A Novel Image Enhancement Using Type-II Bell Shaped Membership Function for Satellite Images

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Abstract:

Satellite images are more prone to poor visibility due to large distance between camera and object. Therefore, there is a need to enhance the satellite images. Many techniques have been proposed by researchers to enhance the visibility of satellite images. But the majority of techniques suffer from various distortions such as spatial, spectral, and edge. To address these problems, a novel approach is proposed to enhance the satellite images using type-II bell shaped membership functions. Ant colony optimization is also used in the proposed approach. It finds the best similarity value among the given set of values which represents the image in more efficient manner. The modified edge preserving smoothing hypothesis based adaptive k-fuzzy is also used in the proposed approach. Experimental analyses show that the proposed approach has better image quality and minimum distortion rate as compared to existing techniques.

Keyword: Image enhancement, Histogram equalization, Sensor Characteristics, Remote Sensing images

1.1Introduction

Image enhancement issue will be designed the following: offered the suggestions poor graphic as well as the production good quality graphic pertaining to distinct applications. It is well-known which graphic development while an energetic subject matter with medical imaging has received much particular attention with New Year's. The target should be to boost the visual appeal with the graphic, or even to provide a "better" convert counsel pertaining to long term automated graphic handling, like examination, detection, segmentation as well as recognition. Also, it may help looks at qualifications details that are certainly vital to recognize subject actions with no demanding highly-priced human being visible inspection. Doing graphic development realizing less than poor graphic will be a challenging trouble mainly because of them reasons. As a result of reduced difference, we can't clearly remove products through the black background.

1.2 Histogram equalization

An ATM unit in Umea has become busted and plenty of money has become stolen. A picture of the actual thief was captured by the surveillance system, but unfortunately it had been damaged if the film got its start. The image may seem to see absolutely gray ("robber. bmp") A police interested in image processing shows that histogram equalization should assist in identifying the actual thief.

1.3 Sensor Characteristics

In remote sensing, generally different sensors are designed for different types of features to be observed which in turn depends on the requirements or applications. The spatial resolution is "the area on the ground from which reflectance is obtained and integrated to compute the value assigned to each pixel". The spectral resolution is "the bandwidths utilized in the electromagnetic spectrum". The radiometric resolution is defines as "the number of bits which are used to record a given energy corresponding to a given wavelength". The temporal resolution is "the number of observations, defined by the orbit of the satellite and scanning of the sensor".

1.4 Remote Sensing

Remote means away. By simple meaning, remote sensing means sensing things from far off. In the human body, we have five senses watching, smelling, hearing, testing and touching. From all these senses we use three senses remotely, i.e. watching, smelling and hearing. So, remote sensing is part of our day to day life. But recently human beings are technically improving the power of remote sensing. We can also say remote sensing is our artificial eye. The remote sensing system is developed from observation of a broad area at a time. Preferable to the advance developed remote sensors; it has potential to collect the invisible information from the Earth surface [1]. Increasing availability of remotely sensed images due to the rapid advancement of remote sensing technology expands imagery sources.

Fig l.6: Remote Sensing Images

Remote sensing is required to gather primary information from the surface of the ground. Remote observation requires some form of energy interaction between the object and the sensor [1].

1.5 Remote Sensing Applications Many methods are developed for image registration in other fields such as medical. But there is no single, universal, stand-alone method for image registration in remote sensing field. This is mainly due to some specific challenges associated with the satellite images as summarized below.

1.5.1 Remote sensing vs. other images:
Compared to medical images, the remote sensing images have certain variations which make its registration quite difficult.

(1) Variety in the types of the sensor data and the conditions of data acquisition:
Onetechnique that works well on the images which are captured by some particular sensors, in some particular atmospheric condition or some particular location may not necessarily work well for images which are captured by some other sensor or in different environmental condition or different location. In the field of remote sensing there is so diversity for the sensors in terms spatial, radiometric and spectral resolution as well as technology behind it. There is significant effect of atmospheric condition on image registration for satellite images because it is not indoor as it is for medical field.

(2) The size of the data:
Compared to the other field the satellite images are of very large size say in case of Land sat image, typically it is in terms of 7000x7000 pixels. For processing of such large data, enough computational resources such as speed and memory are the mandatory requirements.

(3) The lack of well-distributed control points resulting in the difficulty to validate image registration methods in the remote sensing.

