

Weekly Report

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1 Intro

This report illustrates the relevant concrete process of imaging and some major problems in this process.

2 Imaging

After extracting visibility from .ms file, we can visualize the coverage of visibility in the UV plane.

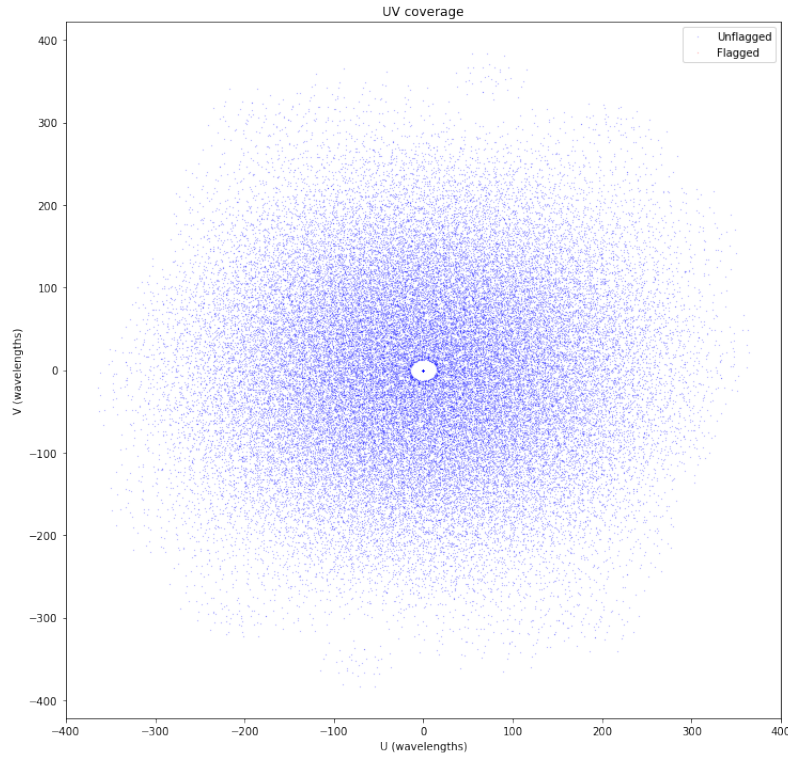


Figure 1: UV plane coverage

In the frequent domain the frequencies do not distribute uniformly in the plane which is the main problem. See Fig 1. If we want to do FFT, we need to grid the frequencies into regular positions which means distribute uniformly.

According to the coverage, it is natural and reasonable to adopt Non-uniform Fourier Transform which will automatically complete the gridding process.

What is more, before the transform, we need to do a sampling on the visibility due to it contains lots of noise in frequencies.

The steps of Non-uniform Fourier Transform are as follow:

1. Spreading

In this step, it will using a kernel to do convolution to finish the gridding process. It will make the output frequencies distribute uniformly on the UV plane by equation (1). In this equation, n denotes for the image size after gridding.

$$b_l = \sum_{j=1}^M c_j \tilde{\psi}(lh - x_j), \quad \text{for } l = 0, 1, 2, \dots, n-1. \quad (1)$$

2. FFT

Using the simple fast Fourier Transform to get the temporary output by equation (2).

$$\hat{b}_k = \sum_{l=0}^{n-1} e^{2\pi i l k / n} b_l \quad (2)$$

3. Correction

Truncating to the central N frequencies, then diagonally scale (deconvolve) the amplitudes array, to give the outputs \tilde{f}_k .

The result \tilde{f}_k is an approximation result with bounded error. Furthermore, in the MRI application, it also have similar property that the coverage is not evenly distributed. Therefore, NUFFT is also used in MRI.

3 Problem

NUFFT is inefficient and time-consuming. The quality of generated image needs to improve. And find a more reasonable way to do gridding.

4 Ideal

Filter - removing some visibility which may be noise or less important before the gridding process. Keep the visibility with high magnitude - absolute value, because the frequency with low magnitude may contain less info based on the compression example.

Approximation or Quick selection to calculate the threshold of maintaining.