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ARTIFICIAL INTELLIGENCE IN ORGANIC AGRICULTURE — FROM PIXEL TO PLANT: AUTOMATED DETECTION OF PLANT DISEASES AND PESTS THROUGH MACHINE LEARNING TECHNIQUES

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Abstract: *Organic agriculture faces major challenges in plant health management, given restrictions on synthetic pesticides. This article explores convolutional neural networks (CNNs) and computer vision as modern phytosanitary diagnosis tools. Architectures MobileNet, ResNet-50, YOLO and EfficientNet are analysed alongside the PlantVillage dataset (54,000+ images, 38 disease categories, 14 crop species). Low-code platforms Teachable Machine and Roboflow enable model training without advanced programming knowledge. The interdisciplinary PlantGuard project (4-6 weeks) connects informatics with biology and organic agriculture within STEM education.*

• Introduction

Organic farming bans synthetic pesticides, making early and accurate identification of diseases and pests critical for crop survival. The EU Farm to Fork strategy targets 25% organic farmland by 2030 [1]. AI and computer vision offer a scalable, evidence-based solution to this challenge [2].

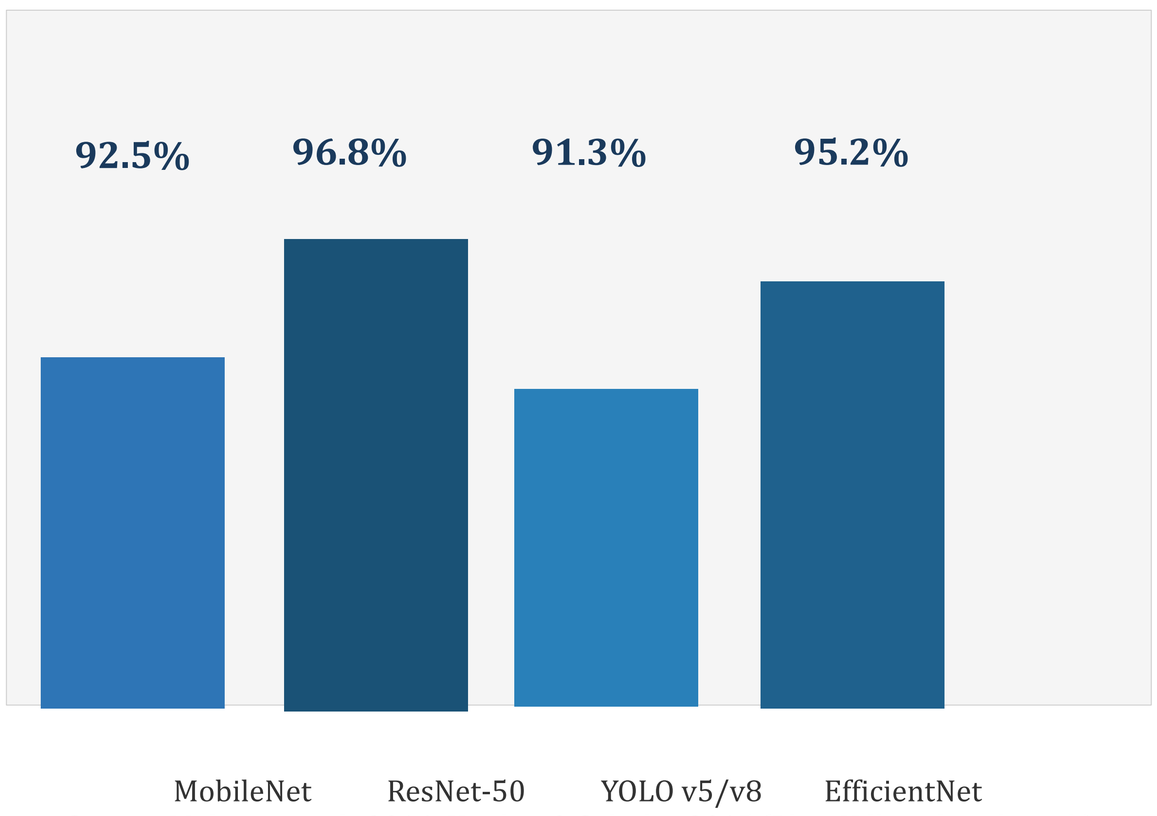
• Material and Method

Theoretical-applied approach: (1) literature review on AI in plant health (Google Scholar, IEEE Xplore, Elsevier); (2) comparative analysis of CNN architectures and low-code platforms on accuracy and accessibility; (3) design of the PlantGuard interdisciplinary project [6].

• Results and Discussions

CNNs learn disease features directly from leaf images. YOLO achieves >90% detection on standardised datasets [7]. PlantVillage: 54,000+ images, 38 disease categories, 14 crop species [4]. Teachable Machine and Roboflow enable training without coding skills [5].

Fig. 1. Detection accuracy (%) of CNN architectures on PlantVillage dataset



Source: Mohanty et al., 2016; Hughes & Salathe, 2015 (PlantVillage benchmark)

Table 1. Comparison of CNN architectures for plant disease detection

Architecture	Accuracy	Speed	Best Use Case	Educational
MobileNet	92.5%	Very fast	Smartphone / field	★★★★★
ResNet-50	96.8%	Moderate	Complex classif.	★★★
YOLO v5/v8	91.3%	Real-time	Pest detect. / video	★★★
EfficientNet	95.2%	Fast	Cloud / mid-range	★★★★

• Conclusions

AI in plant health is an accessible reality — in the classroom too. The PlantGuard project connects informatics, biology and organic agriculture in a fertile educational triad. Future work: pilot validation and extension toward drone-based multispectral imaging.

Acknowledgement: Key words: artificial intelligence, computer vision, convolutional neural networks, organic agriculture, plant disease detection, STEM education, interdisciplinarity, PlantVillage, sustainable agriculture. References: [1] European Commission, 2020, Farm to Fork Strategy; [2] FAO, 2022, Digital Technologies in Agriculture; [3] LeCun et al., 2015, Nature 521; [4] Hughes & Salathe, 2015, arXiv:1511.08060; [5] Google, Teachable Machine; [6] English, 2016, Int. J. STEM Educ. 3(1); [7] Mohanty et al., 2016, Front. Plant Sci. 7.