

REVIEW

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Digital image processing techniques for detecting, quantifying and classifying plant diseases

Jayne Garcia Anna Barbado

Abstract

This paper presents a survey on methods that use digital image processing techniques to detect, quantify and classify plant diseases from digital images in the visible spectrum. Although disease symptoms can manifest in any part of the plant, only methods that explore visible symptoms in leaves and stems were considered. This was done for two main reasons: to limit the length of the paper and because methods dealing with roots, seeds and fruits have some peculiarities that would warrant a specific survey. The selected proposals are divided into three classes according to their objective: detection, severity quantification, and classification. Each of those classes, in turn, are subdivided according to the main technical solution used in the algorithm. This paper is expected to be useful to researchers working both on vegetable pathology and pattern recognition, providing a comprehensive and accessible overview of this important field of research.

Introduction

Agriculture has become much more than simply a means to feed ever growing populations. Plants have become an important source of energy, and are a fundamental piece in the puzzle to solve the problem of global warming. There are several diseases that affect plants with the potential to cause devastating economical, social and ecological losses. In this context, diagnosing diseases in an accurate and timely way is of the utmost importance.

There are several ways to detect plant pathologies. Some diseases do not have any visible symptoms associated, or those appear only when it is too late to act. In those cases, normally some kind of sophisticated analysis, usually by means of powerful microscopes, is necessary. In other cases, the signs can only be detected in parts of the electromagnetic spectrum that are not visible to humans. A common approach in this case is the use of remote sensing techniques that explore multi and hyperspectral image captures. The methods that adopt this approach often employ digital image processing tools to achieve their goals. However, due to their many peculiarities and to the extent of the literature on the subject, they will not be treated in this paper. A large amount of information

on the subject can be found in the papers by Bock et al. (2010), Mahlein et al. (2012) and Sankaran et al. (2010).

Most diseases, however, generate some kind of manifestation in the visible spectrum. In the vast majority of the cases, the diagnosis, or at least a first guess about the disease, is performed visually by humans. Trained raters may be efficient in recognizing and quantifying diseases, however they have associated some disadvantages that may harm the efforts in many cases. Bock et al. (2010) list some of those disadvantages:

- Raters may tire and lose concentration, thus decreasing their accuracy.
- There can be substantial inter- and intra-rater variability (subjectivity).
- There is a need to develop standard area diagrams to aid assessment.
- Training may need to be repeated to maintain quality. Raters are expensive.
- Visual rating can be destructive if samples are collected in the field for assessment later in the laboratory.
- Raters are prone to various illusions (for example, lesion number/size and area infected).

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Congress on Intelligent Systems Harish Sharma, Mukesh Saraswat, Anupam Yadav, Joong Hoon Kim, Jagdish Chand Bansal, 2021-06-01 This book is a collection of selected papers presented at the First Congress on Intelligent Systems CIS 2020 held in New Delhi India during September 5 6 2020 It includes novel and innovative work from experts practitioners scientists and decision makers from academia and industry It covers topics such as Internet of Things information security embedded systems real time systems cloud computing big data analysis quantum computing automation systems bio inspired intelligence cognitive systems cyber physical systems data analytics data web mining data science intelligence for security intelligent decision making systems intelligent information processing intelligent transportation artificial intelligence for machine vision imaging sensors technology image segmentation convolutional neural network image video classification soft computing for machine vision pattern recognition human computer interaction robotic devices and systems autonomous vehicles intelligent control systems human motor control game playing evolutionary algorithms swarm optimization neural network deep learning supervised learning unsupervised learning fuzzy logic rough sets computational optimization and neuro fuzzy systems