2.1 LITERATURE SURVEY

Atta et al. (2015) [1] Simulator effects display this planned method preserves the exact picture configurations extra properly as well as boosts the item with rather negligible vision artifacts. The idea outperforms the standard picture equalization similar to GHE and also nearby histogram equalization (LHE), and also the SVD techniques that will in line with climbing this single value of both qualitatively and also quantitatively.

Bhandari et al. (2015) [2] In this way may also procedure this hi-res darkish as well as smaller comparison pictures, in addition to provides best enhanced end result using tuning parameter regarding Gamma. The particular arranged criteria overcome this specific make any difference utilizing lower-leg functionality plus gamma static a static correction.

Ghosh et al. (2014) [3] Effects are actually merged with this papers plus a conclusion are actually utilized retaining the actual health and fitness regarding photograph and selection of tips all through much better impression because normal. The results have created the ability regarding Cuckoo investigation protocol all through optimizing the actual improvement attributes.

Cheng et al. (2014) [4] With the points of views connected with photo renewal along with photo expansion, a new well-organized along with real-time photo haze elimination strategy throughout take a look at the actual universal dark-channel previous idea along with photo deal advancing had been proposed.

Lee, Kim et al. (2013) [5]boasts talked about a fresh form a contrast enhancement technique determined by dominant purity amount analyze in addition to adaptive strength transformation relating to out of the way sensing graphics. The idea out and about criteria computes brightness-adaptive strength exchange features with all the low-frequency luminance part inside wavelet spot in addition to switches strength values based on the exchange intent. Although a number of histogram equalization strategies happen to be offered inside literary works, they will usually lower the general graphic high quality by means of showcasing saturation artifacts inside each low- as well as high-intensity destinations.

Huang et al. (2013) [6] explained histogram equalization is often a well-known in addition to successful method of bettering the exact compare associated with photographs but the traditional histogram equalization (HE) plan normally results in excellent compare enlargement, which experts claim reasons an upsetting seem in addition to image artifacts through the highly processed photograph. Very first, this supplied histogram separating module is

actually a mixture of this supplied requests many thresholding process and also a excellent the best possible maximum signal-to-noise percentage (PSNR) calculation to split up this histogram using small-scale facet..

Xie et al. (2013) [7] possesses discussed confront recognition which were representing in addition to recognizing faces depending on subspace Discriminant study but also pertaining to individual sample experience acceptance these kinds of solutions are usually extraordinary generalizability dilemma due to small biological samples. This particular paper suggests refreshing non-statistics features removal approach depending on fusion including DCT together with neighborhood Gabor binary structure Histogram (LGBPH). Within DCT together with LGBPH, training plan of action is usually preventable to develop this face design, so that .the generalize ability dilemma is frequently by natural means eradicated. .

Kotkar VA et al. (2013) [8] have described image enhancement is definitely the most fundamental methods of electronic digital image processing. This particular paper highlights combine picture enhancement methods, Weighted associated with Nearby in addition to Bidirectional Smooth Histogram Stretches (WLBSHS) in addition to Nearby and then Bidirectional Smooth Histogram Stretches (LBSHS). WLBSHS makes use of area in addition to worldwide enhancement within heavy approach. Main reason associated with area enhancement is definitely honing perimeters associated with intent in addition to looking at area information.

Demirel et al. (2011) [9] proposed a brand new satellite photograph resolution enlargement system using the interpolation inside high-frequency sub bands attained simply by under the radar wavelet enhance (DWT) and also the feedback image. The particular predicted quality enlargement technique works by applying DWT that can help decompose the specific response picture within sub bands. And also, a high-frequency sub band photographs as well as responses low-resolution picture will be interpolated, and then combining most of these photographs to build up a whole new resolution-enhanced picture with the use of inverse DWT..

Munteanu, et al. [10] introduced the most recent intelligent image enhancement method pushed by means of of a evolutionary search engine optimization process. These individuals recommended any work of fiction goal qualifying criterion related to enhancement, in addition to endeavor seeking the best image good respected being approved smeasure.Due on the high complexity of the enhancement qualifying evaluate recommended, many people utilized a evolutionary key elements (EA) as being a global search system to get the best enhancement. These

individuals when compared the tactic for some other automated enhancement methods, like change elongating as well as histogram equalization. Effects attained, both pertaining to summary as well as intent appraise, show the exact superiority of the method.

Brankov et al. [11] suggested A smallest outline time-span (MDL) getting qualified calculate seemed to be accustomed to look at the publication of the particular representation dimensions. Inside the necessary paperwork, either MDL and as well CHO indicated the ideal a number of mesh nodes is frequently roughly 5 so that you can several instances compact versus the variety of projector screen bins. The learning defined on this report makes certain a base pertaining to impending growth of one's (four-dimensional) space-time reconstruction platform related to photo series where a built-in deformable mesh type may be used to course the picture motion.

