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Fruit Grading Using Digital Image Processing Techniques

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Abstract: New safe and fast methods for grading of fruits have important place in agricultural economy. At the present time traditional grading methods have still been used broadly. But high costs and some inconsistencies guide post harvesting industry to automation applications in classification operations.
Recently, enterprises incline towards to automation systems for increasing working capacity and decreasing working costs. Inconsistencies associated with manual grading decrease when automated grading systems are used. Thus, error rate and costs decrease while speed increases.
As known; size, shape, color and tissue are base criteria in the classification process. In this study, automatic apple grading by size and color using digital cameras and computerized image processing techniques were studied. The assembled system has achieved basic tasks but it needs to be developed further.
Key words: Image process, Digital image process, Machine vision, Fruit classification

Bilgisayarlı Görüntü İşleme Yöntemleri ile Elma Tasnifi

Özet: Meyvelerin güvenilir ve hızlı bir şekilde sınıflandırılması için geliştirilen yeni yöntemler, tarımsal endüstride teknik ve ekonomik açıdan önemli bir yere sahiptir. Günümüzde halen yaygın olarak el ile sınıflandırma yöntemi kullanılmaktadır. El ile yapılan sınıflandırmadaki yüksek maliyet ve olası tutarsızlıklar hasat sonrası endüstriyi sınıflama operasyonlarında otomasyon uygulamasına gitmeye yönlendirmektedir.
Son yıllarda işletmeler iş kapasitelerini arttırmak ve işletme maliyetlerini düşürmek amacıyla otomasyon sistemlerine yönelmektedir. Otomatik sınıflandırma ile meyve tasnifi sayesinde el ile sınıflandırmada yaşanabilecek insan faktöründen kaynaklanan tutarsızlıklar en aza inerek hata oranı büyük ölçüde düşmekte, hız artmakta ve maliyet azalmaktadır.
Bilindiği gibi geleneksel yöntemlerle elmaların sınıflandırılmasında boyut, şekil, renk ve doku gibi özellikler sınıflandırmanın temel kriterleridir. Bu çalışmada dijital kameralar ve bilgisayarlı görüntü işleme teknikleri kullanılarak elmaların otomatik olarak boy ve renk ayrımı yapılmaya çalışılmıştır. Elde edilen düzenek temel olarak işlevlerini yerine getirmekle birlikte gelişime açıktır.
Anahtar kelimeler: Görüntü işleme, Sayısal Görüntü işleme, Makine görüsü, Meyve tasnifi.

INTRODUCTION

Summary of Literature

In the studies of non destructive fruit classification apple (Bern *et al*., 2002; Bennedsen *et al*., 2005; Rehkugler *et al*., 1986), tomato (Wolfe *et al*., 1989), orange (Pla *et al*., 1995), wild myrtle and pepper (Wolfe *et al*., 1985), prune (Delwiche *et al*., 1993), wild grass (Haggar *et al*, 1983), potato (McClure *et al*, 1988) was examined.

To detect the fruit in front of camera, in some studies images taking from the camera are processing continuously (Haggar *et al*, 1983, 1984) on the other hand some studies use sensor (Shropshire *et al*, 1988).

Various studies have been done on the colors of fruit. Bern (2002), make color classification using RGB color components and CIE chromaticity with Matlab, make size classification with form factor and box structure methods.

McClure (1988) works with white potatoes to detect size and shape information, Rehkugler and Throop (1986) works with "Red Delicious" apples to detect defects of apples. Monochrome camera was used in both studies. At the end of works greens and other scars of potatoes creases and blemishes (reddish brown) of apples couldn't detected with

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Chuanlei Zhang,Dong Sun Park,Sook Yoon,Shanwen Zhang

Fruit Grading Using Digital Image Processing Techniques:

Recent Advances in Postharvest Technologies, Volume 2 Noureddine Benkeblia,2024-09-10 The elapsing time from producer to consumer has significantly increased as a result of food marketing and trade globalization Consequently maintaining quality along the food value chain is becoming a significant challenge Postharvest losses are considered a major component of food loss and waste in the supply chain from farmers to consumers due to improper handling storage transport preservation techniques and spoilage Postharvest science aims to extend the shelf life of fresh and perishable commodities and to reduce heavy losses thereby contributing to food security While significant progresses have been made in postharvest preservation and shelf life extension the continuous development of emerging technologies have changed our vision on postharvest science Furthermore recent advancements in molecular engineering of horticultural crops for quality improvement the development of genomics transcriptomics proteomics and metabolomics have led to a better understanding of the physiology and the biochemistry of the senescence processes resulting in better preservation and improved production of fresh crops This two volume work focuses on innovative technologies that extend and preserve shelf life of fruits and vegetables Volume 1 offers a review on the state of the art modern technologies in the postharvest filed The accompanying Volume 2 explores advanced and novel technologies after harvest particularly the application of nanotechnologies to packaging materials **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 **Biometrics: Concepts, Methodologies, Tools, and Applications** Management Association, Information Resources,2016-08-30 Security and authentication issues are surging to the forefront of the research realm in global society As technology continues to evolve individuals are finding it easier to infiltrate various forums and facilities where they can illegally obtain information and access By implementing biometric authentications to these forums users are able to prevent attacks on their privacy and security Biometrics Concepts Methodologies Tools and Applications is a multi

volume publication highlighting critical topics related to access control user identification and surveillance technologies Featuring emergent research on the issues and challenges in security and privacy various forms of user authentication biometric applications to image processing and computer vision and security applications within the field this publication is an ideal reference source for researchers engineers technology developers students and security specialists **Advanced Digital Image Processing and Its Applications in Big Data** Ankur Dumka,Alaknanda Ashok,Parag Verma,Poonam Verma,2020-12-09 This book covers the technology of digital image processing in various fields with big data and their applications Readers will understand various technologies and strategies used in digital image processing as well as handling big data using machine learning techniques This book will help to improve the skills of students and researchers in such fields as engineering agriculture and medical imaging There is a need to be able to understand and analyse the latest developments of digital image technology As such this book will cover Applications such as biomedical science and biometric image processing content based image retrieval remote sensing pattern recognition shape and texture analysis New concepts in color interpolation to produce the full color from the sub pattern bare pattern color prevalent in today s digital cameras and other imaging devices Image compression standards that are needed to serve diverse applications Applications of remote sensing medical science traffic management education innovation and analysis in agricultural design and image processing Both soft and hard computing approaches at great length in relation to major image processing tasks The direction and development of current and future research in many areas of image processing A comprehensive bibliography for additional research integrated within the framework of the book This book focuses not only on theoretical and practical knowledge in the field but also on the traditional and latest tools and techniques adopted in image processing and data science It also provides an indispensable guide to a wide range of basic and advanced techniques in the fields of image processing and data science **Handbook of Research on Emerging Perspectives in Intelligent Pattern Recognition, Analysis, and Image Processing** Kamila, Narendra Kumar,2015-11-30 Digital Image Processing - Latest Advances and Applications Francisco Cuevas,Pier Luigi Mazzeo,Alessandro Bruno,2024-07-24 This book offers a comprehensive analysis of image processing and its many applications in various fields From improving the resolution of blurry images to identifying crop pests optimizing water resource management and extracting crucial details from photographs and videos it covers a wide range of techniques and uses Readers will be immersed in the fascinating world of image edge detection combining color based multidimensional scaling maps to highlight areas of saliency and using deep learning to transform perception in driver assistance systems and autonomous vehicles Additionally they will explore how visual recognition can predict crack trajectories bionic color theory and the creation of realistic simulations of radar images A highlight of the book is its focus on the revolutionary application of image processing in dentistry from making precise measurements to developing next generation dental biometrics systems With a detailed and broad overview this book provides readers with the tools and