Trends in Plant Disease Assessment Imran Ul Haq, Siddra Ijaz, 2022-10-26 This edited book provides the readers with the concepts and in depth knowledge of plant disease assessment and conventional and modern technologies that aid in precise and accurate phytomathometry This book discusses the evolution of plant disease assessment procedures from the primary visual estimation based assessment to modern approaches their practical application for reliable disease quantification yield loss estimation and the efficacy of disease control strategies for sustainable crop protection Significant information is provided on the major aspects of the topic including remote sensing imaging techniques molecular phytopathometry microarray and immunotechnology The book helps plant scientists plant pathologists practitioners researchers and students in disease quantification developing predictive models for plant disease epidemics assessing crop losses and the magnitude of plant disease control methods This book describes the classical plant disease assessment methods based on visual observations It Provides information regarding the modern and emerging technologies in Phytopathometry precision and accuracy This book also discusses the application of disease assessments in predictive models disease warning systems expert systems and decision support systems in applied plant pathology

Advances in Signal and Data Processing S. N. Merchant, Krishna

Warhade, Debashis Adhikari, 2021-01-11 This book presents the select peer reviewed proceedings of the International Conference on Signal and Data Processing ICSDP 2019 It examines and deliberates on the recent progresses in the areas of communication and signal processing The book includes topics on the recent advances in the areas of wired and wireless communication low complexity architecture of MIMO receivers applications on wireless sensor networks and internet of things signal processing image processing and computer vision VLSI embedded systems cognitive networks power electronics and automation mechatronics based applications systems and control cognitive science and machine intelligence information security and big data The contents of this book will be useful for beginners researchers and professionals interested in the area of communication signal processing and allied fields Computational Signal Processing and Analysis

Asoke K. Nandi, N Sujatha, R Menaka, John Sahaya Rani Alex, 2018-04-02 This book comprises a collection of papers by international experts presented at the International Conference on NextGen Electronic Technologies ICNETS2 2017 ICNETS2 encompassed six symposia covering all aspects of electronics and communications engineering domains including relevant nano micro materials and devices Featuring the latest research on computational signal processing and analysis the book is useful to researchers professionals and students working in the core areas of electronics and their applications especially signal processing embedded systems and networking Modern Techniques for Agricultural Disease Management and Crop Yield Prediction

Pradeep, N., Kautish, Sandeep, Nirmala, C.R., Goyal, Vishal, Abdellatif, Sonia, 2019-08-16 Since agriculture is one of the key parameters in assessing the gross domestic product GDP of any country it has become crucial to transition from traditional agricultural practices to smart agriculture New agricultural technologies provide numerous opportunities to maximize crop yield by recognizing and analyzing diseases and other natural variables that may affect it Therefore it is necessary to understand how computer assisted technologies can best be utilized and adopted in the conversion to smart agriculture Modern Techniques for Agricultural Disease Management and Crop Yield Prediction is an essential publication that widens the spectrum of computational methods that can aid in agriculture disease management weed detection and crop yield prediction Featuring coverage on a wide range of topics such as soil and crop sensors swarm robotics and weed detection this book is ideally designed for environmentalists farmers botanists agricultural engineers computer engineers scientists researchers practitioners and students seeking current research on technology and techniques for agricultural diseases and predictive trends *Intelligent Computing*

Kohei Arai, 2024-06-13 Explore the forefront of computing with the proceedings of the Computing Conference 2024 Featuring 165 carefully selected papers from a pool of 457 submissions this collection encapsulates the cutting edge research and innovation presented during the conference Delve into a diverse range of topics insights and methodologies that shape the future of computing Whether you re an academic researcher or enthusiast this concise volume offers a snapshot of the dynamic and collaborative spirit defining the Computing Conference 2024 Image Processing and Capsule Networks

Joy Iong-Zong Chen, João Manuel R. S.