Shao et al. [12] suggested a new and sometimes shocking approach pertaining to classifying hinders into detailed regions, second time beginners zones and also sleek places. This entropy bring the sign associated with the amount of smoothing needs to be applied for a particular region. Trial and error consequences demonstrate that the advised algorithm criteria may perhaps maintain the main points and reduce html coding artifacts superior to costlier state of the art techniques

3.1 Gaps in Earlier work

Following are the different gaps in earlier research on image enhancement techniques.

1. **Static adjustment factor:** The existing k factor has been taken statically i.e. 128 by most of researchers**.**

2. **Color misbalancing:** Most of the methods depends upon certain predefined rules no concentrate on the objects or regions in the given image; so may imbalance the color of the output image.

3. **Edge degradation:** Edges plays significant role in vision processing but image enhancement technique may change the edges too. So can lead to degraded edges.

4.1Proposed Technique

This section discusses the mathematical formulation of the proposed technique.

4.1.1 Fuzzy Image Definition

In accordance with the thought of fuzzy set principle, introduce by Zadeh [1,2], a mathematical figure for image processing issues might be recognized [4,5,8]. For the image , I , when g_{mn} presents the degree of the pixel and its membership value, then might be shown as an array membership prices.

$$I = \overset{MN}{\underset{m\,n}{UU}} \frac{\mu_{mn}}{g_{mn}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where m= 1, 2, 3…M and n = 1, 2, 3… N. Utilising the linear set of fuzziness we could determine the image fuzziness [5]:

$$\gamma(I) =$$
$$\frac{2}{MN}\sum_{i=I}^{N}\sum_{j=I}^{M} \min[\mu_I(g_{ij}), \bar{\mu}_I(g_{ij})] ,\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Here, $\mu\; I\,(g_{ij})$ is the membership function of grey level (g_{ij}) and $\bar{\mu}_I(g_{ij})(g_{ij})$

4.1.2 Fuzzy Hyperbolization

The thought of the histogram and cloudy histogram hyperbolization is defined in [7], [9], and [13]. In the method shown in [3], the membership price for each and every grey period is determined as:

$$\mu(g_{mn}) = \frac{g_{mn}-g_{min}}{g_{mn}-g_{min}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where in actuality the image minimum and optimum gray level is displayed by $g$min and $g$max , respectively. Then, using parameter as β fuzzifier and the specified quantity of gray level , the brand new gray levels may be calculated using the subsequent transformation [3]:

$$\acute{g}_{mn} = \left(\frac{l-1}{E}\right) \times [E^{-\mu(g_{mn)}} - 1] \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

4.1.3 Locally Adaptive Image Enhancement

Along with various methods of image enhancement, local growth practices are usually used. In the strategy planned in [3] a locally versatile strategy is put on split an image in to a several sub-images. On the basis of the price tag on homogeneity, explained by formula:

$$\mu_{homo} = (1 \frac{g_{max\_Local} - g_{min\_Local}}{g_{max\_global} - g_{min\_global}})2$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

and provided $M \times N$ This section, we presented your type-2 fuzzy set image enhancement method . This research is conducted by making use of some sort of type-2 fuzzy image processor , which is made employing in part primarily based advance. 1st, among the best attainable type-1 fuzzy logic programs [3,5,9] is preferred, and it is consequently employed to initialize the parameters on the type-2 algorithm.

These kinds of a blueprint have the following benefits: (i) clever initialization associated with the standards on the type-2 wooly established, plus ii) smart initialization an elementary method whoever efficiency is often compared to those of the modern one. As mentioned before, some sort of type-2 fuzzy established may be obtained simply by clouding some sort of type-2 fuzzy set membership function. For this purpose most people utilize interval-based models to develop your type-2 fuzzy established simply by understanding your lower and upper regular membership values using

$$\mu_{UPPER\,(x)} = (\mu(x))^{0.5}, \ldots\ldots\ldots\ldots\ldots\ldots(6)$$
And
$$\mu_{lower\,(x)} = (\mu(x))^{2}, \ldots\ldots\ldots\ldots\ldots\ldots(7)$$

