

# Remote Sensing Image Enhancement Technique Using Modified Fuzzy Based T-2 Bell Shaped Membership Function

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## Abstract

Image enhancement plays an important role in remote sensing based vision applications. Recently, many techniques have already been proposed for enhancing the digital images. However, the existing techniques suffer from some limitations like edge, spectral, and spatial distortions. To overcome the limitations, a new technique is proposed which will evaluate k factor automatically using the ant colony optimization (ACO). ACO finds the best similarity value among the given set of values which represents the image in more efficient manner. The proposed approach have the ability to boost the contrast in digital images. It is also utilizing the modified edge preserving smoothing hypothesis based adaptive k-fuzzy image enhancement algorithm. The proposed approach has ability to reduce the effectuation of noise and preserves the edges in efficient manner. From the result analyses, it has been found that the proposed approach outperforms over the other techniques.

**Keyword:** Image enhancement, Spatial domain methods, Frequency domain methods. Sharpening associated, Image Registration for Remote-sensing.

## 1. Introduction

Image enhancement shows a really necessary part in different types of image processing applications. Image enhancement contains number of procedures are used to improve the visible act of an image. The main intent behind image improvement is to improve features of an image. 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. 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. Many color centered solutions will probably fail about this make any difference when along with the products as well as those of the background usually are similar. Now a days there is a great increase in number of people that are suffering from eye related disorders.

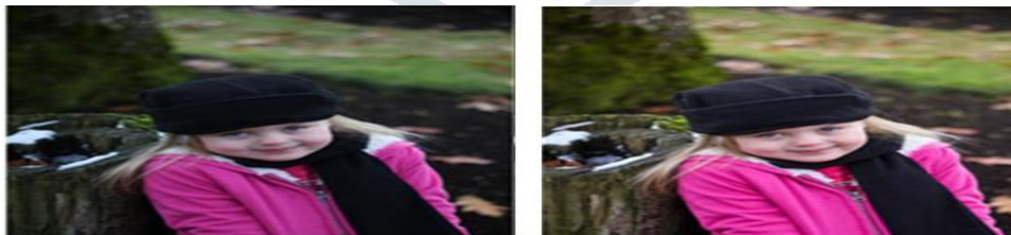


Fig 1: Results of enhancement (a) before enhancement (b) after enhancement

Image enhancement techniques:

- Spatial domain methods.
- Frequency domain methods.

### a. Spatial domain methods.

Spatial domain method directly care for the visual pixels. The pixel price ranges are manipulated to get desired improvement. Spatial internet site techniques including the logarithmic modifications, power regulation transforms, histogram equalization, derive from the primary manipulation while using the pixels within the image. Each purpose describes how colours as well as grey prices (intensities, as well as brightness) range in area:



A different image representation is founded on spatial frequencies with regards to grey relevance or color variations inside the image airplane. This a couple of representation by way of a spectrum with regards to different occasionally components seemingly equivalent towards conventional spatial outward exhibitions:

### b. Frequency domain method

Transformation or maybe frequency location techniques derive from the manipulation with the orthogonal transform with the image instead of the image alone. Transformation location techniques are designed for processing this image based on the frequency written content .The phase is employed to recover the impression time for that spatial location. The most common orthogonal changes are individually distinct cosine alter, discrete Fourier alter, Hartley Convert etc. The Alpha rooting can be a simple but effective means regarding image enhancement from the transform or maybe frequency region. The effect is visible in the majority of the images what is the best alpha rooting is really applied together with becomes extra pronounced should there is darker first images. Thus at times, the end result image, even though sharp, is really unacceptably richer; it is really poor on the other hand and settings expected from the good improvement.

#### 1. Sharpening associated with images

With a top pass filter you possibly can emphasize the actual contour associated with an object. Normally, this is a beneficial first help further automated manipulations with the image, however the result does not look "better" for the human vision. It is more widespread that you want to "sharpen" the actual image by simply enhancing its contours. This is done by simply combining the main image that has a high pass filtered version of the usb ports .

#### 2. Image Registration for Remote-sensing

Remote sensing can be defined as “the process by which information about an object or phenomenon is acquired from a remote place”. In our case the objects are on the Earth and the remote place is a satellite or an aircraft. Satellite imaging is referred as “the use of sensors located on space-borne platforms to capture electromagnetic energy that is reflected or emitted from surface of the Earth”. In this case the Sun is a source of energy so the sensor is termed as passive source. While in case of active sensors such as radar, they use their own source of energy to capture specific targets.

