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Review on Gauss Jordan Method and it's Applications

Mr. V. V. Mehtre[1,a], Mr. Shubham Tiwari[2,b]

[1] Department of Electrical Engineering, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune

[2] Student, Department of Electrical Engineering, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune

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ABSTRACT

This paper Examine the review on gauss Jordan method for solving system of linear equations. Various terminologies are discussed, some problems are considered in conjunction with the afore-mentioned methods used in solving system of linear equations. Some real-life application is discussed for understanding the uses of this method in real life.

KEYWORDS: Gauss Jordan, fingerprint, Fingerprint Image Enhancement, segmentation, noise remover.

I. INTRODUCTION

The Gauss – Jordan approach is a modification of the Gaussian elimination. It is named after Carl Friedrich Gauss and Wilhelm Jordan due to the fact it is a variation of Gaussian elimination as Jordan defined in 1887 while Gaussian removal locations zeros under each pivot inside the matrix beginning with the pinnacle row and working downwards, Gauss – Jordan removal technique is going a step-in addition by setting zeroes reduced row echelon form and Gauss – Jordan removal is assured to find it.

The paper pursuits at investigating the methods of solving gadget of linear equations using Gauss and Gauss – Jordan removal strategies, examine and comparison the 2 methods and at locating out utility of the methods to different fields of have a look at.

The paper goals at reviewing the strategies of fixing machine of linear equations the use of Gauss – Jordan elimination strategies, and finding the utility of the method in actual life.

above and underneath every pivot. each matrix has a

II. LITERATURE REVIEW

In this observe, the studies reviewed few subjects particular research articles and additionally tries to discover sensible uses of the Gauss Jordan approach.

[1] It isn't unexpected that the begin of matrices and determinants ought to stand up through the take a look at of linear structures. The Babylonians studied issues that introduced approximately simultaneous linear equations and some of those are preserved in clay tablet that live on. The chinese language between 200BC and 100BC got here lots inside the course of matrices than the Babylonians. truly, it is sincere to mention that the textual content 9 chapters on the arithmetic art work written for the duration of the Han Dynasty provide the primary seemed example of matrix techniques.

Cardan, in artwork Magna (1545), offers a rule for fixing a gadget of linear equations which he known as ordinary de modo and that is called mom of guidelines. This rule gives what basically is Crammer's rule for fixing a 2 x 2 system. The idea of a determinant regarded in Japan and Europe at almost exactly identical time even though Seki in Japan genuinely published first. In 1683, Seki wrote approach of fixing the dissimulated problem that includes matrix techniques written as tables in exactly the chinese language strategies describe above were built. without having any phrase that corresponds to „determinant", Seki though brought determinants and gave widespread techniques for calculating them primarily based on examples. the usage of his "determinant", Seki turned into capable of discover determinants of 2 x 2, 3 x 3, 4 x 4 and 5 x 5 matrices and applied them to resolve equations however not system of linear equation.

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inside the 1730"s, Maclaurin wrote Treatise of Algebra even though it become now not published until 1748, years after his lack of lifestyles. It incorporates the primary published results on determinant proving Crammer's rule for two x 2 and 3 x three systems and indicating how the four x 4 case might art work. Crammer gave the overall rule for n×n systems in a paper creation to the evaluation of algebraic curves (1750). It arose out of a choice to find the equation of a aircraft curve passing via a number of given elements.

In 1764, Bezout gave strategies of calculating determinants, as did Vandermonde in 1771. In 1772, Laplace claimed that the method brought by means of the use of Crammer and Bezout were impractical and in a paper wherein he studied the orbits of the internal planets, he referred to the answer of device of linear equation without a doubt calculating it by using the usage of determinants. as an alternative surprising Laplace used the word „resultant" for what we now call the determinant. distinctly since it's miles the same phrase as used by Leibniz but Laplace ought to have been unaware of Leibniz's art work. Laplace gave the expansion of a determinant that is now named after him.

