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(71)**Name of Applicant :**
1)Mr. N. V. S. V. Vijay Kumar
Address of Applicant :Assistant Professor, Department of ECE, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India. Pin Code: 530045. Andhra Pradesh India
2)Dr.A.Ch.Sudhir
3)Mr.Paladugu Raju
4)Dr.B.Suribabu Naick
5)Mr.Pradeep Vinaik Kodavanti
6)Mrs.K Renu
7)Mr.Koteswara Rao Naik.R
8)Mr.Md Khwaja Muinuddin Chisti
9)Mr.Dabbara Jayanayudu
10)Mr.Durga Prasad Tumula
(72)**Name of Inventor :**
1)Mr. N. V. S. V. Vijay Kumar
2)Dr.A.Ch.Sudhir
3)Mr.Paladugu Raju
4)Dr.B.Suribabu Naick
5)Mr.Pradeep Vinaik Kodavanti
6)Mrs.K Renu
7)Mr.Koteswara Rao Naik.R
8)Mr.Md Khwaja Muinuddin Chisti
9)Mr.Dabbara Jayanayudu
10)Mr.Durga Prasad Tumula

(57) Abstract :
To restore the high quality images from the degraded images, restoration is used. By removing the noise from the noisy image, Image Denoising restores the true images. The traditional Deep Convolutional Neural Network (DCNN) improves the Denoising of images mainly by concentrating on the minimization of Mean Square Error (MSE). The Present invention, Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks comprising of: Noisy image (401); Convolutional Layer (402); Convolutional Layer (403); Block-1 (404); Up-Scaler (405); Block-2 (406); Up-Scaler (407); Block-3 (408); Up-Scaler (409); Convolutional Layer (410); Convolutional Layer (411); Super Resolution Denoised Image (412); Noisy image (413); Block-1 (414); Block-2 (415); Block-3 (416); Block-4 (417); Full Connected Network (418) Layer; Leaky Rectified Linear Unit (419); Full Connected Network (420) Layer; Probability (421); Generated Image (422); generates a realistic images by performing image Denoising and Image Super Resolution. The invention disclosed here is an Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks yields the Average Performance metrics Peak Signal-to-Noise Ratio (PSNR) of 34.65, Structural Similarity Index Measure (SSIM) of 0.982 and Perceptual Distance from the Reference Image (PDR) of 0.056.

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FORM 2

THE PATENTS ACT, 1970

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THE PATENTS RULES, 2003

COMPLETE SPECIFICATION

(See section 10, rule 13)

1. TITLE OF THE INVENTION:

IMAGE SUPER RESOLUTION DENOISING SYSTEM WITH DEEP CONVOLUTIONAL GENERATIVE ADVERSARIAL NETWORKS

2. APPLICANT(S)

Sr.No	Name	Nationality	Address	Country	State
1	Mr. N. V. S. V. Vijay Kumar	India	Assistant Professor, Department of ECE, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India. Pin Code: 530045.	India	Andhra Pradesh
2	Dr.A.Ch.Sudhir	India	Assistant Professor, Department of ECE, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India. Pin Code: 530045.	India	Andhra Pradesh
3	Mr.Paladugu Raju	India	Assistant Professor, Department of ECE, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India. Pin Code: 530045.	India	Andhra Pradesh
4	Dr.B.Suribabu Naick	India	Assistant Professor, Department of ECE, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India. Pin Code: 530045.	India	Andhra Pradesh
5	Mr.Pradeep Vinaik Kodavanti	India	Assistant Professor, Department of ECE, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India. Pin Code: 530045.	India	Andhra Pradesh
6	Mrs.K RENU	India	Assistant Professor, Department of ECE, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India. Pin Code: 530045.	India	Andhra Pradesh
7	Mr.Koteswara Rao Naik.R	India	Assistant Professor, Department of ECE, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India. Pin Code: 530045.	India	Andhra Pradesh
8	Mr.Md Khwaja Muinuddin Chisti	India	Assistant Professor, Department of ECE, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India. Pin Code: 530045.	India	Andhra Pradesh
9	Mr.Dabbara Jayanayudu	India	Associate Professor, Department of ECE, Siddaratha Institute of Science and Technology, Puttur, Andhra Pradesh, India. Pin Code: 517583.	India	Andhra Pradesh
10	Mr.Durga Prasad Tumula	India	Assistant Professor, Department of ECE, GITAM Institute of Technology, GITAM (Deemed to be University), Visakhapatnam, Andhra Pradesh, India. Pin Code: 530045.	India	Andhra Pradesh

