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# An Efficient Approach De-Interlacing Using Spatial Frequency Domain

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*Abstract*—**In this paper we have introduce about the Discrete Wavelets Transform (DWT) and interlace video and video frames, DWT techniques apply on interlace video capture frame. Make video from the interlace video to DWT de-Interlace video, from the capture video using the MATLAB Digital Camera API tool through the system. DWT work on the resolution as well as frequency, is use to compress data image different resolution will be obtained through the DWT techniques apply on image passing various filters.**

***Index Terms*—Discrete Wavelets Transform (DWT), Slicing, Average De-Interlacing, Motion Blur Filter.**

## I. Introduction

Wavelet is associate progressively widespread tool in image process and laptop vision. Several applications, like compression, detection, recognition, image retrieval are explored. Moving ridge remodel has nice options of space frequency localization and multi-resolutions. The most reasons for moving ridge transforms quality are its complete theoretical framework, the nice flexibility for selecting bases and therefore the low procedure quality (Bai-Ling Zhang 2004). Wavelets decompose complicated signals into sums of basic functions - during this respect they're kind of like alternative distinct image transforms. However, wavelets are native in each frequency and time and are able to analyze knowledge at completely different scales or resolutions far better than straightforward trigonometric function and circular function in (Milan Sonka 2001). There are 2 huge categories of moving ridge transforms, particularly continuous and distinct, however distinct transforms is redundant, orthogonal, or bi-orthogonal.

As a time-frequency scale transformation tool for knowledge, operate and operator, moving ridge remodel could be an excellent methodology for compression by that redundancies of the image are removed and original options of the image are reserved. Wavelets are functions that satisfy bound mathematical needs and are utilized in presenting knowledge or alternative functions, kind of like sines and cosines within the Fourier remodel.

The motivation behind moving ridge transformation is that human sensory system method pictures in a very multi-scale means that is comparable to moving ridge decomposition, consistent with the psychotic person visual analysis. The moving ridge reworked face pictures exhibit sturdy characteristics of abstraction neighborhood, scale, and orientation property. These pictures are able to turn out salient native options that are most fitted for face recognition, whereas cut back the computation quality.

Wavelets is enforced as a collection of filter banks comprising a high pass (wavelet) and a low-pass (scaling) filter, every followed by down-sampling of 2. The low-pass filtered and decimated output is recursively undergone similar filter banks to any cut back the dimension, which is additionally known as a multi resolution analysis.

In one dimensional remodel, sets of samples are rotten into low pass and high-pass samples. Low-pass samples represent a down sampled, low resolution version of the initial set. High-pass samples represent a down sampled residual version of the initial set.

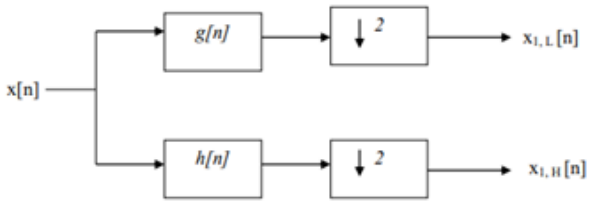


Fig. 1. The concept of discrete wavelet transforms

2D-DWT is that the extension of 1D-DWT by applying it 1st on the rows of image so on the columns. The implementation of 2 dimensional riffle remodels is disbursed by applying a one-dimensional remodel to the rows of the initial image knowledge and also the columns of the row reworked knowledge severally. riffle remodel performs multi resolution image analysis and also the g[n] h[n] a pair of a pair of x1, L [n] x1, H [n] x[n] twenty three transformation is completed by passing the image through a series of filter bank stages.

The two channel filter bank methodology parallel filters a sign (X) by the low pass filter H and high-pass filter G followed by down sampling. The filter H removes the high frequency info and keeps the low frequency info. The filter G removes the low frequency parts and retains the high ones. Repetition a similar steps for $X_l$ and $X_h$, we are able to decompose the image into completely different sub bands.