Jacque's strum gave a generalization of eigen price problem in the context of fixing device of everyday differential equations. In reality, the idea of an eigen fee regarded eighty years earlier all over again in paintings on systems if linear differential equations with the aid of O" Alembert reading the movement of a string with mass connected to it at severa points.

the first to use term „matrix" modified into Sylvester in 1850. Sylvester described a matrix to be an oblong arrangement of phrases and observed it as some element that brought about numerous determinants from rectangular arrays contained interior it. After dwelling the United States and returning to England in 1851, Sylvester have become a lawyer and met Cayley, a fellow legal expert who shared his interest in mathematics. Cayley speedy noticed the importance of matrix idea and via 1853 Cayley had posted a notice giving for the primary time, the inverse of matrix.

Frobenius, in 1878, wrote an critical paintings on matrices on linear substitutions and linear paperwork despite the fact that he seemed ignorant of Cayley's artwork. Frobenius in his paper treated co-

III. GAUSS JORDAN METHOD

First of all, we describe the known Gauss-Jordan method for fixing a device of linear equations. recollect the following actual linear algebraic machine Ax = b, where A = (aij) n×n is a recognized nonsingular n × n matrix with nonzero diagonal entries, b = (b0, b1, ..., bn−1) T is the right-hand aspect and x = (x0, x1, ..., xn−1) T is the vector of the unknowns. In Gauss-Jordan algorithm, first a operating matrix is constructed by augmenting A matrix with b, obtaining (A|B) matrix with n rows and n + 1 columns. Then, this matrix is converted right into a diagonal form, the usage of Gaussian elimination. [2]Gauss-Jordan algorithm is achieved in phases. in the first phase of Gauss-Jordan set of rules, the augmented matrix is converted into a diagonal form in which the factors each above and under the diagonal element of a given column are zero. in the 2d segment, each xi (zero ≤ i ≤ n) answer is computed with the aid of dividing the element from row i and column n of the augmented matrix (ai, n) with the element from the row i of the principal diagonal (ai, i). The serial model of fashionable Gauss-Jordan algorithm for solving a linear system proven in set of rules 1 consists of three nested loops, which we are able to undertake for parallel implementation inside the rest of this paper.

Algorithm 1: Sequential Gauss - Jordan algorithm

for k ← 0 **to** n − 1 **do**
  for i ← 0 **to** n − 1 **do**
ifk != i **then**
    for j ← k + 1 **to** n**do**
     a[i][j] ←
      a[i][j] − (a[i][k]/a[k][k]) ∗ a[k][j]
for i ← 0 **to** n − 1 **do**
 x[i] ← a[i][n]/a[i][i]

The transformation of augmented matrix to diagonal form requires $\frac{4n^3}{3}$ scalar arithmetic operations. Computing solution from diagonal form of the system requires approximately n scalar arithmetic operations, so that the sequential run time of Gauss-Jordan algorithm is $\frac{4n^3}{3} + n$

IV. APPLICATION OF GAUSS JORDAN METHOD

Gauss Jordan method have many real-life applications one of these applications is Fingerprint Image Enhancement

Fingerprint Image Enhancement

[3,4]The proposed system takes the fingerprint as an input for the advancement as shown in Fig. 1. The main steps involved in the given system are described below in a sequential order.

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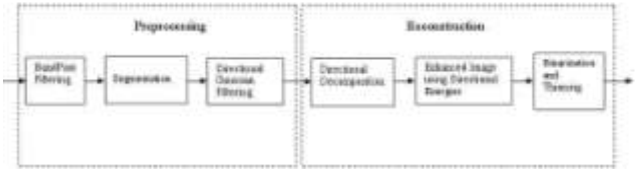

Figure1.ProposedFingerprintImageEnhancementSystem

Figure2.FingerprintTestImage

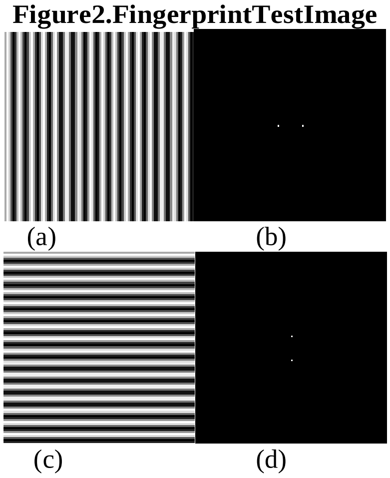

Figure 3. (a),(c) Periodic Sinusoidal of a particular directioninSpatialDomain.(b),(d)PeriodicSinusoidalrepresentedbytwopointsinfrequencyDomain.

