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Independent Pixel Block (IPB) Method Based Binary Matrix Recovery

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ABSTRACT: The binary images are utilized in the various kinds of the medical or non-medical applications. The efficient preservation mechanisms are applied for the storage of the binary data over the computing resources, but the computing resources always carries the probability of crashing and the critical data losses. Such data losses require the efficient data recovery from the storage disk resources, which certainly not possible in some of the cases. The binary image projection data can be preserved in almost 10% total memory of the original image data, which can be easily kept over the multiple internet storage resources. Then, the binary image regeneration methods are required to recreate the appropriate original binary image to reconstruct the data in order to recover the lost data. The proposed model is based upon the Independent Pixel Block (IPB) Method based binary matrix recovery. The IPB method uses the neighbor entity factoring for the recovery of the certain pixels, which do not meet the conditions. The proposed model aimed at the development of the robust binary image reconstruction method, which has been realized using the IPB method. The experimental results have shown the improvement of almost 7-8% than the optimization solution and initial solutions. Hence, it can be easily declared that the proposed model have improved the results significantly under this experiment for the binary matrix regeneration.

KEYWORDS: Binary matrix regeneration, matrix recovery, image recovery, pixel based recovery**.**

I. INTRODUCTION

Binary Image Reconstruction outlines the technique of reproducing an image from the traced image. [1] This traced image is acquired in the structure of projections such as diagonal, vertical and horizontal. [2] These projections are absolutely based on the type of an image that may be 2-D or 3-D image. [5, 7] This involves the concept of binary image reconstruction. A binary image is a digitalized image containing on white and black pixels where white pixels corresponds to binary value 1 &black pixels corresponds to binary value 0. [4, 6]

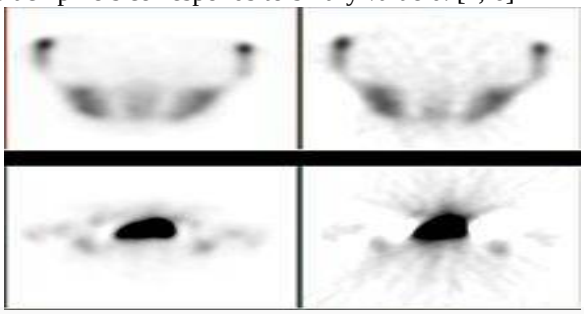

Figure 1: Example showing differences between filtered back projection (right half) and iterative reconstruction method (left half)

In binary images, Image reconstruction is a mathematical process that produces images from Horizontal-Vertical projection data derived from the different angles. [8] Image reconstruction has a major influence on image quality also on radiation noise.For a radiation dose it is necesary to reconstruct images with the lower noise without sacrificing spatial resolution and image quality. [3] Reconstructions methods that improve image quality can be converted into a decrease of radiation dose as images of acceptable quality can be reconstructed at lower dose. [9, 13]
There are plenty of techniques of image reconstruction. Mostly used are:

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i.) Analytical Reconstruction or Filtered back projections(FBP). [10]
ii.) Iterative reconstruction. [10]

Analytical Reconstruction constructs an image in a single step. [17] The widest use of this projection is in the field of clinical binary image scanners. [18] The major reason behind its use is its numerical stability and computation efficiency whereas Iterative Reconstruction constructs an image in multiple steps but provides a complete solution which leads to efficient reconstruction of an image as compared to filtered back projection. [19-20] Also it decreases the image artifacts like beam hardening and metal artifacts. [11]

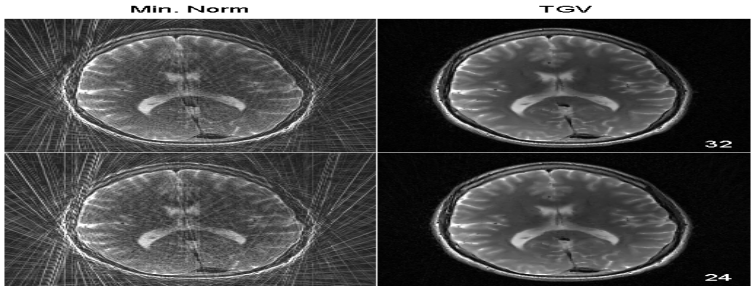

Figure 3: Reconstruction example over the MRI images

The existing work is done on simulated annealing that uses the two level solution for reproducing an image. [8] The simulated annealing inhibits the concept of metallurgy where it is enforced on glass or metal. [19] This provides the excellent strength in glass with accurate flexibility. In this, there are more chances of occurring error while reconstruction phase. As a result of which there is a need of single efficient initial solution algorithm that will produce more accurate results. [13]This paper emphasizes on iterative reconstruction of binary images from HV projections analyzed from different angles. [14, 15, 16] It also emphasizes on obtaining the more efficient results as the solution of optimization problem or to a set of equations which are concluded in a iterative loop. [12]