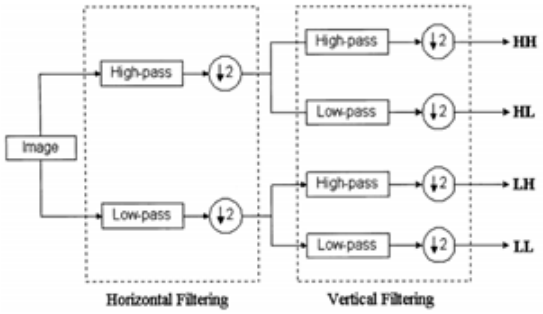


Fig. 2. 2D wavelet sub band representation

An image is first filtered within the horizontal direction. The high-pass filter and also the low-pass filter square measure finite impulse response filters i.e. the output at every purpose depends solely on a finite position of the input. The filtered outputs square measure then down sampled by an element of two in horizontal direction. This merely means each second row of the ensuing image is unbroken. These signals square measure then every filtered by a standardized filter try within the vertical direction and down sampled by an element of two once more. The ultimate result's a decomposition of the image into four sub bands. Associate degree approximation sub band LL and details sub bands – LH, HL and HH. In compression situations, one would discard most or all of the hectoliter, HL, LH and HH details and proceed to the second decomposition solely exploitation the LL sub band as input. The DWT is a twin of a hierarchic sub band system wherever the sub bands square measure logarithmically spaced in frequency and represent octave-band decomposition. By applying DWT, the image is truly rotten into four sub bands and critically sub sampled as shown in Figure.

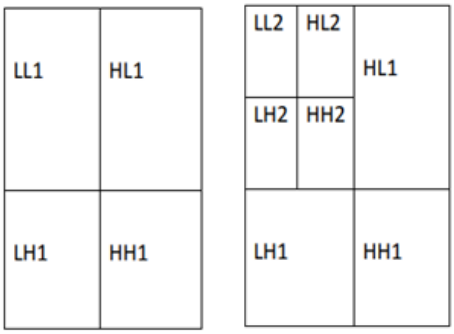


Fig. 3. Image decomposition

When we use the second separate ripple remodel in a picture, we are going to acquire four a part of output, that the dimensions of every half are one fourth of the first size. Figure illustrates the output of image processed by second separate ripple remodel.

De-interlacing is that the method of changing latticed video, like common analog TV signals or 1080i format high-definition television signals, into a non-interlaced type. Associate in Nursing latticed video frame consists of 2 sub-fields taken in sequence, every consecutive scanned at odd, so even, lines of the image sensing element.

Fig. 4. Original image

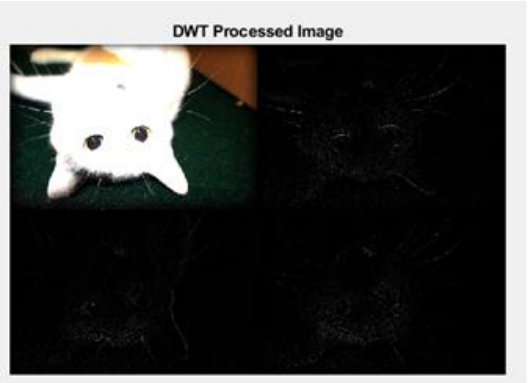


Fig. 5. DWT processed image

Fig. 6. Interlace image

De-interlacing comes in as a mechanism to get rid of or reduce the maximum amount interlocking artifacts as doable whereas combining 2 fields into a frame. As interlocking artifacts are removed, visual quality of video is improved considerably. While removing interlocking artifacts, de-interlacing shouldn't change or destroyed the underlying original contents of video [8].

Many de-interlacing algorithms are planned in literature. They're broadly speaking classified into non-motion compensated and motion remunerated algorithms. Non motion compensated algorithms don't perform advanced motion compensation method. They suppose abstraction or temporal

correlations among pixels to interpolate missing pixels for de-interlacing method. Abstraction interpolation is healthier for dynamic scenes whereas temporal interpolation is additional suitable for static scenes. Some algorithms embrace motion detection method to change between abstraction and temporal de-interlacing. The opposite de-interlacing approach is to interpolate on the foremost correlate edge directions spatially or temporally. Motion-compensated algorithms perform de-interlacing by interpolating on the foremost correlated motion flight. Therefore, they will yield higher de-interlacing results. However they have computationally advanced motion compensation method among fields.

