(1)

A kernel-based method for fast and accurate computation of PHT in polar coordinates

Khalid M Hosny, Mohamed M Darwish

Abstract:

A novel kernel-based method is proposed for fast, highly accurate and numerically stable computations of polar harmonic transforms (PHT) in polar coordinates. Euler formula is used to derive a novel trigonometric formula where the later one is used in the kernel generation. The simplified radial and angular kernels are used in efficient computation PHTs. The proposed method removes the numerical approximation errors involved in conventional methods and provides highly accurate PHTs coefficients which results in highly improved image reconstruction capabilities. Numerical experiments are performed where the results are compared with those of the recent existing methods. In addition to the tremendous reduction in computational times, the obtained results of the proposed method clearly show a significant improvement in rotational invariance.

Keywords:

Polar harmonic transformsKernelFast computationsGray-scale images

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Journal of Real-Time Image Processing , 1-13 , NULL

(2)

Highly accurate and numerically stable higher order QPCET moments for color image representation

Khalid M. Hosny , Mohamed M. Darwish

Abstract:

A novel method is proposed for highly accurate, fast and numerically stable computation of the higher order Quaternion Polar Complex Exponential Transform (QPCET) moments for color images in polar Coordinates. A novel mathematical formula is derived and used to avoid numerical instabilities at higher orders. The proposed method removes the approximation errors involved in conventional methods and provides high image reconstruction capabilities. The proposed method results in a highly accurate rotation invariance. Numerical experiments are performed where the obtained results are compared with those of the recent existing methods.

Keywords:

Quaternion polar complex exponential transform; Reconstruction of color images; Rotational invariance; Polar Coordinates; Numerical stability

Published In:

Pattern Recognition Letters , NULL , NULL

(3)

Comments on "Robust circularly orthogonal moment based on Chebyshev rational function" [Digit. Signal Process. 62 (2017) 249–258]

Khalid M. Hosny , Mohamed M. Darwish

Abstract:

Comments on the recent work of Guo et al. [1] are presented, in order to correct the erroneous equations. The corrected equations of the Chebychev rational moments, for gray-level images, are presented. In addition, one numerical experiment is performed to ensure the validity of the corrected equations.

Keywords:

Chebyshev Rational moments; Corrected equations; ZOA; Gray-level images

Published In:

Digital Signal Processing , Vol.68 , PP.152-153

(4)

New Set of Quaternion Moments for Color Images Representation and Recognition

Khalid M. Hosny · Mohamed M. Darwish

Abstract:

In this paper, a new set of quaternion radial-substituted Chebyshev moments (QRSCMs) is proposed for color image representation and recognition. These new moments are circular moments defined over a unit disk by using a new set of orthogonal basis functions called radial-substituted Chebyshev functions. A new hybrid method is proposed for highly accurate computation of QRSCMs in polar coordinates. In this method, the angular kernel is exactly computed by analytical integration of Fourier function over circular pixels. The radial kernel is computed using a recurrence relation which completely eliminates the coefficient matrix associated with the radial-substituted Chebyshev functions. Rotation, scaling, and translation (RST) invariances for QRSCMs are proved. Numerical experiments were conducted where the results of these experiments show better performance of QRSCMs over existing quaternion moments in terms of image reconstruction capabilities, RST invariances, robust to different noises, and CPU elapsed times.

Keywords:

Quaternion radial-substituted Chebyshev moment · Chebyshev rational moment · Color image representation · RST · Polar coordinates · Color image reconstruction · Classifications of color images

Published In:

Journal of Mathematical Imaging and Vision , NULL , NULL

(5)

Robust color image watermarking using invariant quaternion Legendre-Fourier moments

Khalid M. Hosny & Mohamed M. Darwish

Abstract:

In this paper, a geometrically invariant color image watermarking method using Quaternion Legendre-Fourier moments (QLFMs) is presented. A highly accurate, fast and numerically stable method is proposed to compute the QLFMs in polar coordinates. The proposed watermarking method consists of three main steps. First, the Arnold scrambling algorithm is applied to a binary watermark image. Second, the QLFMs of the original host color image are computed. Third, the binary digital watermark is embedding by performing the quantization of selected QLFMs. Two different groups of attacks are considered. The first group includes geometric attacks such as rotation, scaling and translation while the second group includes the common signal processing attacks such as image compression and noise. Experiments are performed where the performance of proposed method is compared with the existing moment-based watermarking methods. The proposed method is superior over all existing quaternion moment-based watermarking in terms of visual imperceptibility capability and robustness to different attacks.