knowledge necessary to unlock the potential hidden in images opening up new possibilities and applications in fields ranging from agriculture and medicine to technology and science *Machine Learning, Image Processing, Network Security and Data Sciences* Rajesh Doriya,Badal Soni,Anupam Shukla,Xiao-Zhi Gao,2023-01-01 This book constitutes the refereed proceedings of the Third International Conference on Machine Learning Image Processing Network Security and Data Sciences MIND 2021 The papers are organized according to the following topical sections data science and big data image processing and computer vision machine learning and computational intelligence network and cybersecurity This book aims to develop an understanding of image processing networks and data modeling by using various machine learning algorithms for a wide range of real world applications In addition to providing basic principles of data processing this book teaches standard models and algorithms for data and image analysis International Conference on Wireless, Intelligent, and Distributed Environment for Communication Isaac Woungang,Sanjay Kumar Dhurandher,2018-04-17 This book presents the proceedings of the International Conference on Wireless Intelligent and Distributed Environment for Communication WIDECOM 2018 organized by SRM University NCR Campus New Delhi India February 16 18 2018 The conference focuses on challenges with respect to the dependability of integrated applications and intelligence driven security threats against the platforms supporting these applications The WIDECOM 2018 proceedings features papers addressing issues related to the new dependability paradigms design control and management of next generation networks performance of dependable network computing and mobile systems protocols that deal with network computing mobile ubiquitous systems cloud systems and Internet of Things IoT systems The proceeding is a valuable reference for researchers instructors students scientists engineers managers and industry practitioners in industry in the aforementioned areas The book s structure and content is organized in such a manner that makes it useful at a variety of learning levels Presents the proceedings of the International Conference on Wireless Intelligent and Distributed Environment for Communication WIDECOM 2018 organized by SRM University NCR Campus New Delhi India February 16 18 2018 Includes an array of topics related to new dependability paradigms design control and management of next generation networks performance of dependable network computing and mobile systems protocols that deal with network computing mobile ubiquitous systems cloud systems and Internet of Things IoT systems Addresses issues related to the design and performance of dependable network computing and systems and to the security of these systems **Handbook of Research on AI-Equipped IoT Applications in High-Tech Agriculture** Khang, Alex,2023-08-02 The agriculture industry is facing significant challenges in meeting the increasing demand for food while also ensuring sustainable development Traditional agricultural methods are not equipped to meet the demands of the modern world To overcome these challenges the Handbook of Research on AI Equipped IoT Applications in High Tech Agriculture provides an in depth analysis of the opportunities and challenges for AI powered management tools and IoT equipped techniques for the high tech agricultural ecosystem The Handbook of Research on AI Equipped IoT Applications in

High Tech Agriculture explores advanced methodologies models techniques technologies and applications along with the concepts of real time supporting systems to help agricultural producers adjust plans or schedules for taking care of their farms Additionally it discusses the role of IoT technologies and AI applications in agricultural ecosystems and their potential to improve product quality and market competitiveness The book includes discussions on the application of blockchain biotechnology drones robotics data analytics and visualization in high tech agriculture It is an essential reference for anyone interested in the future of high tech agriculture including agricultural analysts investment analysts scholars researchers academics professionals engineers and students **Computer Vision and Machine Learning in Agriculture** Mohammad Shorif Uddin,Jagdish Chand Bansal,2021-03-23 This book discusses computer vision a noncontact as well as a nondestructive technique involving the development of theoretical and algorithmic tools for automatic visual understanding and recognition which finds huge applications in agricultural productions It also entails how rendering of machine learning techniques to computer vision algorithms is boosting this sector with better productivity by developing more precise systems Computer vision and machine learning CV ML helps in plant disease assessment along with crop condition monitoring to control the degradation of yield quality and severe financial loss for farmers Significant scientific and technological advances have been made in defect assessment quality grading disease recognition pests insects fruits and vegetable types recognition and evaluation of a wide range of agricultural plants crops leaves and fruits The book discusses intelligent robots developed with the touch of CV ML which can help farmers to perform various tasks like planting weeding harvesting plant health monitoring and so on The topics covered in the book include plant leaf and fruit disease detection crop health monitoring applications of robots in agriculture precision farming assessment of product quality and defects pest insect fruits and vegetable types recognition **Nondestructive Quality Assessment Techniques for Fresh Fruits and Vegetables** Pankaj B. Pathare,Mohammad Shafiur Rahman,2022-11-17 This book describes the various techniques for nondestructive quality assessment of fruits and vegetables It covers the methods measurements operation principles procedures data analysis and applications for implementing these techniques The book presents the details of nondestructive approaches focusing on the present day trends and existing future opportunities in the fresh food supply chain First it overviews different nondestructive techniques in food quality detection Then it presents nondestructive methods monochrome computer vision imaging techniques biospeckle laser technique Fourier Transform Infrared FTIR Spectroscopy hyperspectral imaging Raman spectroscopy near infrared NIR spectroscopy X ray computed tomography ultrasound acoustic emission chemometrics electronic nose and tongue Selected applications of each method are also introduced As a result readers gain a better understanding of how to use nondestructive methods and technologies to detect the quality of fresh fruits and vegetables With a wide range of interesting topics the book will benefit readers including postharvest food scientists technologists industry personnel and researchers involved in fresh produce quality detection The book can also serve as a readily