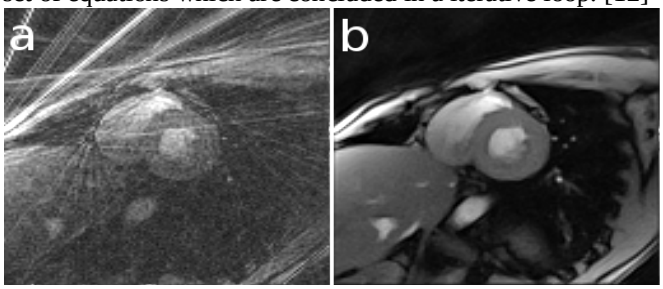

Figure 2: A single frame from a Real-time MRI movie of a human heart. a) direct reconstruction b) iterative (nonlinear -inverse) reconstruction

II. RELATED WORK

In [1] authors have worked on reconstructing h-convex binary pictures from its horizontal and vertical projections by simulated hardening. This paper uses the convexity property of binary pictures and also the downside of reconstruction of h-convex binary pictures from its horizontal and vertical projections is taken into account here. This downside is remodeled into 2 completely different optimization issues by process 2 acceptable objective functions. Then 2 simulated hardening (SA) algorithms to unravel the has been developed the strategy for economical approach for Reconstruction of umbellate Binary pictures Branch and sure technique during this paper reconstruction rule of umbellate binary image in separate pictorial representation created economical by implementing branch and sure technique. The authors have centered on diagonal and anti-diagonal (dad) projections and comparison through with the standard horizontal and vertical (hv) projections.In [2] authors have been developed the strategy for economical approach for Reconstruction of umbellate Binary pictures Branch and sure technique during this paper reconstruction rule of umbellate binary image in separate pictorial representation created economical by implementing branch and sure

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technique. In [3] authors have been centered upon the reconstruction of hv-convex sets by their coordinate X-ray functions. the fundamental result [28] is that the generalized conic operate associated to a compact tabular set determines the coordinate X-rays and the other way around.In [4] authors have worked on reconstruction of binary pictures from 2 orthogonal projections. Reconstruction of binary pictures (or matrix) with 2 projections has been mentioned wide in literature and every one the reconstruction algorithms with 2 projections either use horizontal and vertical projections or horizontal and diagonal projections.In [5] authors have concentrated on the combination of two rules named as simulated hardening and genetic rule for the reconstruction of HV convex binary matrices. In this paper, the authors have worked upon the row and column sums of umbellate binary matrices i.e. Horizontal and vertical. The major concept is the NP-Complete which is a replacement hybrid genetic rule with use of simulated hardening and is project to conclude the most approximate conclusion or answer. In [6] authors have worked on the individualismin the conclusion for the reconstruction of HV-convex polyominoes from the morphological skeleton and H-V projections. In this authors focused on the distinctiveness of the reconstruction of a H-V convex picture.

III. EXPERIMENTAL DESIGN

In this section some definition are given which explain the movement of chromosomes in Genetic programming process.

3.1 Adjacent cells and adjacent points

Any two cells (i,j) and (i',j') in X are said to be adjacent if either $i = i'$ and $|j - j'| = 1$ or $|i - i'| = 1$ and $j = j'$.

3.2 Adjacent points of binary image or connected image

If $f_{ij} = F(X(i,j))$ and $f_{i'j'} = F(X(i',j'))$ both have value 1 and cells (i,j) and (i',j') are adjacent then these points of binary image are said to be connected. If all the points of binary image F are connected then it is called connected image.