### 2.LITERATURE SURVEY

**Li, Ping et al. [1]** suggested your block-based content adaptive sharpness enhancement design of which can change this peaking within the frame items for any hinder level. In the distinct proposed design, your frame is split up in to several in cases in hinders. Making use of lots of easy content-analysis approaches, just about every block is gathered in to forms with various properties to be able to Our Video Process (HVS). Ideal working will then be put on just about every hinder according to their group. The fresh results indicate this proposed block-based content-adaptive peaking design accomplishes an even greater snapshot excellent opposed to conventional peaking scheme.

**Ming-Hui et al. [2]** discussed the actual manifestation of digital camera CR medication light graphic features vast dynamic collection, considerable information plus very poor difference, so it is important to strengthen CR graphic on the necessity of physician examination. Nevertheless the standard enhancement algorithms will never consider particular person graphic features, consequently them leaves forwards CR medication graphic image adaptive enhancement algorithm criteria making use of anyone graphic home, and that is usually more very understanding of modern location racket unlike details area racket, and creates graphic edges details enlargement excellent at length location, and also details enlargement minor throughout even area, with which in turn factor P is dependent on room adjust regarding graphic website, as a result having non-linear enhancement advantage specifics of CR image. Try things out outcomes exhibit the actual algorithm criteria enhances CR graphic details and also CR graphic boosted

offers very good video effect, and so the strategy is often match associated with advantage details enlargement regarding CR medication light image.

**Gorai et al. [3]** planned a PSO based hue conserving color graphic enhancement strategy. Image enhancement is regarded as a good optimization dilemma and particle swarm marketing (PSO) is used to remedy it. The caliber of the strength image can be improved by way of a parameterized change for better function, through which parameters are generally optimized through PSO according to an purpose function. The strength alteration performs uses nearby and international facts within the suggestions impression plus the aim accomplish points to this entropy coupled with edge particulars to help evaluate the graphic quality. The enhanced color image might be next attained by way of rising, which in turn at times will cause gamut predicament to get number of pixels. Rescaling is done to your certain saturation aspect of take away the certain gamut dilemma. The criteria is tried on many color images and answers are compared along with two additional popular colour image development techniques similar to hue-preserving color image development without extent problem (HPCIE) plus a genetic criteria based method of color graphic enhancement (GACIE). Graphic analysis, detail along with background variance in the resultant images are generally reported. It is observed in which the consist of technique provides a lot better outcomes when compared for some other a couple of methods.

**Xiao, Feng et al. [4]** planned some sort of multi-scale borders detectors requirements that required tender ceiling process to put into action points enlargement along with disturbance lowering of the true color image. To start, receiving the authentic color graphics from varied weighing machines on account of wavelet multi-scale borders detectors requirements, then utilizing the improved upon simple ceiling filtering perform, picking out proper ceiling inside the obtained visual ends to carry out disturbance lessening whilst raise the borders information and facts around the reservation; last but not least, holding aside the weighted 2-norm mixture of edges associated with different-scale-image. Try things out consequences indicate that the algorithm criteria may benefit from color along with gradient information correct color graphics to ensure that you curb seem, help the unique photograph borders details.

**Zhang, Chaofu et al. [5]** showed a crossbreed algorithm to improve the graphic. It truly is utilizing the Gauss filtration digesting to improve image detail throughout the regularity web-site along with smooth this contours inside the picture because the top-hat together with bot-hat becomes throughout spatial site. From the particular crossbreed criteria for you to doubled this infra-red graphic. Not simply boosted the actual infra-red image of the main items, however the particular put together inside the picture offers also already been smooth. Ultimately, this doubled picture outperforms some other criteria connected with effects.

**Choudhury, Anustup et al. [6]** shown a novel method of detail enhancement utilizing a dictionary-based strategy. Each low-resolution suggestions image area, they will search for a thinning rendering at a great over-complete a collection of synonyms and make use of in which so that you can estimation this high-resolution area. Many people customized a pre-existing dictionary-based super-resolution approach in several solutions to acquire enhancement of element without arrival of the latest artifacts. Most of these enhancements contain adaptive development of refurbished details pads reported by edge investigation to prevent halo items and making use of a great versatile regularization term permit noise withdrawal even though increasing detail. Many people considered next to state-of-the-art strategies and signify improved results with regards to development as well as withdrawal connected with noise.