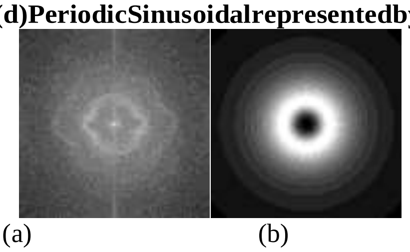

Figure4.a)RepresentationofimageinFrequencyDomain.b)FrequencyResponseofBandpassFilter.

Non-Uniform Illumination Correction

The fingerprint may be approximated via a two-dimensional sinusoidal of various orientations as proposed in [8, 5]. it's far proven in Fig. 3, that a periodic sinusoid of a particular orientation inside the spatial area is represented by using points inside the frequency domain

[6]So, a fingerprint picture may be taken into consideration as a combination of various sinusoids of different orientations in which the ridge frequencies are represented by using the factors in a circular area in the frequency area as shown in Fig. four (a). As we're interested by the enhancement of the ridges most effective in place of the history, so there's a need of filter out whose pass-band can best permit the ridge frequencies to pass through it. For this reason, we have used the non-best butterwort bandpass filter out whose bypass-band is designed in one of these ways that simplest the ridge frequencies can skip thru it as shown in Fig. four. The non-ideal butterwort bandpass clear out no longer most effective extracts the ridge frequencies however its decrease forestall-band area helps inside the removal of non-uniform illumination that's in most cases present as low frequency content in the frequency area. high frequency noise is handled via the upper forestall-band place of the bandpass filter. The bandpass filter became implemented through taking the discrete fourier transform (DFT) of the input photograph as shown in Fig. four. After filtering the photo, inverse DFT has been carried out to

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convert the filtered photo from fourier domain again to spatial domain. eventually we were given a uniformly illuminated image having the ridge frequencies simplest as shown in Fig. five (b).

Segmentation

In case of fingerprint, we're continually interested in enhancing the ridges instead of the background. The background corresponds to the regions outdoor the borders of the fingerprint region, which do not incorporate any legitimate fingerprint information. So, there's always a need of algorithm that could without difficulty separate the foreground i.e., ridges and valleys from the background. For this purpose, variance thresholding based totally on non-overlapping blocks were widely used [9] wherein variance of non- overlapping blocks are kind equation right here. calculated and if the variance is less than the global threshold, then block is assigned to be a back- ground; in any other case, it's miles assigned to be part of the foreground. but the foremost hassle with the non-overlapping blocks is that it gives a blocky impact as shown in Fig. 6 (c), that's why we have favored overlapping blocks for variance thresholding. the grey-level variance for a block of length N × N is defined as

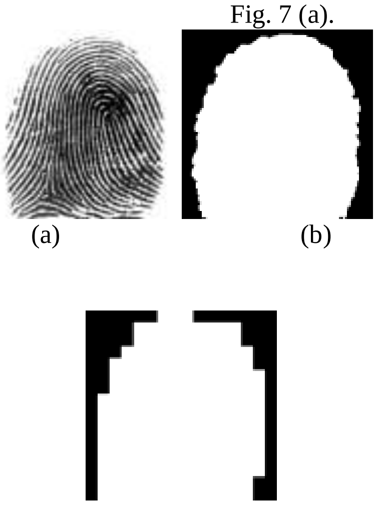
$$V_{(x,y)} = \sum_{x=1}^{x\in sxy} \sum_{y=1}^{y\in sxy} I(x,y) - m_{s_{xy}}$$
(1)

$$ms_{xy} = 1/NS_{xy} \sum_{x=1}^{x\in S_{xy}} \sum_{y=1}^{yS_{xy}} I(xy)$$
(2)

where V (x, y) is the variance of pixel (x, y) over the block Sxy, Sxy is a sub-image of size NSxy i.e. a block centered at (x,y), I(x, y) is the grey-level value at pixel (x, y), and mSxy is the mean grey-level value for the block Sxy. If the value of variance for pixel (x, y) is less than a specific threshold than it is declared as a background pixel represented by black pixels and if its above the threshold then it is represented by white pixels as shown in Fig. 6 (b)