Because H.264/AVC may be a standard video compression commonplace, developing associate economical de-interlacing technique specially or H.264-coded reticulated video sequences has become associate important issue. Though we are able to rewrite associate H.264 bit stream into a reconstructed reticulated video sequence, and so apply the existing de-interlacing strategies to the reconstructed interlaced video sequence, some necessary data in H.264 bit streams, e.g., motion vectors (MVs) and therefore the residual of a block, would be unheeded. Thus, Dong and Ngan's projected the primary de-interlacing technique for H.264-coded video sequences with full high-definition (HD) resolution. Their technique with efficiency used the syntax parts (SEs), such as MVs, intra predictors, and block sizes, in H.264 bit streams to assist within the style of the de-interlacing method, resulting in sensible quality of de-interlaced video sequences. However, Dong and Ngan's technique is specifically designed for the video sequences with full HD resolution, the standard degradation downside might happen once directly applying their technique to the video sequences with lower resolutions. Usually, these lower resolution video sequences, including common international format (CIF), quarter CIF (QCIF), standard-definition (SD), so forth, and square measure usually employed in real applications. As a result, de-interlacing for H.264-coded videos with totally different resolutions is essentially to be thought-about, leading to the most motivation of this analysis.

This paper presents a unique syntax-based de-interlacing method for H.264-coded video sequences [7] with totally different resolutions. In our projected technique, victimization the SEs within the H.264 bit streams, 2 new methods square measure delivered to improve the quality of de-interlaced video sequences. The primary strategy is based on the intra mode to boost the standard of the regions with inclined edges. The second strategy relies on the repose mode to refine the de-interlaced video quality additionally as alleviate the error propagation facet result. By experimenting on standard take a look at video sequences with CIF, QCIF, SD, and full HD resolutions, the results demonstrate the projected de-interlacing technique delivers higher quality of de-interlaced video sequences than Dong and Ngan's technique.

## II. Literature Review

A rippling may be a wave like oscillation with amplitude that starts out at zero, increases, and then decreases back to zero. Wavelets are combined, employing a "reverse, shift, multiply and sum" technique known as convolution, to sight discontinuities in a very signal. Rippling remodel domain has gained variant importance with the topic to grasp, in part, the keenness of its proponent's toward its potential application to varied numerical issues. what is more its properties like sensible localization in time and frequency, simplicity, and easy construction and characterization, invariability below sure elementary operations like translation, smoothness, continuity and differentiability and sensible moment properties, zero moments up to some order. A comprehensive review of literature on numerous problems associated with fingerprint image authentication, image steganography, compression, edge detection techniques and for determination problems like police investigation are presented. We have a tendency to discuss here numerous varieties of wavelets which has separate rippling remodel, Continuous rippling remodel (CoWT), Complex rippling remodel (ℂWT) halfway rippling remodel (FrWT), halfway Random rippling remodel (FrRnWT), dirigible rippling remodel (StWT), Quaternion rippling remodel and Quincunx rippling remodel [1].

The implementations before rising of CUDA, DWT were used over range of devices and totally different programming languages based mostly upon GPU as hardware. The implementation projected in, was supported OpenGL that introduced a decomposition of rippling and reconstruction algorithmic rule that directly works on the graphics hardware of OpenGL [2] capable workstations and accelerates the time intense filtering steps ends up in saving the time. This specific approach has used the convolution and color matrix extensions beside OpenGL's facilities to scale pictures throughout copy instructions; they performed all necessary steps of 2nd tensor product rippling filtering while not repetition knowledge from or to the machines main memory, therefore succeeded in avoiding typical bottlenecks that may occur within the visual image cycle. Open Graphics Library (OpenGL) may be a cross language, cross-platform application programming interface (API) to render 2nd and 3D vector graphics. The API is often accustomed engage with a graphics process unit (GP GPU), to realize quicker graphics rendering. Variant these earliest ways were focused on convolution based mostly operations.