**Cho, Sung Throughout et al. [7]** proposed a sophisticated backlight dimming approach in which saves the standard of coloring along with particulars using images even if the backlight luminance involving water very show (LCD) products will be lowered. The thought out backlight dimming procedure involves the subsequent a couple procedures: backlight luminance stages range along with pixel compensation. In the initial job, to decrease energy apply, your thought out tactic likes an maximum a higher level backlight luminance for your presented graphical based mostly on image excellent evaluation which in turn views the particular peak signal-to-noise ratio (PSNR) along with coloring frame distortions levels. In the 2nd step, it adaptively tunes it will be the RGB ration dependant on image information, thus maximizing image shade in addition to information, which are generally changed for the worse with the reduced backlight luminance stages assessed inside the 1st task. This simulator effects showed that the planned method efficiently selected the appropriate backlight luminance stages in addition to eliminated color distortions, although benchmark method elicited sizeable color distortions using some images. As well, to get precisely the same backlight luminance stages, pixel reimbursement within the planned method lower shade big difference regarding color distortions examination in addition to losing velocity with border toughness, which will confirmed fine detail drop through roughly 3. 58% together with 40. 55%, when compared with benchmark tactics, respectively.

**Kou, Fei et al. [8]** thought out the detail-enhanced being exposed synthesis considerations simply by presenting an LO normal primarily based promoting throughout gradient site. Your designed algorithm powerful ranges fine details in the vector discipline that is certainly created with the gradient grounds in the input image as well as affords the superior details a great advanced photo that is certainly merged simply by an ongoing exposure combine algorithm. Fresh side effects show that your planned strategy may enhance okay specifics to get merged images.

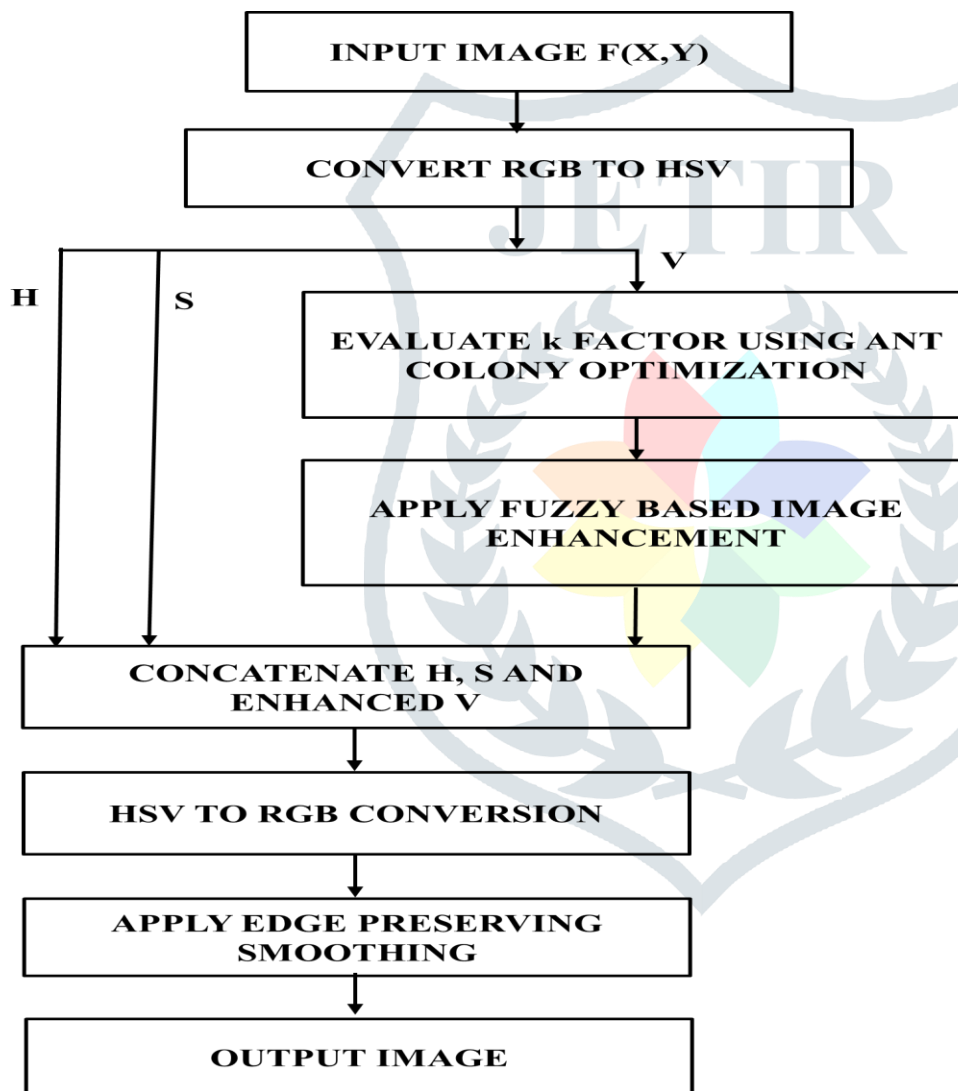
**Sun, Yaqiu et al. [9]** suggested the latest to prevent change function-based small image improvement algorithm criteria is defined forward. Throughout this sort of algorithm criteria, the idea propagate carry out seemed to be purchased with respect this incoherent glow in the to prevent strategy firstly. Consequently, the optical shift function (OTF) ended up purchased with the high-pass filter influenced by to prevent house seemed to be created with the particular incredibly small OTF. Last but not least, tiny image may very well be ready-made making use of the compensating filtering. Since an effect, the particular distinct in addition to non-obvious Getting in touch with effect modest image ended up gained. Furthermore, your little friend image progress algorithm criteria influenced by OTF seemed to be weighed in opposition to image improvement algorithm criteria influenced by Butterworth high-