3. PREAMBLE TO THE DESCRIPTION:

COMPLETE SPECIFICATION

The following specification particularly describes the invention and the manner in which it is to be performed.

IMAGE SUPER RESOLUTION DENOISING SYSTEM WITH DEEP CONVOLUTIONAL GENERATIVE ADVERSARIAL NETWORKS

FIELD OF INVENTION

The present invention relates to the technical field of Electronics and Communication Engineering.

Particularly, the present invention is related to the Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks of the broader field of Digital Image Processing in the Electronics and Communication Engineering.

More particularly, the present invention is related to Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks in which Image Super Resolution and Image Smoothing is performed by the Deep Convolutional Generative Adversarial Networks.

BACKGROUND & PRIOR ART

Image Denoising plays an important role in Image Restoration, Image Segmentation, Image Registration and Image Classification. The Image Denoising can be achieved with several Denoising filters available and with the state of art filters but due to the development of Machine Learning, Majority of the Denoising methods are invented now with traditional Deep Convolutional Neural Network (DCNN) improves the Denoising of images mainly by concentrating on the minimization of Mean Square Error (MSE).

Image Super Resolution is used for improving the details of an image within the image by means of Image Scaling. By taking low resolution images often it is required upscale to obtain higher resolution. Majority of the Image Denoising techniques losses the edges of an image with low resolution. To reduce the computational complexity involved in image

Denoising and Image super resolution, Machine Learning is used. To get adequate results with image resolution denoising, for fast computation, now Deep Convolutional Generative Adversarial Networks is the leading machine learning techniques used for Image super resolution and image Denoising.

Referring to Figure 1, Image Super Resolution Denoising System comprising of: Noisy Low Resolution Image (301); Deep Convolutional Generative Adversarial Networks (302); Super Resolution Denoised Image (303) is used to restore the high quality images from the degraded images, restoration is used to restore the original image. By removing the noise from the noisy image, Image Denoising restores the true images. The traditional Deep Convolutional Neural Network (DCNN) improves the Denoising of images mainly by concentrating on the minimization of Mean Square Error (MSE). Super Resolution Image and complete noisy free image can be achieved by the by the invention disclosed here in.

There are some technologies developed to provide Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks. Some of the work listed in the prior art is as follows:

US10769761 - *Generating high resolution images from low resolution images for semiconductor applications,* presents “Methods and systems for generating a high resolution image for a specimen from a low resolution image of the specimen are provided. One system includes one or more computer subsystems configured for acquiring a low resolution image of a specimen. The system also includes one or more components executed by the one or more computer subsystems. The one or more components include a deep convolutional neural network that includes one or more first layers configured for generating a representation of the low resolution image. The deep convolutional neural network also includes one or more second layers configured for generating a high resolution image of the specimen from the representation of the low resolution image. The second layer(s) include a final layer configured to output the high resolution image and configured as a sub-pixel convolutional layer.”

US10692185 - *Generative methods of super resolution,* presents "A method for training an algorithm to process at least a section of received visual data using a training dataset and reference dataset. The method comprises an iterative method with iterations comprising: generating a set of training data using the algorithm; comparing one or more characteristics of the training data to one or more characteristics of at least a section of the reference dataset; and modifying one or more parameters of the algorithm to optimize processed visual data based on the comparison between the characteristic of the training data and the characteristic of the reference dataset. The algorithm may output the processed visual data with the same content as the at least a section of received visual data. Some aspects and/or implementations provide for improved super-resolution of lower quality images to produce super-resolution images with improved characteristics (e.g. less blur, less undesired smoothing) compared to other super-resolution techniques."