Keywords:

Quaternion Legendre-Fourier moments . Color image watermarking . Geometric attacks . Rotation invariant

Published In:

Multimed Tools Appl , NULL , NULL

(6)

New Set of Multi-Channel Orthogonal Moments for Color Image Representation and Recognition

Khalid M Hosny, Mohamed M Darwish

Abstract:

Orthogonal moments and their invariants to similarity transformations for monochrome and gray-scale images are widely used in many pattern recognition and image processing applications. Quaternion orthogonal moments are used with color images. Recently, the multi-channel framework is proposed as a successful alternative of the quaternion orthogonal moments in representation and recognition of the color images. In this paper, a new set of multi-channel orthogonal moments and their invariants to rotation, scaling and translation (RST) is proposed for color image representation and recognition. The proposed multi-channel moments are based on the orthogonal radial substituted Chebyshev functions. The multi-channel orthogonal radial substituted Chebyshev moments (MORSCMs) are defined in polar coordinates over a unit circle. An accurate kernel-based method is utilized for accurate computation of the MORSCMs. A series of experiments is performed to validate this new set of multi-channel moments and compare its performance with the existing quaternion and multi-channel orthogonal moments. The obtained results ensure the superiority of the proposed MORSCMs over all existing moments in representation and recognition of the color images.

Keywords:

Multi-channel orthogonal momentsQuaternion orthogonal momentsChebyshev rational momentsRSTColor image reconstructionRecognition rates

Published In:

Pattern Recognition , Volume 88 , 153-173

(7)

Parallel Multi-Core CPU and GPU for Fast and Robust Medical Image Watermarking

KHALID M. HOSNY , MOHAMED M. DARWISH , KENLI LI ,AND AHMAD SALAH

Abstract:

Securing medical images are a very essential process in medical image authentication. Medical image watermarking is a very popular tool to achieve this goal. In this paper, an extremely fast, highly accurate, and robust algorithm is proposed for watermarking both gray-level and color medical images. In the proposed method, a scrambled binary watermark is embedded in the host medical image. Simplified exact kernels are used to compute the moments of the polar complex exponential transform (PCET) for the host gray-level images and the moments of the quaternion PCET for the host color images without approximation errors. The stability of the computed moments enables us to use higher order moments in a perfect reconstruction of the watermarked medical images. The accurate moment invariant to rotation, scaling, and translation ensures the robustness of the proposed watermarking algorithm against geometric attacks. Performed experiments clearly show very high visual imperceptibility and robustness to different levels of geometric distortions and common signal processing attacks. The implementation of parallel multi-core CPU and GPU result in a tremendous reduction of the overall watermarking times. For a color image of size 256 × 256, the watermarking time is accelerated by 20× and 11× using a GPU and a CPU with 16 cores, respectively.

Keywords:

Medical image watermarking, telemedicine, polar harmonic transforms, geometric attacks, parallel architecture, multi-core CPUs, GPU

Published In:

IEEE Access , Volume: 6, Issue:1 , 77212-77225

(8)

Adaptive dual synchronization of chaotic (hyperchaotic) complex systems with uncertain parameters and its application in image encryption

G. M. Mahmoud, Ahmed A. Farghaly, Tarek M. Abed-Elhameed, and Mohamed M. Darwish

Abstract:

The adaptive dual synchronization of chaotic (hyperchaotic) complex systems with uncertain parameters has been investigated. The analytical control functions are derived using a theorem to synchronize the chaotic (hyperchaotic) solutions of these systems. The adaptive dual synchronization between the chaotic complex Chen and Lorenz systems is introduced as an example, and another example is used to test the validity of the technique of this paper. Other examples of chaotic or hyperchaotic complex systems can be similarly studied. Based on the up-to-date laws, the parameters of the drive systems can be identified. The image encryption technique based on the adaptive dual synchronization of chaotic complex Chen and Lorenz systems is presented for gray and color images in the same time. Meantime, in the receiver side, information can be recovered successfully by adaptive technique. The presented technique is robust with respect to different levels of white Gaussian noise. The communication channel as well as the effect of the increase of noise are big challenge which have not been considered. Numerical simulations are given to verify the feasibility of our proposed synchronization and better performance of image encryption technique in terms of histogram, robustness to noise and visual imperceptibility.

