Customizable Approaches To Multi-Frame Super-Resolution

Sachin R. Sonawane , Ajeet A. Ghodeswar

Abstract - **The motive of this paper is to explain the approach of creating a High Resolution Image from the set of Low Resolution images. Multi frame Super-Resolution is a process by which a number of Low Resolution images are combined into a single High Resolution image, which has a greater resolving power. Super Resolution is not only useful to enhance the resolving power of an image; it can also, to some extent, reduce the aliasing noticeably. This project is a research based project in which we are aiming to understand among the provided algorithms, which algorithm is suitable for a particular image and give the user the ability to compare different Super Resolution restoring techniques that exist with respect to the output and computation time.**

I. INTRODUCTION

Naturally, there is always a demand for higher quality and higher resolution images. In most digital imaging applications, high resolution images or videos are usually desired for later image processing and analysis. The desire for high image resolution arrives from two principal application areas; one is the improvement of pictorial information for human interpretation and other one is helping representation for automatic machine perception.

Multi-Frame Super-Resolution is a software would contain tools which allow a user to input an image set and expect a High Resolution output in return which is much better to perceive than the original input image. The application as the name suggests is customizable and thus can allow users to customize the approaches and algorithms used.

Super-Resolution (SR) is a process by which a number of Low Resolution images are combined into a single High Resolution image, which has a greater resolving power.

The 2 main steps involved in the process to create a higher resolution image are

- IMAGE REGISTRATION
- IMAGERECONSTRUCTION

Motion Estimation mainly involves algorithms which can estimate the Shift and Rotation among multiple images in a set. There are many motion estimation algorithms such as Patrick Vandewalle‟s Algorithm, Keren et al, Marcel et al etc. In this implementation, we mainly focus on Patrick Vandewalle‟s method of image registration mainly involving Aliased Images.

Reconstruction Algorithms mainly take in the estimation parameters produced in Registration module and help in generation of a High Resolution image.

Image Reconstruction Algorithm mainly focused in this implementation are:

1. Interpolation
2. Iterated Back Projection
3. Robust Super Resolution
4. Structure Adaptive Convolution

II. PROBLEM STATEMENT

A lot of Super-Resolution approaches are present, but only few work well with multiple images and especially in cases with low resolution images having a lot of aliasing. There isn‟t a standalone application that allows one to use a lot of these methods and compare the output and the performance.

The aim of this project is to discover the possibilities that Super Resolution (SR) offers to enable users to easily test and compare different SR techniques that exist today. The Goal of this application is to unify a number of approaches allowing user to select from various „Estimation‟ and „Registration‟ techniques available today and see the different results of different,Reconstruction‟ techniques with the performance in real time.

III. LITERATURE SURVEY

In Super-Resolution approaches [1] like the PS, the predicted boundary is jagged because of its location lie between sub-pixels. While some other method the contouring method may be able to break limit of pixel grid it can mis-represent the shape and area of an object. This method combines both PS and contour based approaches and seek to combine the positive features of both these approaches.

In this they proposed a novel approach [2] of single image SR method by finding similarity redundancy across different scales and within the same scale in a given LR image itself. The redundancy for different scales was find to gain example learning based detail synthesis,so the NE based algorithm was used to calculate the mapping relationship between the LR and HR image pairs.

This method uses [3] Bayesian nonparametric model for super resolution. It uses beta-Bernoulli process to learn a set of recurring visual patterns from the data. Then it performs large scale human evaluation experiments to asses the visual quality of the generated results.It used two algorithms first is Gibbs sampling to approximate the posterior.But this is not suitable for large scale data. To overcome this they developed another an online variational Bayes algorithm,which finds high quality dictionaries in a fraction of the time needed by the Gibbs sampler.

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IV.ALGORITHMS WITH EXPLANATION

A) Image registration:

1) Patrick Vandewalle's Registration of Aliased Images:

This method [4], uses the property that a shift in the space domain is translated into a linear shift in the phase of the image's Fourier Transform. Similarly, a rotation in the space domain is visible in the amplitude of the Fourier Transform. Hence, the Vandewalle‟s motion estimation algorithm computes the images' Fourier Transforms and determines the 1-D shifts in both their amplitudes and phases. One advantage of this method is that it discards high-frequency components, where aliasing may have occurred, in order to be more robust.

B) Image restoration :

1) Iterative Back Projection:

The idea behind Iterated Back Projection [5] is to start with a rough estimation of the HR image, and iteratively add to it a "gradient" image, which is nothing but the sum of the errors between each LR image and the estimated HR image that went through the appropriate transforms (given by the motion estimates).
Here, a base image is taken (mostly the first image from the set) and all the other images are compared to this base image to detect the „gradient‟. Gradient basically means the differences in each image get added to this base image and in the end, this image gets laid out on a high resolution grid.

