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LIGO (LHO)
Project Proposal

Background:

The aim of this project is to write a program in MatLAB extending a two-dimensional Fast Fourier Transform (FFT) program into a functioning, three-dimensional version. The FFT is an algorithm that computes the discrete Fourier Transform; in doing so, it converts a finite number of samples of a function from the time domain into the frequency domain, producing a finite combination of sinusoidal functions in their frequencies. Three-dimensional FFT will allow for quicker processing of large amounts of data. This program will be applied to signals with noise from binary pulsar systems (around 100 to 1000 Hz) in order to extract signals of gravitational waves. Binary pulsar systems are considered to be likely sources of gravity wave signals due to their observed losses in energy that are completely modeled by Einstein's theory of general relativity, which predicts the emission of gravitational waves from two orbiting neutron stars. Thus far, however, gravitational waves have remained undetected. This is due to their small signal frequencies that are easily obscured by observational noise. If successful, this program may be capable of detecting gravitational waves from previously acquired signals of binary pulsar stars. A discovery of gravitational waves would be another confirmation of Einstein's general relativity as well as a potential tool to analyze early cosmological history.

Objectives/Project Schedule:

The only materials needed for this project are a computer system and the MatLAB program. There will be no need to acquire any additional materials. I will spend the first two weeks working to understand the Fast Fourier Transform, how it works, and how it applies to signal processing. I will also use this time to further familiarize myself with MatLAB and the program for the Fast Fourier Transform in MatLAB. With the guidance of my mentor, I will begin to understand how to approach the project. First, I will work with the FFT in two dimensions, applying it to a signal that is not warbling. Once I am comfortable with the concepts involved in this process, I will then move on to an application of the FFT to a warbling signal. The next three to four weeks will be spent working to understand the three-dimensional FFT and writing the program. After the program is finished, the following two weeks will be spent applying the program and performing analysis on the program and its efficiency. This time will also be spent making adaptations to the program if necessary. Once it has been deemed suitable for a final product, the next week to two weeks will be devoted to running the program on previously acquired data and analyzing the results. The final week or two will be spent reflecting on the work done and writing a report on the results of the project.

References:

Discussions with Dr. Richard Gustafson (University of Michigan)

The Scientist and Engineer's Guide to Digital Signal Processing, Dr. Steven W. Smith
(can be accessed at http://www.dspguide.com/pdfbook.htm)