Keywords:

NULL

Published In:

Acta Physica Polonica B , DOI:10.5506/APhysPolB.49.1923-1939. , Vol. 49, No.11 , 1923-1939

(9)

Resilient Color Image Watermarking Using Accurate Quaternion Radial Substituted Chebyshev Moments

KHALID M. HOSNY, MOHAMED M. DARWISH

Abstract:

In this work, a new quaternion-based method for color image watermarking is proposed. In this method, a novel set of quaternion radial substituted Chebyshev moments (QRSCMs) is presented for robust geometrically invariant image watermarking. An efficient computational method is proposed for highly accurate, fast, and numerically stable QRSCMs in polar coordinates. The proposed watermarking method consists of three stages. In the first stage, the Arnold transform is used to improve the security of the watermarking scheme by scrambling the binary watermark. In the second stage, the proposed accurate and stable QRSCMs of the host color image are computed. In the third stage, the encrypted binary watermark is embedded into the host image by employing the quantization technique on selected-magnitude QRSCMs where the watermarked color image is obtained by adding the original host color image to the compensation image. Then, the binary watermark can be extracted directly without using the original image from the magnitudes of QRSCMs. Numerical experiments are performed where the performance of proposed method is compared with the existing quaternion moment-based watermarking methods. The comparison clearly shows that the proposed method is very efficient in terms of the visual imperceptibility capability and the robustness under different attacks compared to the existing quaternion moment-based watermarking algorithms.

Keywords:

Quaternion radial substituted Chebyshev moments, color image watermarking, geometric attacks, noise resistance, JPEG compression

Published In:

ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM) , 15-2 , 1-46

(10)

New fractional-order Legendre-Fourier moments for pattern recognition applications

Khalid M Hosny, Mohamed M Darwish, Tarek Aboelenen

Abstract:

Orthogonal moments enable computer-based systems to discriminate between similar objects. Mathe- maticians proved that the orthogonal polynomials of fractional-orders outperformed their corresponding counterparts in representing the fine details of a given function. In this work, novel orthogonal fractional- order Legendre-Fourier moments are proposed for pattern recognition applications. The basis functions of these moments are defined and the essential mathematical equations for the recurrence relations, orthog- onality and the similarity transformations (rotation and scaling) are derived. The proposed new fractional- order moments are tested where their performance is compared with the existing orthogonal quaternion, multi-channel and fractional moments. New descriptors were found to be superior to the existing ones in terms of accuracy, stability, noise resistance, invariance to similarity transformations, recognition rates and computational times.

Keywords:

Color image descriptors, Pattern recognition, Rotation invariance, Fractional-order moments, Legendre-Fourier moments

Published In:

Pattern Recognition , 103 , NULL

(11)

Novel Multi-channel Fractional-Order Radial Harmonic Fourier Moments for Color Image Analysis

Khalid Hosny, Mohamed Darwish, Mohamed Meselhy Eltoukhy

Abstract:

The classical radial harmonic Fourier moments (RHFMs) and the quaternion radial harmonic Fourier moments (QRHFMs) are gray-scale and color image descriptors. The radial harmonic functions with integer orders are not able to extract fine features from the input images. In this paper, the authors derived novel fractional-order radial harmonic functions in polar coordinates. The obtained functions are used to defined novel multi-channel fractional-order radial harmonic moments (FrMRHFMs) for color image description and analysis. The invariants to geometric transformations for these new moments are derived. A theoretical comparison between FrMRHFMs and QRHFMs is performed from the aspects of kernel function and the spectrum analysis. Numerical simulation is carried out to test these new moments in terms of image reconstruction capabilities, invariance to the similarity transformations, color image recognition and the CPU computational times. The obtained theoretical and numerical results clearly show that the proposed FrMRHFMs is superior to the QRHFMs and the existing fractional-order orthogonal moments.