Figure 3.2: Connected binary image and not connected binary image

3.3 Boundary of a binary image

The binary image F says that it contains 1's at some cell (i, j) and 0's at other cells in discrete set X, here after by an image we will refer the cells having value of F as 1 i.e $F(X(i,j)) = f_{ij} = 1$ and the cell or point (I,j) of X will be said to be a point of binary image F, i.e. $f_{ij} = 1 \Longrightarrow (i,j) \in F$.

The set of all cells (points) (i, j) in F which separate 1's from 0's will be called the boundary of F, thus the boundary of F is represented as

$$B_F = \{(i,j) \in F : \exists\ adjacent\ point\ (i',j') \notin F\} \qquad (3.1)$$

In the similar manner boundary is defined in [202].

3.2 Boundary point

The element $(i,j) \in B_F$ will be called the boundary point. Thus boundary point can be defined alternatively: A point (cell) $(i,j) \in F$ will be called boundary point if at least one of following four properties is satisfied

(i) $f_{i-1,j} = 0\ or\ i = 1$
(ii) $f_{i,j-1} = 0\ or\ j = 1$
(iii) $f_{i+1,j} = 0\ or\ i = m$
(iv) $f_{i,j+1} = 0\ or\ i = n$

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Based on this alternative definition boundary points can be categorized in following categories:
If a boundary point satisfies only one property it will be called type 1 boundary point, if any boundary point satisfies any two properties only it will be called type 2 boundary points, if any boundary point satisfies any 3 properties only then it will be called type 3 boundary point. A boundary point satisfying all four properties will be an isolated point of image *F* and will be called type 4 boundary point.

Algorithm 1: Independent Pixel Block (IPB) Method based binary matrix recovery

Input: {Original Image, HV-Projections}
Output: {Regenerated output}

1. Perform the Projection data acquisition
2. Run the projection data using the initial solution
3. Produce the initial level solution
4. Apply the optimization over the initial solution matrix
5. Return the fixed matrix with optimized value
6. Run the iteration for each block of 3x3 in the overlapping manner
7. Perform the **Independent Pixel Block (IPB) Method over each 3x3 block matrix**
    a. Acquire the block (3x3) from the optimized image matrix
    b. Store the value of center pixel to Ci
    c. Check the matching pixels in the neighboring elements
    d. Return the density of the matching pixels
    e. If the matching pixels are observed higher than three
        i. Return the reconstructed binary matrix
    f. Otherwise
        i. Keep the current matrix
        ii. Go to next iteration
8. Compute the final results
9. Return the final matrix

IV. RESULT ANALYSIS

The proposed model results have been observed in the form of the various steps altogether. The proposed model has been analyzed to study the level of improvement in the reconstruction of the binary matrix data. The binary matrix data has been reconstructed using the hybrid solution in the proposed model, where the multi-layered architecture has been deployed on the work for the efficient recovery of the binary matrix from the projection data. The significant improvement has been recorded on all of the steps under the proposed model. The matrix recovery begins with the incorporation of the initial solution method, which helps to recreate the initial solution in the form of the binary image matrix, which is further processed using the high order optimization algorithm.

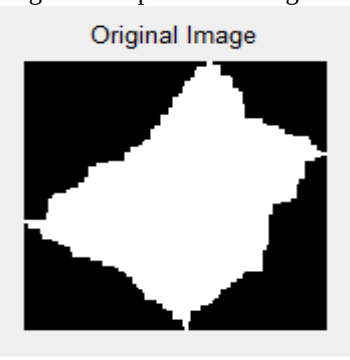

Figure 4.1 shows the Original Binary Image

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The figure 4.1 shows the Original Binary Image. The binary images are the 1-bit images which contain only two types of combinations or 1 and 0. This image is used for image reconstruction process.

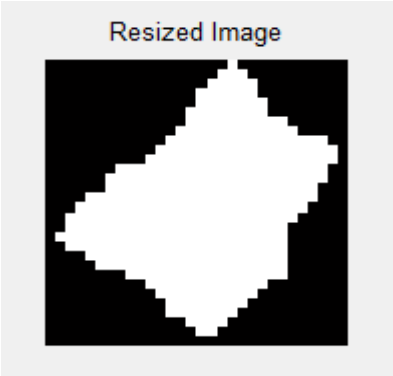

Figure 4.2 shows Resized image matrix

The Figure 4.2 shows Resized image matrix. It is resized for the quick response regeneration. This Figure 4.2 is resized from the original image and then it is used to obtained the initial solution. The chang's algorithm applied on figure 4.2 to obtained the initial solution projections which contained the horizontal, vertical and diagonal projections.

