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A Novel Approach For Super-Resolution Reconstruction of Video Sequences

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Abstract: Video quality plays important role in many fields like engineering, medical field as well as in social areas. There are many problems are occurs in video quality likes sharpening, pixel quality, visual effect, color enhancement, color intensity etc. Super-resolution technique is used for enhance the resolution of real-time video clips. In order to improve the video quality, Super-Resolution reconstruction (SR) method is applied to restore a high-resolution image from consecutive frames in the video sequence. The proposed system based on fusion process, edge detection, dilation, super-resolution technique. The proposed system is implemented based on SIMULINK software. Compare resize video like (Interpolation method like Nearest Neighbor output) and SR video output like Bilinear or Bi-cubic SR method by observing Bit Error Rate (BER), PSNR, SSIM, MSE and frame rate calculations. They convert Low-Resolution (LR) video to High-Resolution (HR) flexible video like de-noising, sharpening, color corrections, pixel. In this proposed work, SR is applied for better video quality.

Keywords: Video super-resolution; Image fusion process; frames; resize;

I. INTRODUCTION

Video quality plays important role in many fields like engineering, social areas as well as in medical researchers and companies. Video super-resolution is technology that enhances or improvement the resolution of the video system. Super-resolution technique convert low-resolution video to the high- resolution of flexible video editing like de-noising, color correction, sharpening, visual effects, pixels etc. The Super-Resolution (SR) is a technique for generating a higher resolution image from several number of low resolution images. The pixel density will be high in high resolution images and we get more details about the original images. Super-Resolution combines non redundant data in the low resolution images (LR) and generate high resolution image. Video SR techniques can also help video coding and decoding, video surveillance systems, remote sensing systems, intelligent robotic system, video enhancement and restoration, video standard conversion, microscopy, face recognition, medical image analysis and stereoscopic video processing. Super-resolution technique is mostly used in astronomy and microscope. For detail information of original video frame with increase pixel density, edge sharpness, brightness, color enhancement, increase the intensity etc.

II. RELATED WORK

In this paper the important problem is to understand the fundamental concepts of various filters and apply these filters in identifying a shark fish type which is taken as a case study. In this paper the edge detection techniques are taken for consideration. The software is implemented using MATLAB. The main two operators in image processing are Gradient and Laplacian operators. The case study deals with observation of Shark Fish Classification through Image Processing using the various filters which are mainly gradient based Roberts, Sobel and Prewitt edge detection operators, Laplacian based edge detector and Canny edge detector. The advantages and disadvantages of these filters are comprehensively dealt in this study.[1] Super-Resolution reconstruction produces a higher resolution image based on a set of low resolution images, taken from the same scene. Recently, many papers have been published, proposing a variety of algorithms of video super resolution. This paper presents a new approach to video super resolution, based on sparse coding and belief propagation. First, find the candidate pixels on multiple frames using sparse coding and belief propagation. Second, exploit the similarities of candidate pixels using the Non-local Means method to average out the noise among similar patches.[2] In this paper introduced the problem of reconstructing a super-resolution image sequence from a given low resolution sequence. Two iterative algorithms, the R-SD and the R-LMS, to generate the desired image sequence. These algorithms assume the knowledge of the blur, the down-sampling, the sequences motion, and the measurements noise characteristics, and apply a sequential reconstruction process. It has been shown that the computational complexity of these two algorithms makes both of them practically applicable. In this paper,

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rederive these algorithms as approximations of the Kalman filter and then carry out a thorough analysis of their performance. For each algorithm, calculate a bound on its deviation from the Kalman filter performance, also show that the propagated information matrix within the R-SD algorithm remains sparse in time, thus ensuring the applicability of this algorithm.[3] To determine the interpolation function that gives the most visually appealing images, a comparison of common kernels is made. Linear, cubic, and windowed sinc functions are compared in terms of frequency response and with prints of images resized using separable extensions of these functions. Cubic interpolation is shown to provide the best compromise between image sharpness and these edge artifacts. For image rotation, and resizing by an arbitrary factor, the filter coefficients (samples of the interpolation function) need to be computed for each pixel of the new image. Alternatively, significant computation can be saved by dividing the distance between pixels of the original image into a number of intervals and pre-computing a set of coefficients for each interval. Each new pixel is then computed by finding the interval in which it falls and using the corresponding set of coefficients. An analysis of the errors introduced with this resampling method is presented. This analysis shows the number of intervals required to produce high-quality resampled images.[4] Image Fusion is a process of combining the relevant information from a set of images into a single image, where the resultant fused image will be more informative and complete than any of the input images. Image fusion techniques can improve the quality and increase the application of these data. This paper presents a literature review on some of the image fusion techniques for image fusion like, primitive fusion (Averaging Method, Select Maximum, and Select Minimum), Discrete Wavelet transform based fusion, Principal component analysis (PCA) based fusion etc. Comparison of all the techniques concludes the better approach. [5]