Wherever $0 \leq \mu\,(x) \leq 1$ is the membership function to value x (Fig. 3). Applying a couple of changes in the

technique presented in [3], together with matrixes containing bare minimum and maximum grey level sub-images, third matrix while using suggest valuation of sub-images is generate. Interpolated beliefs are usually determined by way of linear 2-D exclamation function. After calculations regarding μ (x) making use of image (3), μ_{UPPER} and also μ_{lower} are usually determined from equations (8) and also (9), respectively. Right now, the blurry area, generally known as the Presence regarding Skepticism, is bounded by lower and upper account functions. Issues within the blurry area'include account levels provided by type-1 account function μ.So, FOU gives an additional dimension, and thus enabling the uncertainties inside form and also placement in the type-1 fuzzy arranged being represented. Listed here, $\mu_{T\,2}$ the consist of account function is portrayed as:

$$\mu_{T\,2}(g_{mn}) = \mu_{LOWER} \times \alpha) + (\mu_{UPPER} \times (-\alpha))$$

Where $0 \leq \alpha \leq 1 \; and$

$$\alpha = \frac{g_{Mean}}{L}$$

g_{Mean} symbolizes the related suggest value of the sub-image and also L is how many dull levels.

Applying $\mu_{T\,2}$ beliefs results in innovative dull ranges and also our consist of increased image. Hence, the image is efficient around dim areas and also and thus obtains the next step regarding contrast.

5.1 RESULTS AND DISCUSSIONS

5.1.1 CONTRAST GAIN: Contrast Gainare shown below in the comparison Table 3. As contrast gain should be reduced therefore the proposed algorithm is showing the better results than the available methods as contrast gain is reduced in every case.

Table .1: Contrast Gain comparison table

| S. No.	IMAGE NAME	CONTRAST GAIN	
		Existing Image	Existing Image
1.	Betsiboka River	1.8278	1.8278
2.	Disputed South China Sea	2.5137	2.5137
3.	Arunachal bordering China	2.5192	2.5192
4.	Rare footage	2.0111	2.0111
5.	Radar at stanford	2.7107	2.7107
6.	North Sentinel Island	2.6351	2.6351
7.	MOUNTRORAI MA	2.1606	2.1606
8.	Island-danger	1.8817	1.8817
9.	Andaman Island chain	2.5522	2.5522
10.	North Sentinel Island	2.257	2.257
11.	Building in Washington	2.7044	2.7044
12.	UMD	1.9889	1.9889
13.	UK	2.5161	2.5161
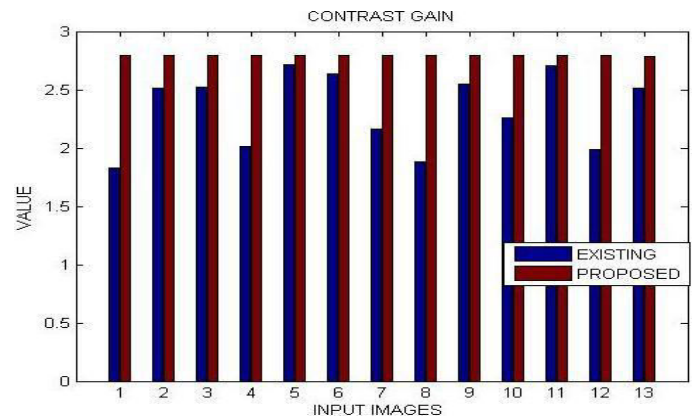
Fig.1: Contrast Gain

Shows the comparison of contrast gain between existing and purposed method where x axis shows input image and y axis shows the value. In our case the purposed contrast gain values are comparatively greater than the existing approach.

5.1.2.EXECUTION TIME: Execution Timeare shownbelow in the comparison Table 2. As contrast gain should be reduced therefore the proposed algorithm is showing the better results than the available methods as Execution time is reduced in every case.