accessible reference material for postgraduate students *Recent Advances in Machine Design* C. V. Chandrashekara,N. Rajesh Mathivanan,K. Hariharan,2024-07-26 This book presents the select proceedings of 21st ISME conference on Advances in Mechanical Engineering It covers the latest research and technological advancements in the area of machine design Various topics covered in this volume are product design and development CAD CAE FEM modelling and simulation fatigue fracture and failure analysis vibrations condition monitoring rotor dynamics multi body dynamics tribology robotics and mechatronics computational mechanics sensors and actuators materials failure analysis engineering optimization machines and mechanisms mechanics of composites biomechanics and fracture mechanics This book is useful for researchers and professionals working in the area of machine design and allied fields *Proceedings of International Conference on Machine Intelligence and Data Science Applications* Manish Prateek,T. P. Singh,Tanupriya Choudhury,Hari Mohan Pandey,Nguyen Gia Nhu,2021-05-07 This book is a compilation of peer reviewed papers presented at the International Conference on Machine Intelligence and Data Science Applications organized by the School of Computer Science University of Petroleum Energy Studies Dehradun on September 4 and 5 2020 The book starts by addressing the algorithmic aspect of machine intelligence which includes the framework and optimization of various states of algorithms Variety of papers related to wide applications in various fields like image processing natural language processing computer vision sentiment analysis and speech and gesture analysis have been included with upfront details The book concludes with interdisciplinary applications like legal health care smart society cyber physical system and smart agriculture The book is a good reference for computer science engineers lecturers researchers in machine intelligence discipline and engineering graduates

Artificial Intelligence Algorithms and Applications Kangshun Li,Wei Li,Hui Wang,Yong Liu,2020-05-25 This book constitutes the thoroughly refereed proceedings of the 11th International Symposium on Intelligence Computation and Applications ISICA 2019 held in Guangzhou China in November 2019 The 65 papers presented were carefully reviewed and selected from the total of 112 submissions This volume features the most up to date research in evolutionary algorithms parallel computing and quantum computing evolutionary multi objective and dynamic optimization intelligent multimedia systems virtualization and AI applications smart scheduling intelligent control big data and cloud computing deep learning and hybrid machine learning systems The papers are organized according to the following topical sections new frontier in evolutionary algorithms evolutionary multi objective and dynamic optimization intelligent multimedia systems virtualization and AI applications smart scheduling intelligent control big data and cloud computing statistical learning **Advances in IoT and Security with Computational Intelligence** Anurag Mishra,Deepak Gupta,Girija Chetty,2023-09-22 The book is a collection of peer reviewed best selected research papers presented at the International Conference on Advances in IoT and Security with AI ICAISA 2023 organized by Deen Dayal Upadhyaya College University of Delhi New Delhi India in collaboration with University of Canberra Canberra Australia and NIT Arunachal Pradesh Itanagar AP India during March 24