Keywords:

Color image analysis,fractional-order orthogonal moments, radial harmonic Fourier moments, rotation invariance

Published In:

IEEE Access , 8 , 40732 - 40743

(12)

New fractional-order shifted Gegenbauer moments for image analysis and recognition

Khalid M. Hosny, Mohamed M. Darwish, Mohamed Meselhy Eltoukhy

Abstract:

Orthogonal moments are used to represent digital images with minimum redundancy. Orthogonal moments with fractional-orders show better capabilities in digital image analysis than integer-order moments. In this work, the authors present new fractional-order shifted Gegenbauer polynomials. These new polynomials are used to defined a novel set of orthogonal fractional-order shifted Gegenbauer moments (FrSGMs). The proposed method is applied in gray-scale image analysis and recognition. The invariances to rotation, scaling and translation (RST), are achieved using invariant fractional-order geometric moments. Experiments are conducted to evaluate the proposed FrSGMs and compare with the classical orthogonal integerorder Gegenbauer moments (GMs) and the existing orthogonal fractional-order moments. The new FrSGMs outperformed GMs and the existing orthogonal fractional-order moments in terms of image recognition and reconstruction, RST invariance, and robustness to noise.

Keywords:

Fractional-order Shifted Gegenbauer moments; geometric transformations; Image recognition; Image analysis; Image reconstruction

Published In:

Journal of Advanced Research , NULL , NULL

(13)

-Improved recognition of bacterial species using novel fractional order orthogonal descriptors

Mohamed Abd Elaziz, Khalid M Hosny, Ahmed A Hemedan, Mohamed M Darwish

Abstract:

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Keywords:

NULL

Published In:

Applied Soft Computing , NULL , NULL

(14)

New machine learning method for image-based diagnosis of COVID-19

Mohamed Abd Elaziz, Khalid M Hosny, Ahmad Salah, Mohamed M Darwish, Songfeng Lu, Ahmed T Sahlol

Abstract:

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Keywords:

NULL

Published In:

PloS one , NULL , NULL

(15)

Accelerated CPU□GPUs implementations for quaternion polar harmonic transform of color images

Ahmad Salah, Kenli Li, Khalid M Hosny, Mohamed M Darwish, Qi Tian

Abstract:

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Keywords:

NULL

Published In:

Future Generation Computer Systems , 107 , 368-382

Classification of galaxy color images using quaternion polar complex exponential transform and binary Stochastic Fractal Search

KM Hosny, MA Elaziz, IM Selim, MM Darwish

Abstract:

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Keywords:

NULL

Published In:

Astronomy and Computing , NULL , NULL

(17)

Novel fractional-order generic Jacobi-Fourier moments for image analysis

Khalid M Hosny, Mohamed M Darwish, Tarek Aboelenen

Abstract:

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Keywords:

NULL

Published In:

Signal Processing , NULL , NULL

(18)

Color face recognition using novel fractional-order multi-channel exponent moments

Khalid M. Hosny, Mohamed Abd Elaziz, Mohamed M. Darwish

Abstract:

Color face recognition has more attention recently since it considered one of the most popular biometric pattern recognitions. With a considerable development in multimedia technologies, finding a suitable color information extraction from color images becomes a hard problem. Several color face recognition methods have been developed. However, these methods still suffer from some limitations, such as increasing the number of extracted features, which leads to an increase in computational time. Besides, among those features some of them are redundant and irrelevant that will influence the quality of the recognition. Therefore, this paper presents a novel color face recognition method that depends on a new family of fractional-order orthogonal functions, which is called orthogonal fractional-order exponent functions. Then, using these functions as the basis functions of novel multi-channel orthogonal fractional-order exponent moments (FrMEMs), these novel descriptors are defined in polar coordinates over the unit circle and have many characteristics. A set of experimental series are performed using a set of well-known color face recognition and compared with other CFR techniques. Besides, a group of feature selection methods with different classifiers used to evaluate the number of extracted features is suitable or needs to be enhanced. Experimental results illustrate that the proposed method based on FrMEMs outperforms other CFR methods. As well as, the recognition rate doesn't influence by reducing the number of features using different FS methods.

Keywords:

Color face recognition ; Multi-channel orthogonal fractional-order exponent moments ; Feature extraction ; Feature selection

Published In:

Neural Computing and Applications , NULL , NULL

(19)

CUDAQuat: new parallel framework for fast computation of quaternion moments for color images applications

Khalid M Hosny, Mohamed M Darwish, Ahmad Salah, Kenli Li, Amr M Abdelatif

Abstract:

Quaternion moments are widely used in several applications, such as image classification, object recognition, and multimedia security. The computation of these moments requires a vast computational time, especially for big-size images. Several attempts to accelerate quaternion moments are not enough to process big-size color images with the desired speedup. In this work, we proposed a new parallel framework for fast computation of quaternion moments in Cartesian coordinates using multi-core CPUs and many-core graphics processing units (GPUs) with the Compute Unified Device Architecture (CUDA). We called the proposed unified computational framework "CUDAQuat." This framework was tested by eleven sets of quaternion moments. Several applications executed using the proposed parallel framework where the CPU times, execution-time-improvement ratio, and speedup were reported. The evaluation outlined significant speedup over the single-core CPU implementation, where the proposed framework accelerated several sets of quaternion moments with speedup 600x.