Table .2: Execution time comparison table

| S. No.	IMAGE NAME	EXECUTION TIME	
		Existing Image	Existing Image
1.	Betsiboka River	5.8291	5.8291
2.	Disputed South China Sea	7.8872	7.8872
3.	Arunachal bordering China	5.5553	5.5553
4.	Rare footage	5.6578	5.6578
5.	Radar at stanford	5.6133	5.6133
6.	North Sentinel Island	5.4829	5.4829
7.	MOUNTRO RAIMA	5.5752	5.5752
8.	Island-danger	5.456	5.456
9.	Andaman Island chain	5.548	5.548
10.	North Sentinel Island	5.4611	5.4611
11.	Building in Washington	5.6698	5.6698
12.	UMD	5.61	5.61
13.	UK	5.503	5.503
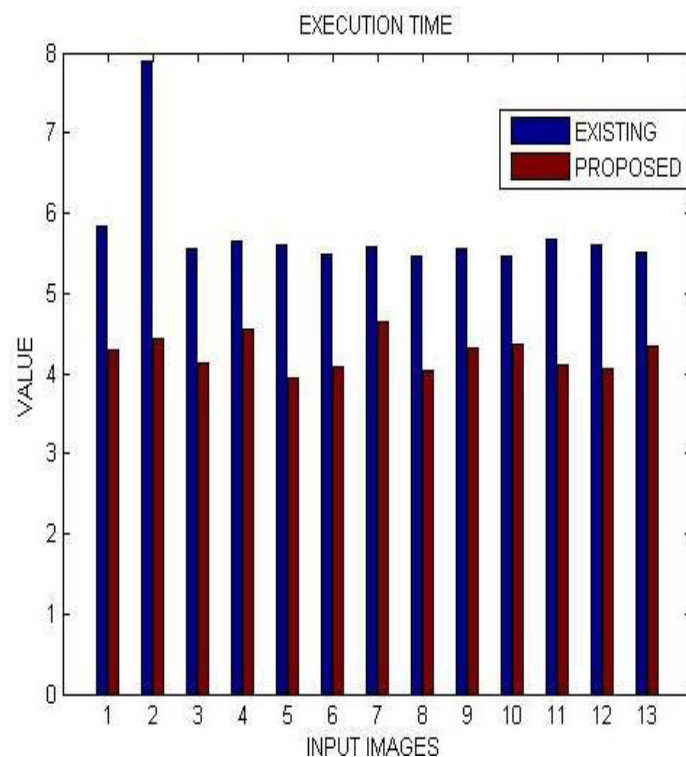
Fig .2: Execution time

Shows the comparison of execution time between existing and purposed method where x axis shows input image and y axis shows the value. In our case the purposed execution time values are comparatively greater than the existing approach.

5.1.3.SATURATED PIXELS: saturated pixels are shown below in the comparison Table 3. As saturated pixels should be reduced therefore the proposed algorithm is showing the better results than the available methods as saturated pixels is reduced in every case.

Table 3: Saturated Pixels comparison table

S. No.	IMAGE NAME	SATURATED PIXELS	
		Existing Image	Existing Image
1.	Betsiboka River	1.4217	1.4217
2.	Disputed South China Sea	1.4228	1.4228
3.	Arunachal bordering China	1.4239	1.4239
4.	Rare footage	1.4219	1.4219
5.	Radar at stanford	1.4227	1.4227
6.	North Sentinel Island	1.4228	1.4228
7.	MOUNTRORAI MA	1.4238	1.4238
8.	Island-danger	1.422	1.422
9.	Andaman Island chain	1.423	1.423
10.	North Sentinel Island	1.4234	1.4234
11.	Building in Washington	1.4233	1.4233
12.	UMD	1.4238	1.4238
13.	UK	1.4223	1.4223

Fig .3: Saturated Pixels

Shows the comparison of Saturated Pixelsbetween existing and purposed method where x axis shows input image and y axis shows the value. In our case the purposed Saturated Pixelsvalues are comparatively greater than the existing approach.

CONCLUSION:

A novel image enhancement approach has been proposed in this paper. The proposed approach has used fuzzy based type-II bell shaped membership function, ant colony optimization and modified edge preserving smoothing method. ACO finds the best similarity value among the given set of values. The proposed approach has ability to reduce the effectuation of noise, preserves the edges and boosts the contrast in digital images. Experimental analyses show that the proposed approach has better image quality and minimum distortion rate as compared to existing techniques. The proposed approach has MSE and PSNR better than the existing techniques.

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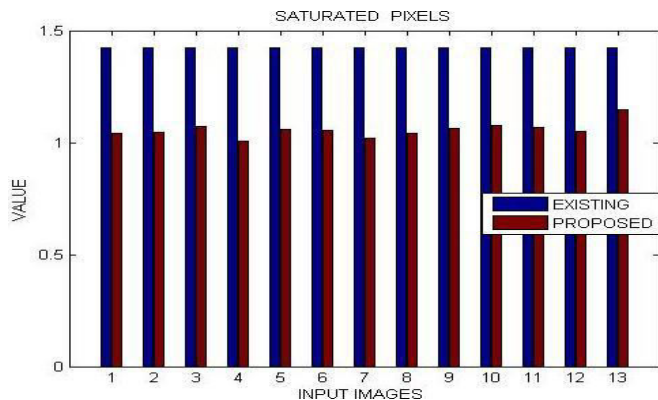
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