)**	28.39
	Both	88.68	88.71	34.47
EfficientNetB0	None	93.52	93.55	**37.22**
	Thresholding	91.93	91.94	34.34
	Subtraction	**95.16 (+1.46)**	**95.16 (+1.46)**	36.70
	Both	**95.16 (+1.46)**	**95.16 (+1.46)**	30.09
ResNet18	None	**96.77 (+3.07)**	**96.77 (+3.07)**	**38.75**
	Thresholding	93.54	93.55	32.62
	Subtraction	93.54	93.55	37.53
	Both	93.54	93.55	32.81

Architecture	Augmentation	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)	8 (%)	9 (%)	Average
DenseNet121	None	6	3.91	15.69	4.06	4.36	3.68	10.49	22.61	3.53	8.54
	Thresholding	84.45	94.42	52.11	90.57	85.58	93.96	36.99	50.08	93.81	74.69
	Subtraction	91.59	96.35	49.14	92.67	85.32	94.94	34.5	29.24	95.52	72.21
	Both	85.08	86.84	79.43	85.9	86.62	87.53	84.09	80.77	88.03	**84.90**
EfficientNetB0	None	18.7	11.91	20.4	14.75	18.92	12.65	19.92	19.34	43.75	20.03
	Thresholding	77.43	86.23	69.52	82.26	77.26	81.93	64.69	57.8	86.18	75.92
	Subtraction	84.71	90.14	80.1	89.3	84.93	87.11	79.79	79.16	90.85	**85.12**
	Both	78.24	90.99	58.09	82.08	88.38	83.48	70.28	40.63	91.23	75.93
ResNet18	None	3.71	29.09	4.89	32.27	3.63	31.37	4.59	4.71	55.98	18.91
	Thresholding	76.63	76.2	75.22	76.84	76.18	77.7	73.02	74.21	75.72	75.74
	Subtraction	90.69	92	89.49	91.29	91.09	92.25	84.69	86.93	92.7	**90.12**
	Both	80.91	80.41	78.78	80.96	79.54	82.05	73	74.33	80.22	78.91

Conclusions and Outlook

We have improved from previous classification scores from [1, 2] by using novel augmentations in our dataset. Moreover, novel robustness testing shows the efficacy of our proposed data augmentations against a baseline of no augmentations.

We are building an XAI pipeline which not only enables us to identify spray deposits accurately in a WSOL task; it also provides us with clear identification of the spray locations and enables us to highlight the features that are important to the classification.

References

[1] Rogers, H., De La Iglesia, B., Zebin, T., Cielniak, G., Magri, B.: An agricultural precision sprayer deposit identification system. In: 2023 IEEE 19th International Conference on Automation Science and Engineering (CASE)

[2] Rogers, H., De La Iglesia, B., Zebin, T., Cielniak, G., Magri, B.: An automated precision spraying evaluation system. In: Annual Conference Towards Autonomous Robotic Systems, p. (2023). Springer

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