Noise Removalusing DirectionalGaussian Filtering

For smoothing and noise reduction cause, we've got used directional Gaussian filtering as proposed in [7]. commonly the principle idea in the back of the directional Gaussian is to divide the im-age into non-overlapping blocks and for each non-overlapping block, apply Gaussian filter in equally spaced instructions with wide variety of instructions ok certain by way of consumer. Variance is stated for each course of a block and in the end the route (α) in which variance is most is selected for the smoothing motive. the overall components for Gaussian filter out is given in Eq. three. The smoothed photograph is constructed by way of adjoining all the filtered blocks as proven in Fig. 7 (a).



(a) (b)

(c)

Figure 6. (a) Original Image, (b) Binary mask using the varianceofoverlappingblock,(c)Binarymaskusingthevarianceofnon-overlappingblock

block, apply Gaussian filter in equally spaced directions with number of directions K specified by user. Variance is noted for each direction of a block and finally the direction (α) in which variance is maximum is selected for the smoothing purpose. The general formula for Gaussian filter is given in Eq. 3. The smoothed image is constructed by adjoining all of the filtered blocks as shown in Fig. 7 (a)

$$g(x, y) = \frac{1}{2\pi\sigma_x 2\sigma_y 2} \exp[-0.5(\frac{x^2}{\sigma_x 2} + \frac{y^2}{\sigma_y 2})] \quad (3)$$

The filter in α direction can be written as

$$h(x, y, \alpha) = \frac{(x\cos\alpha + y\cos\alpha)^2}{\sigma_x 2} + \frac{(-X\cos\alpha + Y\cos\alpha)^2}{\sigma_Y 2}$$

$$g(x, y, \alpha) = \frac{1}{2\pi\sigma_X 2\sigma_Y 2} \exp[-0.5(h(x, y, \alpha))] \quad (4)$$

Blocky Effect Removal

As, we've got used non-overlapping blocks for the smoothing cause as suggested in [7], so we will have blocky effect in the output as shown in Fig. 7 (a). This effect has been decreased by clearly applying the high pass filter to the output of preceding step after which subtracting it from its weighted version as shown in Eq. 5. The end result of this step is shown in Fig. 7 (b). it's far clear from the Fig. 7 (b) that the blocky effect has been decreased by means of applying the Eq. five.

$$high = highpass_{filter}\,(output_{smooth}\,, cutoff, order)$$
$$output = 2 \times output_{smooth} - high \quad (5)$$

Reconstruction of Improved Image

For the development of better image, we've used directional energy of directional images . As mentioned above, that we've used three tiers of NSCT, so we are able to apply the reconstruction set of rules on every stage separately and in the end the 3 enhanced photographs of every level will be added together to provide a final improved fingerprint image. This set of rules works as follows:

1. start through calculating the block-by-block energy of overlap- ping blocks of every directional image for every level of NSCT by means of using the subsequent pair of equations:

$$D^i_{energy}(x, y) = \sum_{x=1}^{x \in S_{xy}} \sum_{y=1}^{y \in S_{xy}} |D^i(x, y) - m^i s_{xy}| \quad (6)$$

$$m^i_{s_{xy}} = \frac{1}{N_{S_{xy}}} \sum_{x=1}^{x \in S_{xy}} \sum_{y=1}^{y \in S_{xy}} D^i(x, y) \quad (7)$$