2) Robust Super Resolution:

Robust Super Resolution [6] is a more robust version of the above Iterated Back Projection. The only difference resides in the computation of the gradient, which is not given by the sum of all errors, but by the median of all errors. This brings robustness against outliners in the LR images.
Thus, most of the steps remain the same, but the computation of error differs since median is taken. This could be very computationally difficult, but taking median helps in better averaging out the error and producing a better output.

3) Convolution:

This method simply aligns all the images pixels on a High Resolution grid, and then applies a Bicubic interpolation using Matlab's built-in grid data. Here, all the images are taken in and the scaling factor is also considered. The images are lined up above one another and each color set is computed separately. In the end, the data are merged to form a single High Resolution output with a resolution „factor‟ time‟s original low resolution image.

ALGORITHM:

1. Take the input image set.
2. If the input image set is of low resolution
   then Accept
   else End
3. Save the image set.
4. Select Image Registration Algo
5. Select Image Restoration Algo

IV.SYSTEM DESIGN

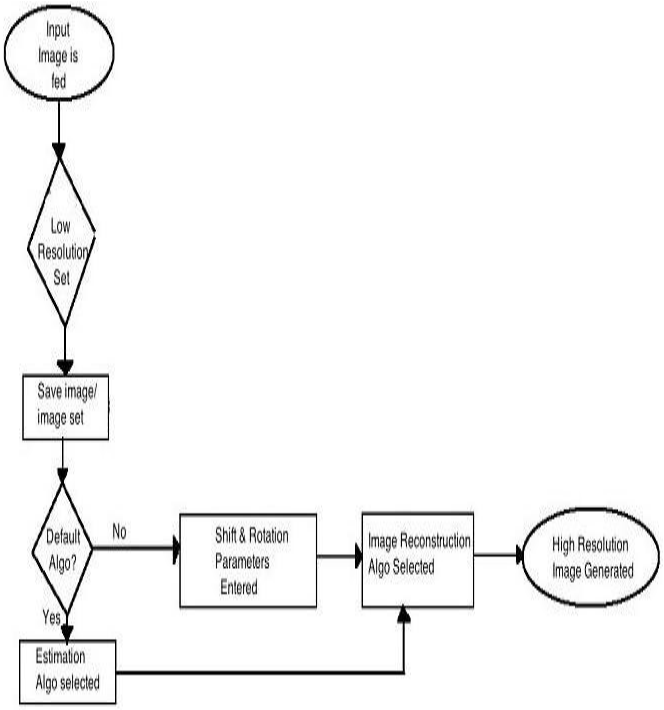

Fig. 1 System Flowchart

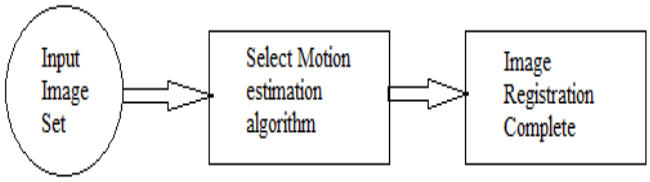

Fig.2 Image Registration

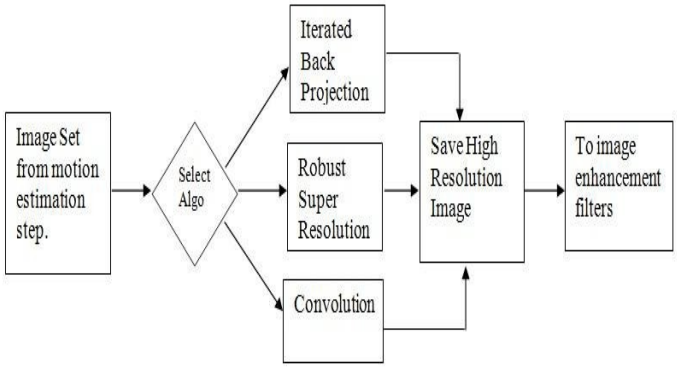

Fig.3 Image Restoration

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V .Generalized Input/Output forms with each step output.

Fig. 4 Original Low Resolution Image

Fig.5 Image Shifted on X-Axis

Fig.6 Image shifted in Y-Axis

Fig.7 Image Rotated

Fig.8 High Resolution Image generated

VI. CONCLUSIONS

There is no one algorithm that gives the best result. Some are light weight in computation, but produce average looking outputs while others are very heavy in processing, but generate better outputs. By exploring in this field we short listed various algorithms depending upon its implementation, working, complexity, efficiency and many such factors.

We found that in Registration method Patrick Vandewalle" s best give best estimation while in Reconstruction Structure Adaptive Convolution gives best result. It was crystal clear yet important that:-

1. Higher the number of frames better is the output.
2. Better the Registration, better the output.

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VII. FUTURE DEVELOPMENT

We can enhance this software in the following ways:
More Algorithms can be added for both Registration and Reconstruction phase.This application can be merged with camera software where the inputs to the application come directly from the frames captured from the camera.This application can be used in the field of astronomy needing to optimize the images taken via Telescopes in Space to detailing.

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