pass filtering. Fresh benefits show that the particular to prevent change function-based modest image progress algorithm criteria can easily make a far better modest image improvement effect.

**Teng, Yanwen et al. [10]** described principle tenets on the Laplacian chart breaking down, plus exploration employing user-defined tolerance prices to separate the actual image information plus corners on the disadvantages, plus give operates the world-wide data immediately to get the ceiling gain method. Inside the foundation of this attained great outcomes, this limitation remapping cellular tiers that apart from have the ability to cut back period and also price tag, plus could certainly minimize the amount of money required in pointless data. As they demonstrated that the procedure produces constantly high-quality translates into is essential impression detail improvement.

### 3. PROPOSED METHODOLOGY

The main objective of the proposed algorithm is to supply better results than existing algorithms to improve the visibility of the digital images. Edge preserving smoothing and color normalization technique will undoubtedly be integrated in to the fuzzy based image enhancement technique to provide better results. Fig 4.1 is showing numerous steps to own objectives.



- Step 1: Image is transfer to the system and some pre-processing procedures are placed onto it.
- Step 2: Image is modified within HSV plane.
- Step 3: As H and S elements remain constant but V is the only factors which require some change while improving the images.
- Step 4: Apply k adjustment variable will be considered for image enhancement using aging leader based ACO.
- Step 5: Fuzzy based image enhancement is applied on the image.
- Step 6: Concatenate H, S and enhanced V component.
- Step 7: Re-convert given image to HSV to RGB again.
- Step 8: Apply Edge preserving smoothing.
- Step 9: Get output image.

### 4.RESULTS AND DISCUSSIONS

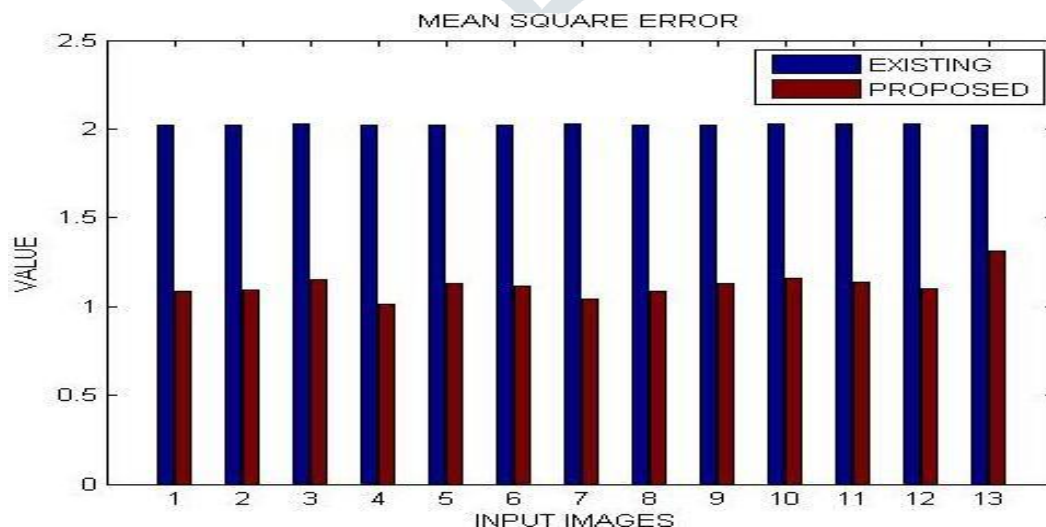
#### 4.1 Experimental set-up

To implement the proposed algorithm, design and implementation has been performed in MATLAB using image processing toolbox.

