Webology, Volume 18, Number 5, 2021
ISSN: 1735-188X
DOI: 10.29121/WEB/V18I5/98

Memetic Algorithm-Based Blind Image Reconstruction for Satellite - derived.

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ABSTRACT

The need to repair damaged satellite photos is growing. Degradation may be caused by a variety of imperfectly presented factors, including aliasing, blurring, noise, and air turbulence. The Memetic image restoration method is presented in this publication. Although previous restoration methods have been explored, the maximum cases barely near solving the resultant criteria. For this reason, more rigorous optimization strategies are needed. The hill-climbing strategy used to seed the population and the extended neighbourhood search used by the Memetic algorithm provided herein allow for effective picture representation. For optimal results, the technique is run on a quickbird test satellite picture. Matlab is used to create the optimization routines. The suggested solution improves upon the deteriorated picture by a quarter. Our innovative strategy outperforms certain state-of-the-art alternatives in a competitive setting. In order to show how much better the new technique is than the current one, comparisons are drawn between the two.

Keywords: MemeticAlgorithm,PSF,ExtendedneighborhoodSearch,PSNR

INTRODUCTION

Images are created in order to obtain the necessary data, however owing to flaws in the imaging and capture process, the resulting images are poor representations of reality [1]. It is exceedingly challenging to rectify these flaws. Image processing relies heavily on this operation. Blurring and otherwise transforming a picture into its imperfect form reduces its bandwidth [2]. Object-camera motion, an out-of-focus optical system, aberrations in the optical system, and air turbulence are all potential causes of image degradation [3]. All signals are subject to degradation by noise. Absorption of light at random by the material used to form the picture is one source of noise in the system. The deterioration is mostly due to noise. These damaged picture files have long been an issue in the field of image processing, especially for remote sensing photos. Deblurring or denoising a picture are other names for image restoration. Edge detection refers to the technique of identifying where an image's edges are. There is a lot of important data in the edges. Image processing feature extraction often begins with an edge detection stage [4]. In certain cases, all that's needed is a satellite picture to get the job done. Blur, aliasing, and noise often degrade satellite images. There is

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a requirement for image processing [5] to reflect the improved radiometric and geometric quality of the picture. The process of image restoration involves carrying out the flaws in the image-making process that result in aesthetically distracting blemishes on the final product. The ability to eliminate noise using a simple FIR filter is limited . The noise and degradation system's a priori properties are assumed here. Blur identification is the process of estimating the characteristics of the defective imaging system from the observed picture. The blurring function, d (n, k), is a point-spread function that is independent of time. In this case, we suppose that the point-spread function is either uniform throughout the whole picture or is spatially independent.

We may provide a mathematical description of these presumptions in the following way.
$g(n, k) = d(n, k) * f(n, k) + w(n, k)$ (1)

The noise-free and sharp original discrete picture is represented by f (n, k), whereas the blurred and noisy version is modelled by g. (n, k) [8]- .

The additive Gaussian noise is denoted by w (n, k). The already-fuzzy signal is completely ruined. When a picture is damaged or deteriorated, the restoration process attempts to recreate the original signal by creating a close approximation, or f' (n, k), from the original g (n, k) (n, k). Having no average value, white noise is assumed .

To repair one's reputation

There is a wide variety of algorithms and methods used for restoring images. There are distinctive characteristics and qualities of each algorithm and methodology. In general, two types of picture restoration methods have been identified. It is possible to rebuild original pictures from degraded ones with no prior knowledge of PSF using these methods, which estimate both PSF h and the desired image f from the provided damaged image g. Compared to non-blind restoration, these methods are very hard to apply and somewhat complex. If you already know the PSF and/or the degradation function, they'll work better for you. That's why that method is so helpful. Full iterative image reconstruction is noise-tolerant and capable of recreating a picture from incomplete data, but it is computationally intensive and time-consuming. Recently, DWT has emerged as the go-to method for compressing images.

Image restoration was frequently utilised and accepted in early applications. The continued popularity of the wiener filter may be attributed to its excellent efficiency]. Regularization and maximum posterior (MAP) are also often used after projections onto convex sets for restoring images. In addition to using nonlocal techniques, sparse restoration is employed to fix damaged images. Recently, the marginal likelihood optimization (MLO) technique has been applied, which first estimates the point spread function (PSF) before proceeding to the image estimation. Joint techniques include the maximum variety of approaches. An iterative blind deconvolution technique (IBD) is used to estimate the blurred image and the sharp original image in the frequency domain. The MAP method and other maximum likelihood techniques are suggested for use in the wavelet domain. Most blind restoration techniques assume a fixed point spread function (PSF) size [6].

