**1.1 Problem in a Nutshell**

Super resolution(SR)(Timofte et al., 2013) (Jianchao Yang et al., 2010) (Kaibing Zhang et al., 2012) (Nasrollahi and Moeslund, 2014)is a popular image reconstruction problem, it reconstructs the high-resolution image from the low-resolution image. This technology has vast application field including medical imaging, satellite imaging, pattern recognition, etc.

Dictionary-based method(Jianchao Yang et al., 2010) (Kaibing Zhang et al., 2012) is one of the widely talked method to this problem. It takes a training dataset consists of known low-resolution and high-resolution image pairs and get image patch signals with partition and some successive image processing. Based on this patch signals, it tries to learn a low-resolution dictionary Al and high-resolution dictionary Ar which can represent image patch signals as:

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where xl and xh are the low-resolution and high-resolution image patch signal and alpha is the sparse representation. alpha is a sparse vector with only a few non-zero elements. Ar and Al are consisted of vectors of the same length of patch signals and these vectors are called atom. Patch signals are actually represented as the linear combination of those atoms and alpha is the combination coefficients. Since alpha is sparse(Jianchao Yang et al., 2010), only a few atoms will be used to form the patch signal, hence, the representation alpha is called spares representation. After getting the dictionary pair Ar and Al, the corresponding low-resolution patch signal and high-resolution patch signal can be represented as the same sparse representation alpha with Ar and Al respectively. The high-resolution image can be reconstructed by computing the sparse representation of the low-resolution image patches using Al, mapping the sparse representation, getting the corresponding high-resolution patches using Ar and stitching them to get the final output.

The key step of this method is learning the dictionary pairs Ar and Al, one of the algorithm is K-SVD(Aharon et al., 2006). It iteratively learns the dictionary from the training data. For each iteration, K-SVD firstly compute the sparse representation with current dictionary for training signals with some pursuit algorithm and then uses the representation to refine the dictionary to decrease the error between representation and original patch. The refining process involves SVD, which in SR problem, K-SVD needs massive computation because the training process usually uses millions of patch signals.

The computation of K-SVD can be reduced by replacing SVD computation in every step with simple but coarse computation in every iteration.(Irofti and Dumitrescu, 2014) (Rubinstein et al., 2009). It accelerates the K-SVD method with only a little precision loss.

Our project focus on parallelizing the key procedure of the dictionary learning process: K-SVD and to achieve better speed performance, the approximated K-SVD(Rubinstein et al., 2009) is used. The other part of the dictionary-based super resolution algorithm, which only take a small part of whole computation is implemented in sequential fashion.

**2 Prior Work**

Summary of key prior work, results and references

(Jianchao Yang et al., 2010) gives the general framework of dictionary-based approach to the super resolution. The K-SVD algorithm is detailed described in the article (Aharon et al., 2006). The article (Rubinstein et al., 2009) comes up with the approximated K-SVD algorithm.