US10706503 - *Image processing using a convolutional neural network,* states "According to one implementation, an image processing system includes a computing platform having a hardware processor and a system memory storing a software code including a convolutional neural network (CNN) trained using one or more semantic map(s). The hardware processor executes the software code to receive an original image including multiple object images each identified with one of multiple object classes, and to generate replications of the original image, each replication corresponding respectively to one of the object classes. The hardware processor further executes the software code to, for each replication, selectively modify one or more object image(s) identified with the object class corresponding to the replication, using the CNN, to produce partially modified images each corresponding respectively to an object class, and to merge the partially modified images, using the CNN, to generate a modified image corresponding to the original image."

US10636141 - *Adversarial and dual inverse deep learning networks for medical image analysis,* states "Methods and apparatus for automated medical image analysis using deep learning networks are disclosed. In a

method of automatically performing a medical image analysis task on a medical image of a patient, a medical image of a patient is received. The medical image is input to a trained deep neural network. An output model that provides a result of a target medical image analysis task on the input medical image is automatically estimated using the trained deep neural network. The trained deep neural network is trained in one of a discriminative adversarial network or a deep image-to-image dual inverse network."

WO/2019/090213 - *Segmenting and Denoising Depth Images for Recognition Applications using Generative Adversarial Neural Networks,* states "A method of removing noise from a depth image includes presenting real-world depth images in real-time to a first generative adversarial neural network (GAN), the first GAN being trained by synthetic images generated from computer assisted design (CAD) information of at least one object to be recognized in the real-world depth image. The first GAN subtracts the background in the real-world depth image and segments the foreground in the real-world depth image to produce a cleaned real-world depth image. Using the cleaned image, an object of interest in the real-world depth image can be identified via the first GAN trained with synthetic images and the cleaned real-world depth image. In an embodiment the cleaned real-world depth image from the first GAN is provided to a second GAN that provides additional noise cancellation and recovery of features removed by the first GAN."

IN201941039142 - *A Method of Image Denoising and A System Thereof,* states "An embodiment of the present disclosure is related, in general, to image processing, exclusively to a method and system of de-nosing one or more image. The method comprises of receiving, by an image denoising system, one or more denoised images from a source. Also, the method comprises classifying the type of one or more images by extracting a plurality of feature associated the one or more images and estimating a plurality of optimized filter coefficients of Dual-Tree Complex Wavelet Transform (DT-CWT) for the classified one or more images using Earth

Worm-Based Grey Wolf (EWGW) optimization technique. Thereafter, the method comprises filtering the one or more images using an obtained filter based on the estimated plurality of filter coefficients, thereby denoising the one or more images."

Groupings of alternative elements or embodiments of the invention disclosed herein are not to be construed as limitations. Each group member can be referred to and claimed individually or in any combination with other members of the group or other elements found herein. One or more members of a group can be included in, or deleted from, a group for reasons of convenience and/or patentability. When any such inclusion or deletion occurs, the specification is herein deemed to contain the group as modified thus fulfilling the written description of all related groups used in the appended claims.

The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY OF INVENTION

Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks is invented to provide Image Super Resolution and Image Denoising by the Deep Convolutional Generative Adversarial Networks comprising of Generator and Discriminator. The Generator in the networks generates similar realistic images as the training dataset and Discriminator compares the generated data of generator with the original image. With the help of well-connected Convolutional layers, Deep Convolutional Generative Adversarial Networks is formed in the invention to provide Image Super Resolution with Up Scale and Image Denoising by the fully connected layers of GAN Network. The invention disclosed here is an Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks yields the Average Performance metrics

Peak Signal-to-Noise Ratio (PSNR) of 34.65, Structural Similarity Index Measure (SSIM) of 0.982 and Perceptual Distance from the Reference Image (PDR) of 0.056.

