



Universiteit
Leiden
The Netherlands

From pixels to patterns: AI-driven image analysis in multiple domains

Javanmardi, S.

Citation

Javanmardi, S. (2024, September 18). *From pixels to patterns: AI-driven image analysis in multiple domains*. Retrieved from <https://hdl.handle.net/1887/4092779>

Version: Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/4092779>

Note: To cite this publication please use the final published version (if applicable).

From Pixels to Patterns: AI-Driven Image Analysis in Multiple Domains

Proefschrift

ter verkrijging van
de graad van doctor aan de Universiteit Leiden,
op gezag van rector magnificus prof.dr.ir. H. Bijl,
volgens besluit van het college voor promoties
te verdedigen op woensdag 18 september 2024
klokke 11:30 uur

door

Shima Javanmardi

geboren te Shiraz, Iran
in 1989

Promotores:

Prof. Dr. Ir. F.J. Verbeek

Prof. Dr. M.M. Bonsangue

Promotiecommissie:

Prof. Dr. T.H.W. Bäck

Prof. Dr. R.V. van Nieuwpoort

Prof. Dr. H.P. Spaink

Dr. A.V. Kononova

Prof. Dr. H. Trautmann (Paderborn University, Germany)

Prof. Dr. R. Veltkamp (Utrecht University)

ISBN: 978-90-3610-769-3

Cover designed by Shima Javanmardi.

Copyright © 2024 Shima Javanmardi. All rights reserved. No part of this thesis may be reproduced in any form or by any means without permission of the author.

Contents

1	Introduction	1
1.1	Background	2
1.2	Research Questions and Contributions	7
1.3	Thesis Overview	13
1.4	Contribution of this Thesis	14
2	Corn Seed Feature Extraction via Deep Learning	17
2.1	Chapter Summary	18
2.2	Introduction	18
2.2.1	Problem statement	19
2.2.2	Motivation and Contributions	20
2.3	Data and methods	21
2.3.1	Sample preparation	21
2.3.2	Image acquisition and preprocessing	22
2.3.3	Hand-crafted features extraction	23
2.3.3.1	Gray Level Co-Occurrence Matrix	24
2.3.3.2	Local Binary Patterns	25
2.3.4	The convolutional neural network features extraction	26
2.3.5	Machine learning classifiers	29
2.3.5.1	Support vector machine	29
2.3.5.2	Weighted k-nearest-neighbors	30
2.3.5.3	Artificial neural network	30
2.3.5.4	Boosted and bagged trees	31
2.3.5.5	Linear discriminant analysis	32
2.3.6	Performance evaluation	32
2.3.7	Software	33

2.4	Results and discussion	33
2.5	Conclusions	41
3	Mulberry Ripeness Detection via Deep Learning	45
3.1	Chapter Summary	46
3.2	Introduction	46
3.2.1	Problem Statement	48
3.2.2	Novelty	49
3.2.3	Related Work	50
3.2.4	Main Contributions and Chapter Structure	52
3.3	Materials and Methods	52
3.3.1	Dataset Composition	52
3.3.2	Acquisition of Images and Preprocessing	53
3.3.3	CNN Models	54
3.3.4	Fine-Tuning The Models	57
3.3.5	Software And Hardware Platform	58
3.4	Results	58
3.4.1	Performance Evaluation	58
3.4.2	White Mulberry Classification Results	59
3.4.3	Black Mulberry Classification Results	62
3.4.4	Classification Results Of Combining Both Genotypes	64
3.5	Discussion	67
3.6	Scale-Up and Integration of Technology	68
3.7	Conclusion	69
4	Zebrafish Image Segmentation via Deep Learning	71
4.1	Chapter Summary	72
4.2	Introduction	72
4.3	Related Work	74
4.4	Material and Methods	75
4.4.1	Dataset	75
4.4.2	Hardware	76
4.4.3	Preprocessing	77
4.4.4	Segmentation Models	77
4.5	Results	82
4.5.1	Model 1 : 5-layer U-Net	82
4.5.2	Model 2 : 4-layer U-Net	83

4.5.3	TransUnet	86
4.6	Unsupervised Segmentation	88
4.7	Reconstruction	88
4.8	Conclusion and Future Work	90
5	Advancing Image Captioning via Deep Learning	91
5.1	Chapter Summary	92
5.2	Introduction	92
5.3	Related Work	95
5.4	Dataset and Image captioning Methods	98
5.5	Experiments	110
5.5.1	Dataset and implementation details	110
5.6	Results and Discussions	111
5.6.1	Qualitative Results	115
5.7	Conclusions	117
6	Conclusions, Discussion and Future Work	119
6.1	Chapter Summary	120
6.2	Main Findings	120
6.2.1	RQ1	120
6.2.2	RQ2	122
6.2.3	RQ3	123
6.2.4	RQ4	124
6.3	Future work	125
6.3.1	Agronomy applications (RQ1 and RQ2)	125
6.3.2	Expanding Biomedical Image Analysis (RQ3)	126
6.3.3	Advancing Image Captioning Techniques (RQ4)	127
	Bibliography	129
	English Summary	153
	Nederlandse Samenvatting	155
	Curriculum Vitae	157
	Acknowledgements	158