III. PROPOSED METHODOLOGY

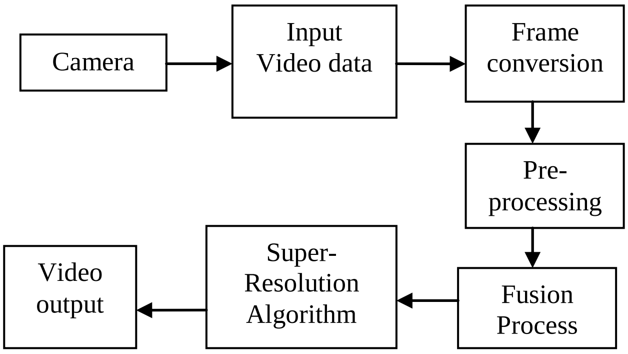

Fig.1 Block diagram of proposed system

The proposed system based on Super-Resolution and fusion process. Video input data from different devices like USB2.0 PC camera, Webcam and multimedia file then conversion of video into frames. This video format is 640X480 pixels. Then apply down resize process upto 25%. This is the input of super-resolution algorithm. One goes to simply resize (upto 400 means 640x480) which is direct method based on interpolation method like nearest neighbor interpolation method and second goes to proposed system. The down resizing output is input of masking process of high/low frequency component and to color space conversion. In color space conversion converts color information between color spaces. The conversion from R’G’B’ to intensity means convert gray level image. Edge detection is an image processing technique for finding the boundaries of objects within images. It works by detecting discontinuities in brightness. Edge detection is used for image segmentation and data extraction in areas such as image processing, computer vision, and machine vision. The edge detection process for the system only visible part or edge is required hence, Prewitt edge operator is used. Perform morphological dilation on an intensity or binary image. The dilation operation usually uses a structuring element for probing and expanding the shapes contained in the input image. In this process black spot or area darker so edge of the given part more visible and clear. In masking process of low and high frequency component one masking image given to product and another input from mask which is three copy of mask plane concatenate by matrix. The output of product is masked image. In gamma correction process increases the color intensity. It is applied on high frequency component. Here we fused two images having process parallely for Edge region process for better visibility using Prewitt Edge detect and Dilation, fuse them with the low frequency component at add step. The output of adding block is input of bilinear/bi-cubic resize block and bilinear/ bi-cubic resize is the interpolation method of super-resolution process. In this resizing, image is 640x280 pixels in original format and resizes up-to 400 of input image like 160x120 pixels. In this process, super-resolution of video frames are using bilinear or bi-cubic algorithm. After the super-resolution process video is save in multimedia file like AVI format. In this process observe the bit error rate, PSNR, SSIM, MSE value of proposed system and resize video output (Nearest neighbor interpolation).

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B. Flow Chart

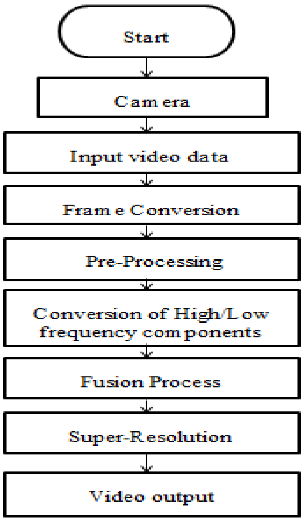


Fig.2 Flow chart of proposed system

Step 1: Video input data from USB 2.0 PC camera or Webcam or multimedia file. This video convert into frame, size is 640x480 pixels. Resize the video upto 25% (160x120) this is the input for proposed algorithm. One is goes to direct resize (Nearest neighbor interpolation) and second is goes to proposed system.