Keywords:

Quaternion moments, Color images, GPU, Multi-core CPU,Parallel processing, Image reconstruction, Image classification

Published In:

Cluster Computing , NULL , 1-22

(20)
-Robust Color Images Watermarking Using New Fractional Order Exponent Moments

Khalid M Hosny, Mohamed M Darwish, Mostafa M Fouda

Abstract:

Robust watermarking is a valuable methodology used in protecting the copyright and securing digital images. In this paper, new fractional-order multi-channel orthogonal exponent moments (MFrEMs) and their invariants to geometric transformations are derived for the first time. We utilized these highly accurate moments to construct a new robust watermarking algorithm for color images. This algorithm consists of three phases. First, the bits of the binary watermark scrambled by using a 1D Sine chaotic map. Second, the fractional-order MFrEMs are calculated from the host color image. Finally, a quantization process is performed, where the scrambled bits of the binary watermark embedded into the host color image. Various experiments were conducted to test the proposed watermarking algorithm and compare it with the existing robust watermarking algorithms for color images. The obtained results ensure the proposed robust watermarking algorithm s superiority over existing algorithms regarding the visual imperceptibility and robustness against various attacks.

Keywords:

Robust watermarking , fractional-order orthogonal moments , sine mapping , geometric attacks

Published In:

IEEE Access , 9 , 47425-47435

(21)

A New Image Encryption Algorithm for Grey and Color Medical Images

Sara T Kamal, Khalid M Hosny, Taha M Elgindy, Mohamed M Darwish, Mostafa M Fouda

Abstract:

Recently, diagnosing diseases using medical images became crucial. As these images are transmitted through the network, they need a high level of protection. If the data in these images are liable for unauthorized usage, this may lead to severe problems. There are different methods for securing images. One of the most efficient techniques for securing medical images is encryption. Confusion and diffusion are the two main steps used in encryption algorithms. This paper presents a new encryption algorithm for encrypting both grey and color medical images. A new image splitting technique based on image blocks introduced. Then, the image blocks scrambled using a zigzag pattern, rotation, and random permutation. Then, a chaotic logistic map generates a key to diffuse the scrambled image. The efficiency of our proposed method in encrypting medical images is evaluated using security analysis and time complexity. The security is tested in entropy, histogram differential attacks, correlation coefficient, PSNR, keyspace, and sensitivity. The achieved results show a high-performance security level reached by successful encryption of both grey and color medical images. A comparison with various encryption methods is performed. The proposed encryption algorithm outperformed the recent existing encryption methods in encrypting medical images.

Keywords:

Image encryption , chaotic logistic map , color medical images , image blocks scrambling

Published In:

IEEE Access , 9 , 37855-37865

(22)

COVID-19 diagnosis from CT scans and chest X-ray images using low-cost Raspberry Pi

Khalid M Hosny, Mohamed M Darwish, Kenli Li, Ahmad Salah

Abstract:

The diagnosis of COVID-19 is of vital demand. Several studies have been conducted to decide whether the chest X-ray and computed tomography (CT) scans of patients indicate COVID-19. While these efforts resulted in successful classification systems, the design of a portable and cost-effective COVID-19 diagnosis system has not been addressed yet. The memory requirements of the current state-of-the-art COVID-19 diagnosis systems are not suitable for embedded systems due to the required large memory size of these systems (e.g., hundreds of megabytes). Thus, the current work is motivated to design a similar system with minimal memory requirements. In this paper, we propose a diagnosis system using a Raspberry Pi Linux embedded system. First, local features are extracted using local binary pattern (LBP) algorithm. Second, the global features are extracted from the chest X-ray or CT scans using multi-channel fractional-order Legendre-Fourier moments (MFrLFMs). Finally, the most significant features (local and global) are selected. The proposed system steps are integrated to fit the low computational and memory capacities of the embedded system. The proposed method has the smallest computational and memory resources,less than the state-of-the-art methods by two to three orders of magnitude, among existing state-of-the-art deep learning (DL)-based methods.

Keywords:

NULL

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Plos one , Vol.16 -No. 5 , e0250688