ABSTRACT

One of the challenges in image processing is to produce good image quality. One example of incomplete signal measurement in the frequency domain is astronomical imaging. Imaging remote sources, namely astronomical objects, requires a very large diameter dish telescope. The Very Long Baseline Interferometry (VLBI) technique is used to collect data from a group of telescopes scattered around the Earth's surface simultaneously so that it can match the sample data generated by a telescope with a diameter equal to the maximum distance between a series of telescopes. In this Final Project research, researchers used the compressive sensing theory approach of the ℓ1-minimization method to incomplete frequency information sources from VLBI astronomical images. The ℓ1-minimization method is a technique that can be used to recover the signal by finding the sparsest solution required.

VLBI image reconstruction begins with a training phase with inputs including a low-resolution image and a high-resolution image. The low-resolution image is obtained from the inverse Fourier transform of the dirty beam of the high-resolution image. The previous dirty beam is obtained from the multiplication operation between sparse sampling and high-resolution images in the frequency domain. The two groups of images are then processed with random sampling and sparse coding algorithms and produce an over-complete dictionary. This dictionary is then used to reconstruct the images in the testing stage with the ℓ1-minimization method.

Each reconstructed image is compared with the original image to obtain the smallest MSE value by considering three variables including the number of patches, codebook size, and lambda (sparsity parameter). The smallest MSE is obtained at lambda in the range of 0.05 to 0.3, while at lambda in the range of 0.3 to 1, the MSE value is consistent but not the smallest.

Keyword: image reconstruction, compressive sensing, VLBI, incomplete frequency, ℓ_1-minimization