BRIEF DESCRIPTION OF SYSTEM

The present invention, Referring to Figure 1, Image Super Resolution Denoising System comprising of: Noisy Low Resolution Image (301); Deep Convolutional Generative Adversarial Networks (302); Super Resolution Denoised Image (303) is used to restore the high quality images from the degraded images, restoration is used to restore the original image. By removing the noise from the noisy image, Image Denoising restores the true images.

The Present invention, Referring to Figure 2, Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks comprising of: Noisy image (401); Convolutional Layer (402); Convolutional Layer (403); Block-1 (404); Up-Scaler (405); Block-2 (406); Up-Scaler (407); Block-3 (408); Up-Scaler (409); Convolutional Layer (410); Convolutional Layer (411); Super Resolution Denoised Image (412); Noisy image (413); Block-1 (414); Block-2 (415); Block-3 (416); Block-4 (417); Full Connected Network (418) Layer; Leaky Rectified Linear Unit (419); Full Connected Network (420) Layer; Probability (421); Generated Image (422); generates a realistic images by performing image Denoising and Image Super Resolution. The invention disclosed here is an Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks yields the Average Performance metrics Peak Signal-to-Noise Ratio (PSNR) of 34.65, Structural Similarity Index Measure (SSIM) of 0.982 and Perceptual Distance from the Reference Image (PDR) of 0.056.

DETAIL DESCRIPTION OF THE SYSTEM

Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks is explored and the Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks

is provided in the following layout that explains the entire view of the implementation of the invention that provides the Image Super Resolution and Denoising as referring to Figure 2.

Referring to Figure 1, Referring to Figure 1, Image Super Resolution Denoising System comprising of: Noisy Low Resolution Image (301) to which resolution need to be increased and Noise is to be removed; Deep Convolutional Generative Adversarial Networks (302) contains several convolutional layers arranged in Generator and Discriminator; Super Resolution Denoised Image (303) is restored the high quality image, noise free image.

Referring to Figure 2, Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks comprising of: Noisy image (401) to be Denoised by the invention taken from the dataset; Convolutional Layer (402) contains learnable set of kernels of size 3x3 and total of 64 filters to perform convolution; Convolutional Layer (403) contains learnable set of kernels of size 3x3 and total of 64 filters to perform convolution; Block-1 (404) comprising of Convolutional Layer contains learnable set of kernels of size 3x3 and total of 64 filters to perform convolution; Rectified Linear Unit (Relu) is used as an activation function; Up-Scaler (405) to up-sampling the pixels to increase resolution; Block-2 (406) comprising of Convolutional Layer contains learnable set of kernels of size 3x3 and total of 64 filters to perform convolution; Rectified Linear Unit (Relu) is used as an activation function; Up-Scaler (407) to up-sampling the pixels to increase resolution; Block-3 (408) comprising of Convolutional Layer contains learnable set of kernels of size 3x3 and total of 64 filters to perform convolution; Rectified Linear Unit (Relu) is used as an activation function; Up-Scaler (409) to up-sampling the pixels to increase resolution; Convolutional Layer (410) contains learnable set of kernels of size 3x3 and total of 64 filters to perform convolution; Convolutional Layer (411) contains learnable set of kernels of size 3x3 and total of 64 filters to perform convolution; Super Resolution Denoised Image (412); Noisy image (413) due to denoising and super resolution; Block-1 (414) comprising of Convolutional Layer of kernel size 3x3 and total of 64