25 2023 The book includes various applications and technologies in this specialized sector of Industry 4 0 The book is divided into two volumes It focuses on recent advances in Internet of Things and security with its applications using artificial intelligence Communication and Intelligent Systems Harish Sharma,Vivek Shrivastava,Kusum Kumari Bharti,Lipo Wang,2023-07-24 This book gathers selected research papers presented at the Fourth International Conference on Communication and Intelligent Systems ICCIS 2022 organized by National institute of Technology Delhi India during December 19 20 2022 This book presents a collection of state of the art research work involving cutting edge technologies for communication and intelligent systems Over the past few years advances in artificial intelligence and machine learning have sparked new research efforts around the globe which explore novel ways of developing intelligent systems and smart communication technologies The book presents single and multi disciplinary research on these themes in order to make the latest results available in a single readily accessible source The book is presented in two volumes **Advanced Sensing and Robotics Technologies in Smart Agriculture** Yuliang Yun,Wenyi Sheng,Zhao Zhang,2024-08-27 This book specifically focuses on state of the art advanced sensing and robotic techniques in smart agriculture and comprehensively describes the new knowledge Significant agricultural technology progress in advanced sensing and robotics technology has been made recently which has transformed the conventional agriculture to smart and digital agriculture It provides readers take away knowledge for seed quality detection specialty crop harvest and sorting robotics new sensing method for crop nutrient status and broadband soil dielectric permittivity measurements All these new technologies have been developed tested or practically applied It is a useful reference for readers in the field of smart agriculture and agriculture robotics

Computer Vision-Based Agriculture Engineering Han Zhongzhi,2019-09-16 In recent years computer vision is a fast growing technique of agricultural engineering especially in quality detection of agricultural products and food safety testing It can provide objective rapid non contact and non destructive methods by extracting quantitative information from digital images Significant scientific and technological advances have been made in quality inspection classification and evaluation of a wide range of food and agricultural products Computer Vision Based Agriculture Engineering focuses on these advances The book contains 25 chapters covering computer vision image processing hyperspectral imaging and other related technologies in peanut aflatoxin peanut and corn quality varieties and carrot and potato quality as well as pest and disease detection Features Discusses various detection methods in a variety of agricultural crops Each chapter includes materials and methods used results and analysis and discussion with conclusions Covers basic theory technical methods and engineering cases Provides comprehensive coverage on methods of variety identification quality detection and detection of key indicators of agricultural products safety Presents information on technology of artificial intelligence including deep learning and transfer learning Computer Vision Based Agriculture Engineering is a summary of the author s work over the past 10 years Professor Han has presented his most recent research results in all 25 chapters of this book This unique work

provides students engineers and technologists working in research development and operations in agricultural engineering with critical comprehensive and readily accessible information It applies development of artificial intelligence theory and methods including depth learning and transfer learning to the field of agricultural engineering testing **Smart Innovations in Communication and Computational Sciences** Shailesh Tiwari,Munesh C. Trivedi,Krishn K. Mishra,A. K. Misra,Khedo Kavi Kumar,2018-11-19 The book presents the latest advances and research findings in the fields of computational science and communication The areas covered include smart innovation systems and technologies embedded knowledge and intelligence innovation and sustainability advanced computing and networking and informatics It also focuses on the knowledge transfer methodologies and the innovation strategies employed to make these effective This fascinating compilation appeals to researchers academics and engineers around the globe **Understanding Digital Image Processing** Vipin Tyagi,2018-09-13 This book introduces the fundamental concepts of modern digital image processing It aims to help the students scientists and practitioners to understand the concepts through clear explanations illustrations and examples The discussion of the general concepts is supplemented with examples from applications and ready to use implementations of concepts in MATLAB Program code of some important concepts in programming language C is provided To explain the concepts MATLAB functions are used throughout the book MATLAB Version 9 3 R2017b Image Acquisition Toolbox Version 5 3 R2017b Image Processing Toolbox Version 10 1 R2017b have been used to create the book material Meant for students and practicing engineers this book provides a clear comprehensive and up to date introduction to Digital Image Processing in a pragmatic manner

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