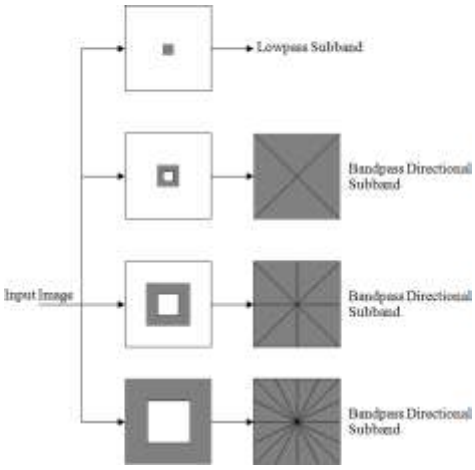
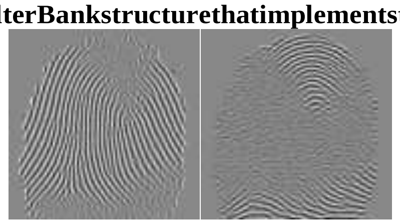


Figure8.NonsubsampledFilterBankstructurethatimplementstheNSCTasproposedin [11]



(a) (b)

Figure9.DirectionalImagesoffirststageofNSCT

whereS_{xy}isasub-

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imageofsizeN_{Sxy}i.e.,ablockcenteredat (x, y).

[8]InEq.6, $m^i_{s_{xy}}$ is subtracted from each block to make it zero mean and also to get rid of any uniform illumination present within the block to present upward push to directional electricity image correspond to each output of NSCT.

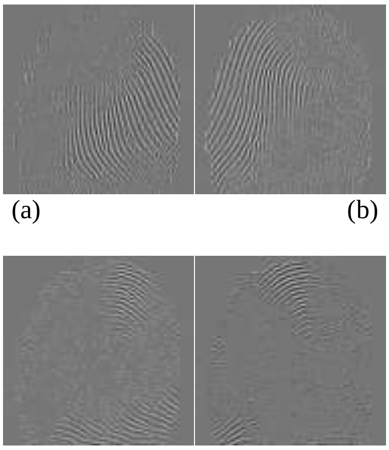
Finally, the improved image Henh for each level of NSCT may be made out of the directional energy photographs by means of the use of following steps.

1. Foreachpixel(x, y)findthe energy image havingmaximumdirectionalenergyforeachstage.For example,forpixelposition(x,y),find maximum (max (D^i_{energy} (x, y))) in all D^i_{energy} images of each step separately. Here (x,y) are pixel positions in an image lattice. Mathematically we can say that,

$$[val,ind]=max(D^i_{energy}\ (x,y)) \quad (8)$$

wherei=1,2...2^nandn=StagenumberofNSCT

[10]whereval is the value of maximum energy for a particular pixel position (x,y) and ind is the index of the D_{energy} image from which pixel (x, y) is said as maximum. After calculating maximum energy for every pixel, a new image E_{image} having only maximum energies is formed. ThisE_{image} is the improved photo for each level of NSCT as shown in Fig. 12. So, we are able to have three improved pictures corresponding to 3 levels of NSCT which have been used in the proposed set of rules. The final improved fingerprint photo final image is received by adding all of the three improved pictures of each level of NSCT as shown in Fig. 13 (c). evaluating the end result with the authentic photo shown in Fig. 13 (a) famous that everyone the ridge structure is intact at the same time as the spatial noise has been cleaned substantially. it is clear from Fig. 13 (c), (d) that out proposed set of rules works well with NSCT and Gabor Wavelets. Fig. 13 (b) indicates the bad performance of Gabor Wavelets once they were mixed with directional gaussian filtering without performing any segmentation and non-uniform illumination correction.



(a) (b)

(c) (d)

Figure10.DirectionalImagesofsecondstageofNSCT

(a) (b)

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(c) (d)

Figure11.(a)OriginalImage.(b)Enhancedimageafterapply-ingourproposedsystemonfirststageofNSCT.(c)Enhancedimage after applying our proposed system on second stageof NSCT. (d) Enhanced image after applying our proposedsystemonthirdstageofNSCT.

V. CONCLUSION

This work shows us how we can use gauss Jordan method for solving systems of linear equations and how we can implement this method in real life. In this paper we also saw that one of its implementations is to Robust Fingerprint Image Enhancement as it decomposes the image into aset of images based on the ridge pattern directions, removesnoises, and reconstructs a final enhanced image.

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