DWT was evaluated for the DWT was evaluated for the primary time mistreatment lifting theme. They are incontestable a straightforward however powerful and price effective resolution to implement 2-D DWT on the patron level GPU. No tailor created therein and no overpriced DWT hardware is required to realize such performance. They need shown that 2-D DWT is enforced on any SIMD-based GPU comes with traditional configuration of PCs. This methodology unifies the mathematically-different forward and inverse DWT. totally different rippling filter kernels and boundary extension schemes

area unit incorporated by modifying the filter kernel values and indirect address table severally. Incontestable 2D-DWT is relevance in wavelet-based geometric deformation, artificial image process, texture brightness decoupling, and JPEG2000 secret writing. Although the convolution based mostly approach was widespread antecedently because the lifting theme needs intermediate values to be shared among coefficients. Tools were unavailable to implement lifting theme with efficiency within the past. That was confirmed in by experimentation, during which each the convolution and also the lifting approach were enforced and compared for the performance along.

The paper presents chosen ways and algorithms associated with signal and image decomposition and reconstruction mistreatment rippling remodel initially. Ways of rippling decomposition area unit then used for signal de-noising and recovery of their corrupted elements mistreatment chosen threshold limits. These ways were developed and verified for simulated one dimensional and two-dimensional signal with additive noise parts then applied to process of real medical specialty pictures of human brain obtained by the resonance methodology. All ensuing algorithms area unit verified within the process and visual image MATLAB setting providing tools for remote signal process mistreatment MATLAB internet server.

Signal rippling decomposition by rippling remodel (WT) provides another to the separate Fourier remodel (DFT) for signal analysis permitting decomposition into two-dimensional functions of your time and scale [3]. The most advantage of WT over DFT is in its multi-resolution time-scale analysis ability. Rippling performs used for signal analysis area unit derived from the initial function W(t) forming basis for the set of functions.

$$W_{m,k}\ (t) = \frac{1}{\sqrt{a}} W\left(\frac{1}{a}\ (t-b)\right) = \frac{1}{\sqrt{2^m}} W\ (2^{-m}\ t - k) \quad (1)$$

For discrete parameters of dilation a = $2^m$ and translation b = k $2^m$. Wavelet dilation, which is closely related to spectrum compression, enables local and global signal analysis.

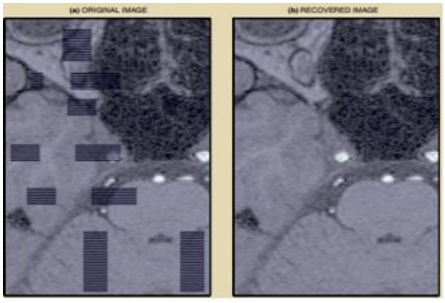


Fig. 7. Recovery of a real biomedical image of the brain presenting (a) given corrupted image and (b) recovered image

Video police investigation has received tons of attention as a helpful technology for crime deterrence and investigations, and has been wide deployed in several circumstances like airports, convenience stores, and banks. Video police investigation permits U.S.A. to remotely monitor a live or recorded video feed which frequently includes objects like individuals. Though video police investigation contributes to realizing a secure and safe community, it conjointly exposes the privacy of the item within the video. Therefore, it's fascinating to style a closed-circuit television with a balance between security and privacy fitly. Over the past few years, many techniques on privacy protection in video closed-circuit television are planned [4]. Newton et al. planned associate algorithmic program to shield the privacy of the people in video police investigation information by de-identifying faces specified several facial characteristics stay however the face cannot be dependably recognized. Kitahara planned a video capturing system referred to as "Stealth Vision," that protects the privacy of the objects by blurring or pixelizing their pictures. However, each strategy defends solely the faces of objects, and alternative elements of the objects aren't protected. What is more, privacy data of the initial pictures is lost once these strategies area unit applied. Wickramasuriya defend object's privacy supported the authority of either object or viewers. Though this method fulfils some needs of privacy protection, it conjointly features a potential security flaw as a result of it doesn't keep record of the initial privacy data. Zhang planned a technique for storing original privacy data in video exploitation data activity. It will recover the initial privacy data if necessary. However, the strategy has the downside that the massive quantity of the privacy data should be embedded to recover the initial image since the privacy data is obtained from the complete data of the item regions. Though all the privacy data may well be embedded into the video by exploitation information compression technique, the planned algorithmic program doesn't perform in real time. During this paper, we tend to propose a distinct ripple rework (DWT) based mostly recoverable image process for privacy protection, that scale backs the privacy data of the item considerably, and thus, all the initial privacy data is embedded into the police investigation video in real time.