Tavares,Subarna Shakya,Abdullah M. Iliyasu,2020-07-23 This book emphasizes the emerging building block of image processing domain which is known as capsule networks for performing deep image recognition and processing for next generation imaging science Recent years have witnessed the continuous development of technologies and methodologies related to image processing analysis and 3D modeling which have been implemented in the field of computer and image vision The significant development of these technologies has led to an efficient solution called capsule networks CapsNet to solve the intricate challenges in recognizing complex image poses visual tasks and object deformation Moreover the breakneck growth of computation complexities and computing efficiency has initiated the significant developments of the effective and sophisticated capsule network algorithms and artificial intelligence AI tools into existence The main contribution of this book is to explain and summarize the significant state of the art research advances in the areas of capsule network CapsNet algorithms and architectures with real time implications in the areas of image detection remote sensing biomedical image analysis computer communications machine vision Internet of things and data analytics techniques

Smart Computing Techniques and Applications Suresh Chandra Satapathy,Vikrant Bhateja,Margarita N. Favorskaya,T. Adilakshmi,2021-07-13 This book presents best selected papers presented at the 4th International Conference on Smart Computing and Informatics SCI 2020 held at the Department of Computer Science and Engineering Vasavi College of Engineering Autonomous Hyderabad Telangana India It presents advanced and multi disciplinary research towards the design of smart computing and informatics The theme is on a broader front which focuses on various innovation paradigms in system knowledge intelligence and sustainability that may be applied to provide realistic solutions to varied problems in society environment and industries The scope is also extended towards the deployment of emerging computational and knowledge transfer approaches optimizing solutions in various disciplines of science technology and health care

Handbook of Medical and Healthcare Technologies Borko Furht,Ankur Agarwal,2013-11-20 This book equips readers to understand a complex range of healthcare products that are used to diagnose monitor and treat diseases or medical conditions affecting humans The first part of the book presents medical technologies such as medical information retrieval tissue engineering techniques 3D medical imaging nanotechnology innovations in medicine medical wireless sensor networks and knowledge mining techniques in medicine The second half of the book focuses on healthcare technologies including prediction hospital readmission risk modeling e health framework personal Web in healthcare security issues for medical records and personalized services in healthcare The contributors are leading world researchers who share their innovations making this handbook the definitive resource on these topics Handbook of Medical and Healthcare Technologies is intended for a wide audience including academicians designers developers researchers and advanced level students It is also valuable for business managers entrepreneurs and investors within the medical and healthcare industries

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Table of Contents Digital Processing Techniques Detecting Diseases

1. Understanding the eBook Digital Processing Techniques Detecting Diseases
 - The Rise of Digital Reading Digital Processing Techniques Detecting Diseases
 - Advantages of eBooks Over Traditional Books
2. Identifying Digital Processing Techniques Detecting Diseases
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Digital Processing Techniques Detecting Diseases
 - User-Friendly Interface
4. Exploring eBook Recommendations from Digital Processing Techniques Detecting Diseases
 - Personalized Recommendations
 - Digital Processing Techniques Detecting Diseases User Reviews and Ratings
 - Digital Processing Techniques Detecting Diseases and Bestseller Lists
5. Accessing Digital Processing Techniques Detecting Diseases Free and Paid eBooks

- Digital Processing Techniques Detecting Diseases Public Domain eBooks
 - Digital Processing Techniques Detecting Diseases eBook Subscription Services
 - Digital Processing Techniques Detecting Diseases Budget-Friendly Options
6. Navigating Digital Processing Techniques Detecting Diseases eBook Formats
 - ePub, PDF, MOBI, and More
 - Digital Processing Techniques Detecting Diseases Compatibility with Devices
 - Digital Processing Techniques Detecting Diseases Enhanced eBook Features
 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Digital Processing Techniques Detecting Diseases
 - Highlighting and Note-Taking Digital Processing Techniques Detecting Diseases
 - Interactive Elements Digital Processing Techniques Detecting Diseases
 8. Staying Engaged with Digital Processing Techniques Detecting Diseases
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Digital Processing Techniques Detecting Diseases
 9. Balancing eBooks and Physical Books Digital Processing Techniques Detecting Diseases
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Digital Processing Techniques Detecting Diseases
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine Digital Processing Techniques Detecting Diseases
 - Setting Reading Goals Digital Processing Techniques Detecting Diseases
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of Digital Processing Techniques Detecting Diseases
 - Fact-Checking eBook Content of Digital Processing Techniques Detecting Diseases
 - Distinguishing Credible Sources
 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development

- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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