Imaging Pipeline Software

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Abstract

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Acknowledgements

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1. Introduction

## 1.1 Aperture Synthesis

The resolution of radio telescopes can be increased by using pairs of telescopes (baselines) and taking the product of the received signals. This resolution can be changed by increases the separation of the baseline, rather then increasing the size of the individual telescopes. This method popularized by the work of (Ryle & Hewish, 1960) states that using these baselines it produces “exactly the same result as that obtained by using the complete large aperture”. This technique allowed for cheaper production of much larger apertures and the eventual development of the techniques used now. These techniques gather Fourier domain data in the form of a visibility, however the way in which they are sampled is non-uniform, so we must place it on a rectangular grid. This process is known as gridding and the methods used now are based on the work by (Brouw, 1975). These visibilities gathered by the baselines can either be gathered by having a large number of baselines and also by using the rotation of the earth to have its location moved around the plane it will be capturing.

## 1.2 Fast Fourier Transform (FFT)

A Fourier Transform is a process for signal-processing and analysis. (Brigham, 1988) states that the extent of the use the process is as follows “biomedical engineering, imaging, analysis of stock market data, spectroscopy, metallurgical analysis, nonlinear systems analysis, mechanical analysis, geophysical analysis, simulation, music synthesis”. It is widely regarded as one of the most important algorithms based on its impact in so many areas. Simply put a Fourier Transform is used to show different parts of a continuous signal, however for Interferometry an Inverse FFT (iFFT) is used as we are combining the amplitude and phase of the signal to form an image. For the performance of the pipeline an inverse Fast Fourier Transform will be used. Using such a method is based upon the work of (Hogg, MacDonald, Conway, & Wade, 1969) where the values from the visibilities are averaged across grid points. The algorithm used was first discovered by Gauss and later rediscovered by (Cooley & Tukey, 1965) which also notes that “Wherever possible the use of N = r^m with r = 2 or 4 offers important advantages” which impacts the design of the pipeline.

## 1.3 Gridding

## 1.4 Deconvolution

2. Methods

3. Results

4. Discussion of Results

5. Conclusion

**References**

Brouw, W. N. (1975). Aperture Synthesis. In C. De Jager, & H. Nieuwenhuijzen, *Image Processing Techinques in Astronomy* (pp. 301-307). Dordrecht: Springer.

Cooley, J., & Tukey, J. (1965). An algorithm for the machine calculation of complex Fourier series. *Mathematics of Computation*, 297-301.

Hogg, D. E., MacDonald, G. H., Conway, R. G., & Wade, C. M. (1969). Synthesis of Brightness Distribution in Radio Sources. *Astronomical Journal*, 1206-1213.

Ryle, M., & Hewish, A. (1960). The synthesis of large radio telescopes. *Monthly Notices of the Royal Astronomical Society, Vol. 120*, 220-230.

(Brigham, 1988)

Appendix

1[Add footnotes, if any, on their own page following references. For APA formatting requirements, it’s easy to just type your own footnote references and notes. To format a footnote reference, select the number and then, on the Home tab, in the Styles gallery, click Footnote Reference. The body of a footnote, such as this example, uses the Normal text style. (Note: If you delete this sample footnote, don’t forget to delete its in-text reference as well. That’s at the end of the sample Heading 2 paragraph on the first page of body content in this template.)]