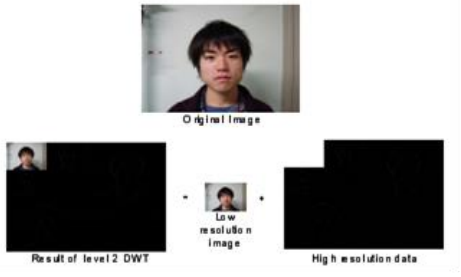


Fig. 8. Result of level 2 DWT

Image resolution sweetening within the moving ridge domain may be a comparatively new analysis topic and recently several new algorithms are projected. Distinct moving ridge remodel (DWT) [5] is one among the recent moving ridge

transforms employed in image process. DWT decomposes a picture into completely different sub band pictures, specifically low-low (LL), low high (LH), poker (HL), and high-high (HH). Another recent moving ridge remodel that has been employed in many image process applications is stationary moving ridge remodel (SWT). In short, SWT is comparable to DWT however it doesn't use down-sampling, thus the sub bands can have an equivalent size because the input image. During this work, we tend to square measure proposing a picture resolution sweetening technique that generates deceiver high resolution image. The projected technique uses DWT to decompose an occasional resolution image into completely different sub bands. Then the 3 high frequency sub band pictures are interpolated mistreatment bi-cubic interpolation. The high frequency sub bands obtained by SWT of the input image square measure being incremented into the interpolated high frequency sub-bands so as to correct the calculable coefficients. In parallel, the input image is additionally interpolated singly. Finally, corrected interpolated high frequency sub-bands and interpolated input image square measure combined by mistreatment inverse DWTT (IDWT) to realize a high resolution output image. The projected technique has been compared with typical and state-of-art image resolution sweetening techniques.

One level DWT (with Daubechies 9/7 as moving ridge function) is employed to decompose associate degree input image into completely different sub-band pictures. 3 high frequency sub-bands (LH, HL, and HH) contain the high frequency parts of the input image. Within the projected technique, bi-cubic interpolation with enlargement issue of two is applied to high frequency sub-band pictures. Down sampling in every of the DWT sub-bands causes data loss within the several sub-bands. That's why SWT is utilized to attenuate this loss. The interpolated high frequency sub-bands and therefore the SWT high frequency sub-bands have an equivalent size which suggests they'll be additional with one another. The new corrected high frequency sub-bands is interpolated more for higher enlargement. Conjointly it's famed that within the moving ridge domain, the low resolution image is obtained by y low pass filtering of the high resolution image. In alternative words, low frequency sub-band is that the low resolution of the initial image. Therefore, rather than mistreatment low frequency sub-band, that contains less data than the initial high resolution image, we tend to square measure mistreatment the input image for the interpolation of low frequency sub-band image. Mistreatment input image rather than low frequency sub-band will increase the standard of the super resolved image.

Although interlocking pattern was adopted for analog television within the past, permitting less transmission bandwidth and decreasing the perceived flicker on gas discharge tube screens, it still survives presently. For contemporary digital video transmission in "Full-HD" resolution format (1920 x 1080), some TV broadcasting standards (like ATSC A/53, half 4:2009 [2]) ponder solely in

Interlaced fields scan to cut back information measure. Thus, it is mandatory to perform the conversion method to use progressive commonplace.

This work proposes a method to mix the qualities of intra-field and inter-field de-interlacing techniques supported a feather impact detector, producing frames with higher overall quality than by using a single de-interlacing method. The main contributions are: a technique to spot wherever the defects square measure and objective criteria to make a decision once the correction brings quality enhancements to the ultimate de-interlaced frame.