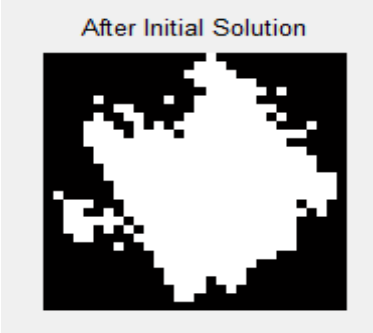

Figure 4.3 shows the Result obtained from the initial solution method

The Figure 4.3 shows the Result obtained from the initial solution method. The binary image reconstruction is based upon the initial solution which computes the initial combinations to satisfy the projection data. The projection data is utilized to recreate the projected binary image in the iterative context which runs the whole programs and computes the various combinations to recreate the initial image matrix. The matrix result obtained from the initial solution is then passed on to the genetic algorithm for the matrix optimization.

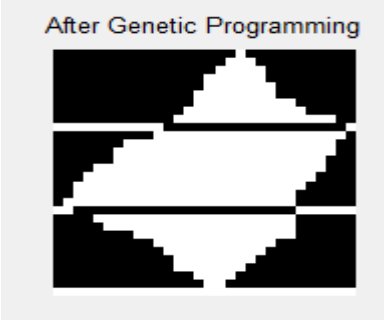

Figure 4.4 shows Response of image matrix regeneration after the optimization algorithm

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The Figure 4.4 shows Response of image matrix regeneration after the optimization algorithm. The GA is responsible for returning the optimal solution with best combination available according to the projection data.

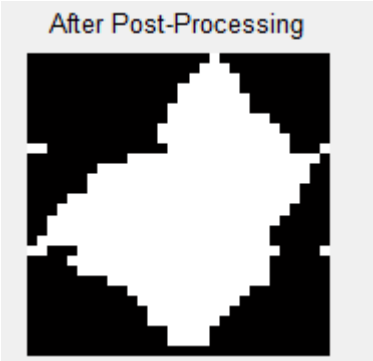

Figure 4.5 shows Independent Pixel Block (IPB) Method based binary matrix

The Figure 4.5 shows Independent Pixel Block (IPB) Method based binary matrix recovery. This shows the results obtained from the binary image matrix. This image shows the reconstructed image which is obtained from the original image after the application of the reconstruction solution.

METHOD	CHANGE IN PIXEL COUNT	PERCENTAGE OF CHANGE
Chang's Initial Solution	**128**	**14.22**
Genetic Programming	**90**	**10**
PROPOSED	**21**	**2.33**

The table 4.1 shows the results obtained from the proposed model

The table 4.1 shows the results obtained from the proposed model. It shows the significant recovery in the terms of percentage of change after the final reconstruction of the matrix, when applied on the binary image matrix.

As per the result evaluation of the proposed model, the matrix recovery shows the significant recovery in the terms of percentage of change after the final recreation of the matrix, when applied over the binary matrix size of 30x30 or 40x40. The proposed model has returned the stronger results for the efficient proposed binary matrix recovery model under out experimental evaluation section.

V. CONCLUSION AND FUTURE WORK

The proposed model is entirely based upon the multi-layered binary matrix recreation solution, which utilizes the various algorithms altogether for the recovery of the binary matrix. The proposed model has been incorporated the weight based matrix recovery mechanism, which works on the principle of neighboring density evaluation measured in the neighbors of similar type. If the quorum condition is not satisfied then the pixel value is switched to fix the matrix noise produced during the initial phase regeneration. The proposed model have posted the efficient results as per shown in the above figure. The proposed model has improved the binary image reconstruction accuracy by nearly 7.5%, which has been observed in the change from 10% to 2.33% approximately. The strong experimental evaluation of the proposed model have posted the significance of the proposed model in reproducing the binary matrix.

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Future Scope

In the future the proposed model can be improved for the time complexity and can be reproduced by designing the quick response genetic algorithm model. Also the better model than the genetic algorithm can be produced to improve the performance of the proposed image reconstruction method.

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