**1. Mean Square Error:** Mean square error are shown below in the comparison Table 1. As mean square error should be reduced therefore the proposed algorithm is showing the better results than the available methods as mean square error is reduced in every case.

**Table 1: Mean Square Error comparison table**

S. No.	IMAGE NAME	MSE	
		Existing Image	Existing Image
1.	Betsiboka River	2.0212	2.0212
2.	Disputed South China Sea	2.0244	2.0244
3.	Arunachal bordering China	2.0275	2.0275
4.	Rare footage	2.0219	2.0219
5.	Radar at stanford	2.024	2.024
6.	North Sentinel Island	2.0245	2.0245
7.	MOUNTROR AIMA	2.0271	2.0271
8.	Island-danger	2.0221	2.0221
9.	Andaman Island chain	2.0248	2.0248
10.	North Sentinel Island	2.026	2.026
11.	Building in Washington	2.0257	2.0257
12.	UMD	2.0273	2.0273
13.	UK	2.0228	2.0228



**Fig .1: Mean Square Error**

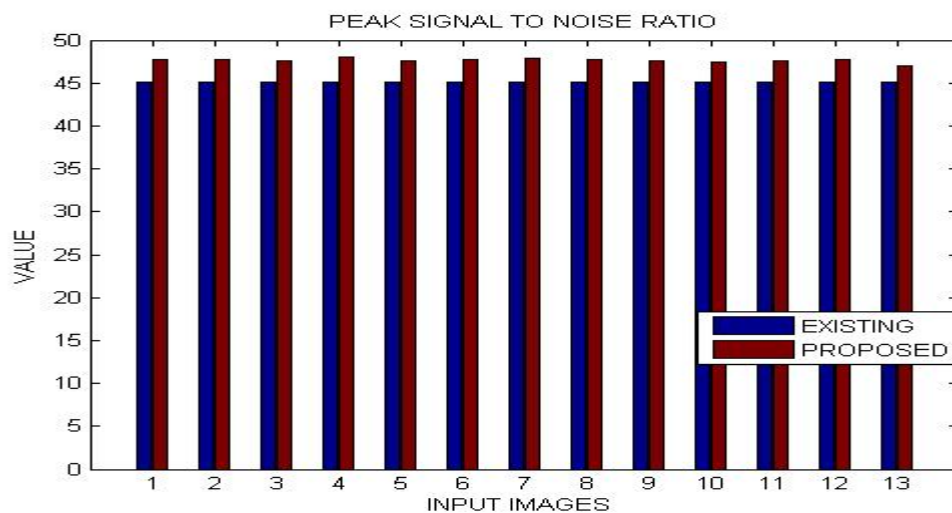
Fig 1- Shows the comparison of Mean Square Error between existing and purposed method where x-axis shows input image and y-axis shows the value. In our case the purposed Mean Square Error values are comparatively greater than the existing approach.

**2. Peak Signal To Noise Ratio:**

Comparison Table 2 shows the PSNR. 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: PEAK SIGNAL TO NOISE RATIO**

S. No.	IMAGE NAME	PSNR	
		Existing Image	Existing Image
1.	Betsiboka River	45.0747	47.7692
2.	Disputed South China Sea	45.0679	47.7474
3.	Arunachal bordering China	45.0612	47.5174
4.	Rare footage	45.0732	48.0906
5.	Radar at stanford	45.0687	47.6156
6.	North Sentinel Island	45.0677	47.6685
7.	MOUNTROR AIMA	45.062	47.9529
8.	Island-danger	45.0728	47.7622
9.	Andaman Island chain	45.067	47.5922
10.	North Sentinel Island	45.0644	47.5022
11.	Building in Washington	45.065	47.5733
12.	UMD	45.0616	47.719
13.	UK	45.0712	46.9456



**Fig 5.4: PEAK SIGNAL TO NOISE RATIO**

Shows the comparison of peak signal to noise ratio between existing and proposed method where x-axis shows input image and y-axis shows the value. In our case the proposed peak signal to noise ratio values are comparatively greater than the existing approach.

## Conclusion

In this paper, an image enhancement technique using modified fuzzy based T-2 bell Shaped membership function is proposed for remote sensing images. It evaluates k factor automatically using ACO. It finds the best similarity value among the given set of values which represents the image in more efficient manner. It is used modified edge preserving smoothing based on adaptive k-fuzzy. The proposed approach has ability to reduce the effectuation of noise, preserves the edges and boosts the contrast in digital images. From the result analyses, it has been found that the proposed approach has MSE and PSNR better than the existing techniques.

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