In this work, solely 2 de-interlacing processes have been considered: terrorist organization and inter-field average, as described by Bellers & Haan. The terrorist organization technique presents excellent performance within the presence of motion, however it method all frame indiscriminately, whether feather is gift or not. On image areas without motion, the applying of terrorist organization produces blurring, that decreases image quality, in terms of Peak ratio (PSNR). Blurring is produced as a result of terrorist organization is actually AN intra-field de-interlacing method supported constituent intensity directional average. On the opposite hand, it had been known throughout this development that straightforward inter-field average technique is able to manufacture terribly prime quality frames once there's no motion or low-level motion within the scene.

ELA technique presents frames with prime quality, and so is that the behavior of quality analysis for many of the frames throughout all video long. Yet, if the complete video is analyzed frame by frame, it's potential to verify an interesting behavior of PSNR [6]. Once many tests of applying de-interlacing algorithms on video files, it revealed that straightforward inter-field average technique is in a position to produce, often, frames with higher quality than the a lot of complicated techniques, particularly once low level of motion is gift on the scene. On straightforward interfiled average, as represented by Bellers & Haan, the estimated lines square measure straightforward average between pixels intensities from even and odd fields.

At the STB, the decoded lattice likes video with 1080i Full HD Format is de-interlaced to the 1080p Full HD [9] format by the proposed edge-directed interpolation methodology. Three illustrates the used de-interlacing theme. The de-interlacing process solely uses three-line buffer, and therefore the spatial domain based edge-oriented detector classifies de-interlaced pixels into 5 edge directions, that tend to the graceful, vertical, horizontal, close to horizontal (i.e. oblique), et al. modes. Then the corresponding interpolation methodology is chosen to de-interlace the pixels by the chosen edge direction.

In the stage, first of all the 1080p video is resized to 3840x2160 pixels by the pre-mapping operation. Secondly, the projected median 6-point edge-directed interpolation (i.e. median EDI) is employed to get the 3840x2160i video.

## III. Proposed Methodology

### A. Slicing Algorithm

#### 1) Odd Row Slicing

In the Odd Slicing method the row of odd number will be eliminate from the matrix for example we have 1080*960 matrix through the odd row slicing method the row of 1,3,5,7… are eliminated from the matrix and matrix will be 540*960 dimensional.

#### 2) Odd Column Slicing

Through the odd Colum Slicing from a matrix the odd number of column are eliminated. We have 1080*960 dimensional matrix odd column slicing the odd number of column for example column number 1,3,5,7…. Are eliminated and matrix will be 1080*480.

#### 3) Even Row Slicing

Even Row slicing method eliminate even number of rows from the matrix for example 1080*960 matrix we have even number of rows 2,4,6,8…. Are removed and matrix will be 540*960 dimensional.

#### 4) Even Column Slicing

In the Even column the even number of column of a matrix will be remove for example the1080*960 matrix we use the even number of column 2,4,6,8… are eliminated and matrix will be 1080*480.

### B. DWT Algorithm

Discrete wavelet transform is a technique through which wavelets are transformed in the discretely sampled. Through the DWT capture both the frequency and location at the time and the resolution is not temporal.

$$X_k = \frac{1}{2}\, x_0 + \sum_{n=1}^{N-1} x_n \cos\left[\frac{\pi}{N} n \left(k + \frac{1}{2}\right)\right] \quad (2)$$

$$k = 0, \ldots\ldots, N-1$$


Fig. 9. DWT apply on image

Using DWT it is possible to filter the interlace frame in frequency sub bands which can help in reducing interlace components of the interlace frame. DWT reduces the frame size to the quarter of origin of frame size but enhances sharpness of interlace video frame.

### C. Motion Blur Filter

Motion Blur is the appearances striking of moving object as like Image, Frame, film or animation. Using of blur filter we can simulate the real world blurring that occur due to the depth of field in image material.