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Genetic and Memetic Algorithm

3In this study, we provide a Memetic algorithm that uses a hill-climbing-based population initialization and an extended neighborhood-search-based local search. In the early stages, the hill climbing approach for selective initialization produces the healthiest people. Using both a global and a local search criteria, this optimization eventually reaches a minimum. Artificial intelligence that learns and improves via trial and error is called a genetic algorithm. An early kind of search algorithm was the genetic algorithm. The process starts off with a completely random population setup. Poor initialization of populations likely to provide subpar outcomes, whereas effective initialization yields desirable outcomes. Even with bad beginning conditions, the algorithm may eventually converge worldwide. When using a genetic algorithm, a population is created via a looping process [7]. Dawkins proposes the "memetic algorithm," which takes its cues from viral memes. The "meme" serves as the information's basic building block. Memes are the units of transmission in the Memetic algorithm, and they carry not just ideas but also tales, facts, and rumours. The memetic algorithm combines the best features of the genetic algorithm and the local search.

The following are the stages of the hill climbing algorithm:.
Start. Create a sample population of answers at random.The fitness value of each person is used to determine how often to generate new neighbours until a better solution is discovered.The new solution then becomes the new parent solution.For other answers, just return to step 4.If the parent problem is not resolved, step 5.

New generations are referred to as offspring populations. To further enhance each progeny, a local search strategy known as extended neighbourhood search is used. Initially, it will explore a small region close to the existing solution, and after it reaches the local optimum, it will expand the size of its search steps to find the global optimum [8].

PERFORMANCE RATINGS

There are two ways to evaluate an image's quality: subjectively and objectively. Judging anything based on how it appears on the outside is a subjective process, whereas judging it based on one or more model parameters is objective. Quickbird test picture is used to evaluate the suggested approach. The objective evaluation of recorded images is measured using two different performance indicators. Measures of comparison include peak signal-to-noise ratio and Q. Ideally, PSNR should be above +. The degree of blur and background noise is expressed ostensibly by the metric Q. If Q is high, the image will have better quality [9].

The picture size is denoted by M x N, and the pixel values at the I j)th position are represented by g(i, j) and I j) in the restored and original images, respectively. The lowest and highest intensities in the grayscale picture are denoted by min and max respectively. Grayscale images should have a range from 0 to 255 for lowest and maximum values, respectively.

Here we provide the PSNR for 300300 grayscale photos with intensity values between 0 and 255 as The Memetic Algorithm calls for first creating an initial population, after which the picture is transformed to a 256-color grayscale [10].

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The picture represents a particle, and the grayscale value of the image represents the particle's size. Where M is the number of lines, N is the number of columns, and grey value 256 is utilised, the total number of potential pictures is 28MN = 2300300, which is a very big number. With just 300 by 300 pixels, the number of conceivable pictures is enormous. As a result, it's crucial to do some preliminary processing on the raw population data. Preprocessing the original population and the degraded picture using the hill-climbing approach only accounts for a subset of the whole population. Equation (1) may be expressed as a matrix if the deterioration model is believed to be linear.Where I represents the improved value and g the original value before degradation. Finding the optimal restored value I is the goal of restoration. The optimal outcome is found by comparing I and f, but neither I nor f can be known in advance. The only data provided pertains to the deteriorated picture. Both gi and I will be generated by the same process, and their resulting values will be compared. The picture with the least value is chosen as the restored one, because it is the one that most closely resembles the original. The best restored value is determined by the lowest value of the itness(i) function, and restoration will converge on the ideal value.

SIMULATION RESULTS

A actual, high-quality, pre-processed quickbird remote sensing picture is used for the simulations.The studies are conducted using a Gaussian blur size of 5x5 and a standard deviation of = 2.1. During the restoration procedure, subimages are created by cropping the original images to 300 by 300 pixels. The picture has been blurred using a 5x5 Gaussian blur with a standard deviation of = 2.1.It's time for a comparative study!

An iterative technique is suggested and evaluated using both noisy and noise-free photos. Gaussian blur with a standard deviation of = 2.1 applied to the original picture yields a noise-free image, whereas applying Gaussian noise (PSNR=20dB) to the blurred image yields a noisy image. In order to verify the efficacy of the suggested technique, it is compared to the IBD method and the MLO method. The findings of the analysis are shown as a bar chart. The suggested technique performs effectively and is less susceptible to noise regardless of whether or not noise is present.PSNR is superior than MLO and IBD in terms of value.The percentages of PSNR gains from the degraded picture in the noisy situation for IBD, MLO, The suggested technique has a PSNR that is 15% higher than MLO and 16% higher than IBD.

Results of the noise-free and noisy cases are presented quantitatively.
The suggested method takes use of the Memetic algorithm's extended neighbourhood search, which needs a low number of iterations. Fewer iterations lead to better outcomes. Both linear and non-linear functions may be used with the suggested approach to recreate the original results. The recommended approach has looked at what's causing the deterioration and what may be done to fix it. The local search is conducted using an expanded neighbourhood criteria, and a novel restoration methodology is provided by the suggested method. The experimental findings demonstrate the effectiveness of this strategy both qualitatively and numerically. The experimental results demonstrate the visual and quantitative efficacy of the suggested strategy. When compared to the deteriorated picture, it demonstrates a 25% improvement in PSNR, while MLO and IBD only achieve 9% and 5%, respectively. However, the suggested approach has a high computational cost.

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