Step 2: Pre-possessing step include color space conversion, edge detection, dilation, gamma correction. In color space conversion, convert RGB to intensity (convert gray level images). Then applied edge detection process for the system only visible part or edge is required hence, Prewitt edge operator is used. After that process gives high frequency component. In dilation process black spot or area darker so edge of the given part more visible and clear.

Step 3: NOT operator is used for conversion of high frequency component to low frequency component then masking operation of low and high frequency component. Gamma correction is applied on high frequency component for increase the color intensity.

Step 4: In this process here we fused two images having process parallely for edge region process for better visibility using Prewitt Edge detect and Dilation fuse them with the low frequency component at add step.

Step 5: In this process Bi-linear interpolation or bi-cubic interpolation algorithm is used then output will be saving in multimedia file like AVI format. Calculate BER, PSNR, SSIM and MSE of nearest neighbor interpolation and proposed system. Also calculate frame rate of system.

IV. RESULTS

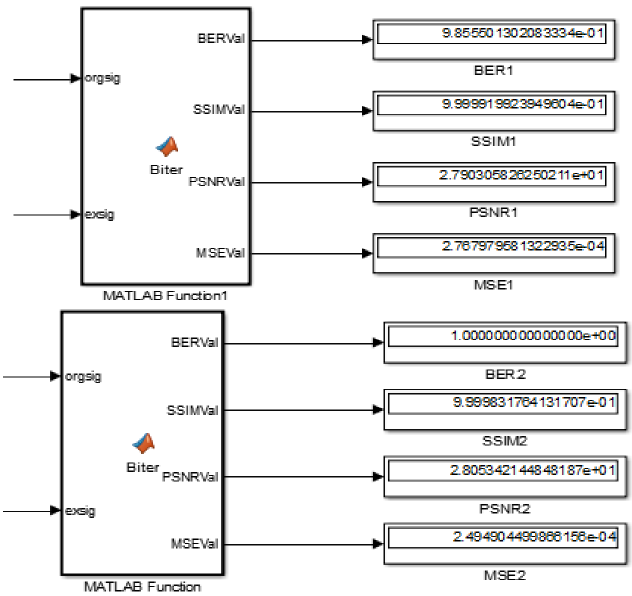


Fig. 3 BER, PSNR, SSIM and MSE display for (a) resize video and (b) SR output

The proposed method is taken from different type of input video device like USB2.0 PC CAMERA, Webcam and Multimedia file (AVI). Calculate the BER, PSNR, SSIM and MSE for comparison between resize video (Nearest neighbor interpolation) and proposed SR system. In this system used Bi-linear and Bi-cubic interpolation method. Input Video having the frame width is 640 and frame height is 480. Length of video is 10 sec. Data rate of video is 222100kbps and total bitrate is also 222100 kbps. Frame rate of video is 30frames/second.

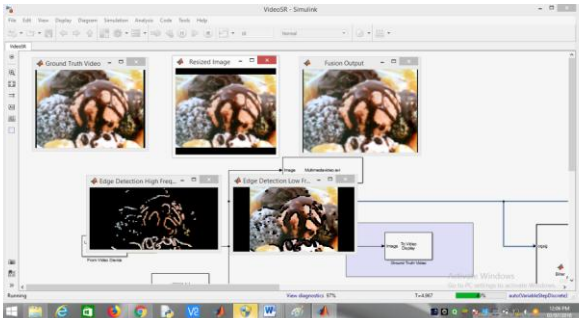
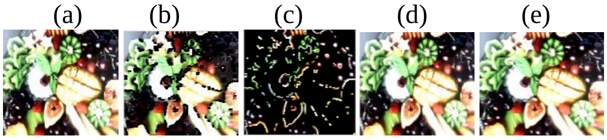


Fig. 4 Output window display (a) Ground truth video (b) Resize video output (c) SR output (d) Edge detection of high frequency (e) Edge detection of low frequency

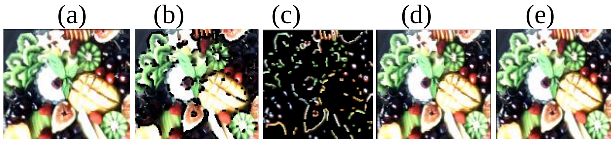
(a) (b) (c) (d) (e)



(a') (b') (c') (d') (e')

Fig. 5 Reconstruction of video sequences by USB2.0 PC camera. (a a') Ground truth video; (b b') Edge detection of low frequency; (c c') Edge detection of high frequency; (d d') Resize video (Nearest neighbor) (e e') SR output(Bi-linear)

