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Survey to enhance the Resolution of MR image

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A B S T R A C T

Super resolution method is used to generate an high resolution image from low resolution images. In medical field this method is used so as to give more diagnostic information. This paper gives techniques like IBP(Iterative Back Projection approach), MAP(Maximum A Posteriori), POCS(Projection Onto Convex Sets) and sparse coding, which are used with Super Resolution mainly for the MR images. For z axis improvement the IBP is done, MAP is used to improve the resolution mainly for the slice selection direction in MR images and the sparse method is used for denoising.

Introduction

IMAGES with higher quality are needed and are essential in many areas like medical, astronomy, surveillance etc. High resolution images are very much needed. Resolution of an image could be increased by either increasing the size of the chip or by reducing the size of the pixel. Or by other way we have to use an higher resolution sensors which in turn are expensive. Thus many kinds of new techniques are used for resolution increment.

Many techniques like PET (Positron Emission Tomography), CT (Computerized Tomography), MRI (Magnetic Resonance Imaging) in medical field are used for detecting the diseases. But still there exist noises in more amount. So here in this survey we mainly see the super resolution techniques in medical imaging. Super resolution is an technique to get an high resolution image from a set of low resolution images.

Super resolution is of two kinds one is the multi frame super resolution and the other is the single frame super resolution. If single noisy low resolution image is used to generate single higher resolution image then that is single frame super resolution. If multiple low resolution images of the same scene is used to generate an higher resolution image then that kind is multi frame super resolution.

There are many techniques in super resolution like: Iterative Back Projection approach (IBP), Maximum a Posteriori

(MAP), Projection Onto Convex Sets (POCS), Sparse Based approach.

Basics of super resolution

Super Resolution is generally an Restoration Method. The basic steps that are followed are:

1.Motion Estimation : The relative shifts between the input low resolution images are determined and registered in the reference grid.
2.Motion Compensation : The low resolution image will be non-uniformly distributed and this is made uniformly distributed in the reference grid.
3.Restoration : This is done to reduce artefacts which is produced by sensor noise.
4.Interpolation : It is the Zoom factor which is predetermined to get the desired higher resolution image.

Super Resolution Techniques

Iterative Back Projection (IBP)

An improved IBP method for the z-axis resolution improvement of MRI with SR tech is proposed by Yan and Lu[1].This method is done in the post processing step. Isotropic images is generally needed for diagnosis which inturn is hard to be got thus for increasing the resolution of these images the SR method is carried out.

Usually, the resolution of 2D-MRI image in the z-axis direction is lower than the x-y plane due to some hardware problems. The super resolution techniques is used in the z-axis for improvement of the slice resolution .Commonly two steps are needed for super resolution of medical images. The shifted sub pixel multiple data set is taken initially. The super resolution algorithm is used then. Here IBP(Iterative Back Projection) method is used with PG(Papoulis-Gerchberg) method. IBP (Iterative Back Projection) method is to solve super resolution through minimizing an error function consisting of the mean squared difference between the original low resolution image and estimated low resolution image. PG method cannot deal with the blur operation in the images. There will be artefacts in the resultant high resolution image. The IBP method integration will overcome these drawbacks. The back projection kernel of IBP is up sample is replaced by PG method. This method is effective to improve the Z-axis resolution using appropriate blur kernel, whereas this is ineffective while using inappropriate blur and sharpen kernel.

Generally by using the back projection there occurs chessboard effect and ringing effect along the edges, the reduction of this is shown in Bilateral Back projection for single image Super Resolution by Han, Wu, Gong [2]. Back projection suffers from ringing and chessboard effects and these effects are reduced by the integration of bilateral filtering in the back projection method called as bilateral back projection. Back projection method is generally used to minimize the reconstruction error but still there occurs artefacts. So to smoothen the effects bilateral filtering is preferred. In the method of Bilateral Back projection the error is propagated according to the information of the edges. If the error is in the homogeneous region then they are projected isotropically. Based on edge information the correction of error is done.

Maximum A Posteriori (MAP)

The low resolution measurement as well as the assumption of motion models or noise is used to estimate unknown MR images. For MAP the estimator is chosen to be of

maximum likelihood type .To regularize the estimation of information probability for the super resolution images are needed. Thus for these type of estimation MAP is used. There will always be resolution degradation in the slice selection direction of the MR images than the in plane direction. Han and Prince [3] have an high resolution image which is reconstructed from two orthogonal scans by adopting an MAP super resolution method . By adopting MAP method in the SR reconstruction the resolution of the slice selection direction is improved. This gives better SNR. The two orthogonal scans are obtained from the same subject. This approach is to find the best estimate by maximizing the a posteriori probability .Here the measurement of the reconstructed image local variance and discrepancy between predicted system output and the real observation are done. The main objective of the MAP method is regularization and this is done with wiener filter incorporation. This is shown by Nelson [4] in MRI iterative super resolution with wiener filter regularization. The tongue MRI are used by the authors here. The paper uses an adaptation in the super resolution method by regularizing the conjugate gradients. The conjugate gradient for the super resolution is the IBP regularization which is created in the high resolution by low resolution image.

Registration Transformation is done as a function and not as an matrix so that it could be used for non-rigid registration. The non-rigid registration is the main step for the adaptation according to the iterations. If there is no formulation of the global linear model then that could be said as an non-rigid registration. The main advantage of this method is that it could be incorporated in all kinds of registrations.

Projection on to Convex Sets (POCS)

POCS is an learning based method where the pair of high resolution and low resolution patches are used in the construction of high resolution image. The high and low resolution patches are in general obtained from an low resolution image. Hsu and Yen [5] has proposed a Wavelet based POCS super resolution for cardio vascular MRI image enhancement. For the successive images a non stationary effect are taken to enhance the spatial resolution of the image. In Wavelet based POCS method for the reconstruction process the non redundant information and the spatial correlations between the successive frames are combined. Along with this the hidden high frequency information in the low resolution frames are also combined. By this method there is increment of the resolution when compared to the other interpolation methods.

Sparse Based Approach

Usually Neighbour-embedding based algorithms for the super resolution is done by two steps, first the Euclidean distance metric is done for searching the neighbours and secondly optimal weights are assigned. Gao, Zhang and Tao has explained an Robust-Sl0 algorithm which does both the actions simultaneously in image super resolution with sparse neighbour embedding [6]. The HOG(histograms of the oriented gradient information) is taken in the synthesis stage here for adaptively choosing the K-NN(K- Nearest Neighbour). The HOG is found generally by clustering. The establishment of the optimal subsets is the challenging problem here and this is done easily by cluster validity analysis to find more subsets. The Robust SL0 algorithm combines the IBP algorithm and TV- based regularization for image deblurring.

Yang and Wright has introduced a compressed sensing to generate a super resolution image as sparse representation of

raw images [7]. The dictionary is created from a small set of randomly chosen raw patches. The compressed sensing is carried out by enforcing global reconstruction constraint and by optimizing the global interpretation of the variables.

By taking the positive weighted coefficients alone ,the computational steps are reduced and then the sparse coding is applied . This is explained by Hoyer in negative sparse coding[8].

Conclusion

The four main techniques like IBP, MAP, POCS and Sparse methods are explained. The paper mainly is about the various methods and techniques used in super resolution to improve the quality of MRI scans. The main limitation of the MR images is the presence of noises and the artefacts which could be reduced by using any of these techniques. Future research could be enhancement in the algorithms to increase the computational speed, since the algorithms vary in accordance to the applications.

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