filters to perform convolution; Batch Normalization for stabilizing the training process; a leaky Relu activation layer ; Block-2 (415) comprising of Convolutional Layer of kernel size 3x3 and total of 128 filters to perform convolution; Batch Normalization for stabilizing the training process; a leaky Relu activation layer; Block-3 (416) comprising of Convolutional Layer of kernel size 3x3 and total of 128 filters to perform convolution; Batch Normalization for stabilizing the training process; a leaky Relu activation layer;; Block-4 (417) comprising of Convolutional Layer of kernel size 3x3 and total of 256 filters to perform convolution; Batch Normalization for stabilizing the training process; a leaky Relu activation layer; Full Connected Network (418) Layer is simply, feed forward neural networks of 1024 neurons; Leaky Rectified Linear Unit (419) used as the activation function; Full Connected Network (420) Layer is simply, feed forward neural networks of 1024 neurons; Probability (421) produces a probability that the input image is a noise-free image; Generated Image (422) is a true image; generates a realistic images by performing image Denoising and Image Super Resolution. The invention disclosed here is an Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks yields the Average Performance metrics Peak Signal-to-Noise Ratio (PSNR) of 34.65, Structural Similarity Index Measure (SSIM) of 0.982 and Perceptual Distance from the Reference Image (PDR) of 0.056.

CLAIMS

We claim:

1. Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks comprising of: Noisy image (401); Convolutional Layer (402); Convolutional Layer (403); Block-1 (404); Up-Scaler (405); Block-2 (406); Up-Scaler (407); Block-3 (408); Up-Scaler (409); Convolutional Layer (410); Convolutional Layer (411); Super Resolution Denoised Image (412); Noisy image (413); Block-1 (414); Block-2 (415); Block-3 (416); Block-4 (417); Full Connected Network (418) Layer; Leaky Rectified Linear Unit (419); Full Connected Network (420) Layer; Probability (421); Generated Image (422); generates a realistic images by performing image Denoising and Image Super Resolution.
2. Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks as claimed in claim 1, wherein it uses Generative Adversarial Networks consisting of Generator and Discriminator.
3. Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Network as claimed in claim 1, wherein generator with seven Convolutional Layers of size 2x3 with 64 filters.
4. Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Network as claimed in claim 1, wherein uses four Convolutional layers of Size 3x3 with total filters as 64, 128,128 and 256 filters in each and two fully connected Convolutional Layers having 1024 neurons
5. Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Network as claimed in claim 1, wherein yields the Average Performance metrics Peak Signal-to-Noise Ratio (PSNR) of 34.65, Structural Similarity Index Measure (SSIM) of 0.982 and Perceptual Distance from the Reference Image (PDR) of 0.056.

Dated this 1st day of October, 2020

IMAGE SUPER RESOLUTION DENOISING SYSTEM WITH DEEP CONVOLUTIONAL GENERATIVE ADVERSARIAL NETWORKS

ABSTRACT

To restore the high quality images from the degraded images, restoration is used. By removing the noise from the noisy image, Image Denoising restores the true images. The traditional Deep Convolutional Neural Network (DCNN) improves the Denoising of images mainly by concentrating on the minimization of Mean Square Error (MSE). The Present invention, Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks comprising of: Noisy image (401); Convolutional Layer (402); Convolutional Layer (403); Block-1 (404); Up-Scaler (405); Block-2 (406); Up-Scaler (407); Block-3 (408); Up-Scaler (409); Convolutional Layer (410); Convolutional Layer (411); Super Resolution Denoised Image (412); Noisy image (413); Block-1 (414); Block-2 (415); Block-3 (416); Block-4 (417); Full Connected Network (418) Layer; Leaky Rectified Linear Unit (419); Full Connected Network (420) Layer; Probability (421); Generated Image (422); generates a realistic images by performing image Denoising and Image Super Resolution. The invention disclosed here is an Image Super Resolution Denoising System with Deep Convolutional Generative Adversarial Networks yields the Average Performance metrics Peak Signal-to-Noise Ratio (PSNR) of 34.65, Structural Similarity Index Measure (SSIM) of 0.982 and Perceptual Distance from the Reference Image (PDR) of 0.056.

Dated this 1st day of October, 2020

Digitally signed by VIJAY KUMAR VENKATA SATYA VARAHA NANDAM
Date: 2020.10.02 10:01:18 +05'30'