(a) (b) (c) (d) (e)



(a') (b') (c') (d') (e')

Fig. 6 Reconstruction of video sequences by USB2.0 PC camera. (a a') Ground truth video; (b b') Edge detection of low frequency; (c c') Edge detection of high frequency; (d d') Resize video (Nearest neighbor) (e e') SR output(Bi-cubic)

Table I: Comparison Of Resize Video (Nearest Neighbor) From Usb2.0 Pc Camera With Sr Output Of (A) Word (A') Fruits

Resize video &SR output	Frame Rate	Bit error rate(BER)	Peak signal to noise ratio (PSNR) (dB)	Structural Similarity (SSIM) (dB)	Mean square error(MSE)
Nearest neighbor & Bi-linear	0.6672	Resize video-0.89 SR output-0.96	Resize video-24.97 SR output-25.43	Resize video-0.99 SR output-0.99	Resize video-0.00206 SR output-0.00149
	0.6713	Resize video-0.80 SR output-0.88	Resize video-24.84 SR output-25.67	Resize video-0.99 SR output-0.99	Resize video-0.0063 SR output-0.0046
Nearest neighbor & Bi-cubic	0.3979	Resize video-0.92 SR output-0.99	Resize video-25.09 SR output-26.02	Resize video-0.99 SR output-0.99	Resize video-0.00193 SR output-0.00101
	0.53081	Resize video-0.86 SR output-0.96	Resize video-25.49 SR output-26.60	Resize video-0.99 SR output-0.99	Resize video-0.0075 SR output-0.4905

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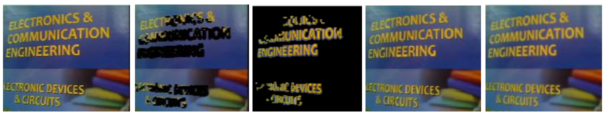
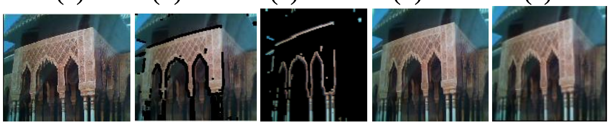


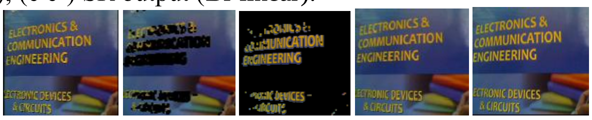
(a) (b) (c) (d) (e)



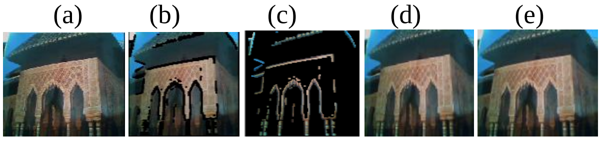
(a’) (b’) (c’) (d’) (e’)

Fig.7 Reconstruction of video sequences by Webcam.

(a a’) Ground truth video; (b b’) Edge detection of low frequency; (c c’) Edge detection of high frequency; (d d’) Resize video (Nearest neighbor); (e e’) SR output (Bi-linear).



(a) (b) (c) (d) (e)



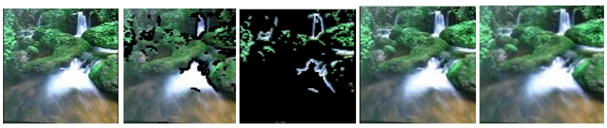
(a’) (b’) (c’) (d’) (e’)

Fig.8 Reconstruction of video sequences by Webcam.

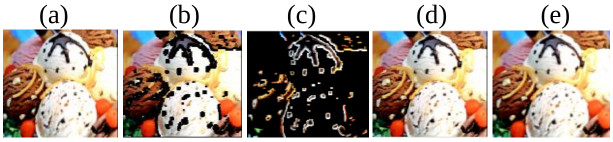
(a a’) Ground truth video; (b b’) Edge detection of low frequency; (c c’) Edge detection of high frequency; (d d’) Resize video (Nearest neighbor); (e e’) SR output (Bi-cubic).