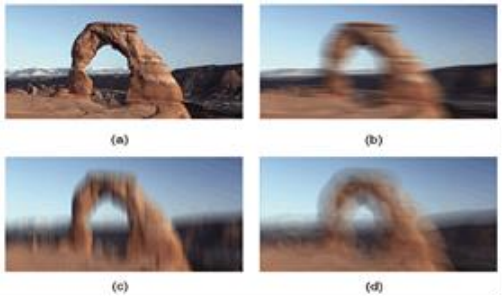


Fig. 10. Motion blur image

Sometimes interlacing can be caused due to camera defects or due to high speed random motion of an object/subject to overcome such natural defects motion blur filter can be used for removing interlacing effects.

Median filter equation is:

$$\hat{f}(x,y) = median_{(s,t)\epsilon S_{xy}} \quad (3)$$

### D. Average De-Interlacing Algorithm

#### 1) Row Average

Through the average algorithm took average of a matrix row value and the column value. In the matrix 1080*960 that we use took average of row 1, 2 and 3,4 and so on… after applying the row average matrix dimensional will be 540*960.

#### 2) Column Average

In the column average method average of two consecutive columns will be taken for example matrix of 1080*960 dimensional using apply column average column number 1,2 and 3,4…..Average calculates the new matrix will be 1080*480 dimensional.

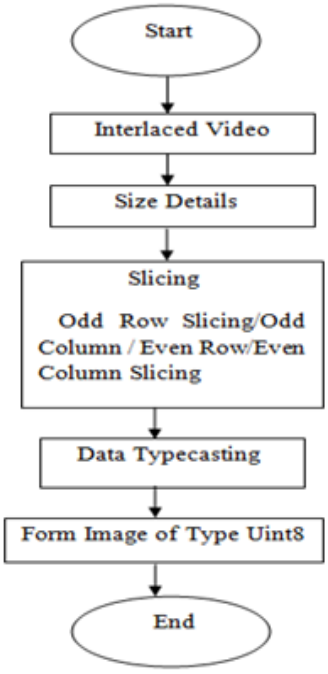


Fig. 11. Flow chart of propose methodology

## IV. Results

PSNR (Peak Signal Noise Ratio) block computes the height signal-to-noise ratio, in decibels, between two pictures. This magnitude relation is commonly used as a quality measurement between the first and a compressed or reconstructed image. The higher PSNR gives the better quality of the compressed or reconstructed image. PSNR represents a live of the height error.

The Mean Square Error (MSE) is that the two error metrics accustomed compare compression quality. The MSE represents the accumulative square error between the compressed and also the original image.

Root Mean Square Error (RMSE) is that the variance of the residuals (prediction errors). Residuals are a measure of how far from the regression line data points are; RMSE could be a measure of however unfolded these residuals are.

The Structural Similarity Index (SSIM) could be a sensory activity metric that quantifies image quality degradation caused by process like knowledge compression or by losses in data transmission. It is a full reference metric that needs two pictures from the same image capture—a reference image and a processed image.

TABLE I
Results

| | PSNR | MSE | SSIM | RMSE |
|---|---|---|---|---|
| ORS | 40.2484 | 2.3762 | 0.9914 | 1.5415 |
| OCS | 29.1291 | 13.1053 | 0.9651 | 3.6201 |
| ERS | 40.2323 | 2.5194 | 0.9913 | 1.5873 |
| ECS | 29.1284 | 4.5566 | 0.9630 | 2.1346 |
| Motion Deblurring | 28.4816 | 234.1867 | 0.8964 | 3.4101 |
| DWT | 9.1325 | 0.1606 | 0.7291 | 15.3032 |
| Avg. Row | 18.1247 | 0.1606 | 0.9050 | 0.4007 |
| Avg. Col | 18.3075 | 0.1632 | 0.9268 | 0.4040 |

## V. Conclusion

In this paper eight algorithms have been studied to de-interlace video in frequency and special domain. Methods that have been used a row and column slicing, average of row and column merging and in frequency domain DWT has been implemented over interlace frame. Numerical analysis results show that average combination of row and column provides the best quality frame over others.

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