Research project proposal, Bobbie Ware, id:17962233

**Title**

Imaging pipeline Software

**Purpose**

To gain an understanding of the image synthesis technique that is widely used in radio astronomy and medical imaging. This will be achieved by developing a Java software to carry out image synthesis. The software will use data readings from multiple smaller antennas “arranged in such a way to gather information equivalent to that obtained from one of much greater size” (Ryle & Hewish, 1960). This technique takes visibilities and uses three techniques, Gridding, Fourier Transform, and Deconvolution, to produce an image of a region of the sky that could not be captured using just the smaller antennas alone. The software will mimic pipelines that will be used for the Square Kilometre Array (SKA).

**Literature Sources**

The software will use data in the form of visibilities that are generated at AUT. Image Synthesis involves mapping visibilities onto a grid using techniques based on knowledge from (Romein, 2012) and (Brouw, 1975). The Fourier Transform used by (Hogg, MacDonald, Conway, & Wade, 1969) will be referred to for the pipeline, this technique was discovered by Gauss and then later rediscovered by (Cooley & Tukey, 1965). The Methodology described below is based on work by (Henver, March, Park, & Ram, 2004).

**Planned Methodology**

This project will follow a Design Science methodology where software will be the generated artefact used to experimentally investigate image synthesis. The project will start with the gathering of knowledge on the techniques used in an imaging pipeline from the literature described above. It will also involve gaining knowledge on solutions to complications such as concurrency control and the mapping of visibilities to a grid. These issues are involved in the Gridding section of the software. Then the project will involve implementing the techniques in the form of a Java program and then will be tested using visibility input data available in the HPC Research Laboratory. The software will be testing against other pipelines and changes will be made to try to improve its performance.

**Expected Analysis**

The output from the developed software using visibility data as input will be an image of the sky. The images produced by the pipeline will be analysed to compare it against the known sky images for the data sets to validate whether the techniques are implemented properly and potentially look at its performance

**Expected Conclusion**

It is expected that an imaging pipeline will be developed with the capability for image synthesis. Also expected to gain knowledge in the three main steps involved in the pipeline, namely gridding, (inverse) Fourier transform, and deconvolution, as well as some techniques for algorithm optimisation.

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.

Henver, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quaterly*, 75-105.

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

Romein, J. W. (2012). An efficient work-distribution strategy for gridding radio-telescope data on GPUs. *ICS '12 Proceedings of the 26th ACM international conference on Supercomputing*, 321-330.

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