TABLE II: Comparison of resize video (nearest neighbor) from Webcam camera with SR output of (a) Book (a’) Palace

Resize video &SR output	Frame rate	Bit error rate(BER)	Peak signal to noise ratio (PSNR) (dB)	Structural Similarity (SSIM) (dB)	Mean square error(MSE)
Nearest neighbor & Bi-linear	0.41592	Resize video-0.988 SR output-0.999	Resize video-24.42 SR output-25.65	Resize video-0.99 SR output-0.999	Resize video-0.0024 SR output-0.00199
	0.3833	Resize video-0.993 SR output-0.999	Resize video-25.70 SR output-26.32	Resize video-0.99 SR output-0.999	Resize video-0.0021 SR output-0.0020
Nearest neighbor & Bi-cubic	0.46331	Resize video-0.988 SR output-0.999	Resize video-25.70 SR output-26.32	Resize video-0.99 SR output-0.999	Resize video-0.0025 SR output-0.00169
	0.37255	Resize video-0.989 SR output-0.999	Resize video-26.72 SR output-27.36	Resize video-0.99 SR output-0.999	Resize video-0.0020 SR output-0.00176



(a) (b) (c) (d) (e)



(a’) (b’) (c’) (d’) (e’)

Fig.9 Reconstruction of video sequences by Multimedia files. (a a’) Ground truth video; (b b’) Edge detection of low frequency; (c c’) Edge detection of high frequency; (d d’) Resize video (Nearest neighbor); (e e’) SR output (Bi-linear).

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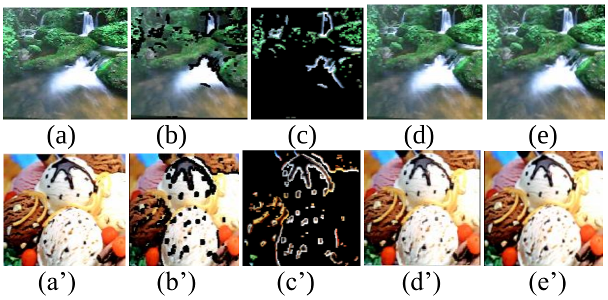

Fig.10 Reconstruction of video sequences by Multimedia files. (a a') Ground truth video; (b b') Edge detection of low frequency; (c c') Edge detection of high frequency; (d d') Resize video (Nearest neighbor); (e e') SR output (Bi-cubic).

TABLE III: Comparison of resize video (nearest neighbor) from Multimedia files with SR output
(a) Nature (a') Ice-cream

Resize video &SR output	Frame rate	Bit error rate(BER)	Peak signal to noise ratio (PSNR) (dB)	Structural Similarity (SSIM) (dB)	Mean square error(MSE)
Nearest neighbor & Bi-linear	0.49732	Resize video-0.95 SR output-0.99	Resize video-23.98 SR output-24.52	Resize video-0.999 SR output-0.998	Resize video-0.0049 SR output-0.4624
	0.6992	Resize video-0.75 SR output-0.94	Resize video-24.97 SR output-25.36	Resize video-0.999 SR output-0.999	Resize video-0.0029 SR output-0.00187
Nearest neighbor & Bi-cubic	0.6908	Resize video-0.95 SR output-0.99	Resize video-24.76 SR output-26.12	Resize video-0.999 SR output-0.999	Resize video-0.00495 SR output-0.004016
	0.69013	Resize video-0.75 SR output-0.973	Resize video-25.32 SR output-26.25	Resize video-0.999 SR output-0.999	Resize video-0.0029 SR output-0.00118

V. CONCLUSION

By developing this novel approach for video sequences based on super-resolution technique. This technique is used for enhance the resolution of real time video with more detail about original video. SR is used to convert low-resolution video to high-resolution video with edge sharpening, improve color and pixel quality and without noise. The experimentation is carried out on the Simulink software. It is a part of MATLAB. The real time video input data taken from USB2.0 PC CAMERA, Webcam and store video data from Multimedia files (AVI format) and observe the various parameters like bit error rate (BER), PSNR, SSIM, MSE based on experimentations these are the conclusions: The difference between bit error rates of resize video and proposed system is near zero. PSNR value of proposed system is greater than resize video output (Nearest neighbor interpolation). Hence, PSNR value of SR video output is better than resize video output. SSIM is used for measuring the similarity between two images. SSIM value of SR output is approximately same as of resize video output. MSE value of video sequence is smaller. Hence, PSNR value is grater which indicates the quality of video output. The better quality of video output sequences with more detail about original video.

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