DISCRETE SPHERICAL HARMONIC TRANSFORMS WITH NON POLAR GRIDS ON 2-SPHERE

H. M. NASIR

Department of Mathematics, Faculty of Science, University of Peradeniya

Discrete spherical harmonic transform plays an essential role in many applications, such as those in computational physics, chemistry, astronomy etc. In these areas, much of the computational effort is directed towards the numerical solutions of partial differential equations in spherical geometry.

The choice of spherical polar coordinates for the three dimensional space, though mathematically elegant, results in a polarized grid system where the grid points converge at the north and south poles. Hence, computing discrete spherical harmonic transforms using the spherical polar coordinates requires concentrated computations near the poles where the results are of less important in many cases; for example, consider the weather prediction at the north and south poles of the earth.

In the present work, the discrete spherical harmonic transforms on a set of non-polarized grid points is computed.

A new stereographic coordinate system, which is piecewise smooth, is introduced The Laplace-Beltarmi operator is then expressed in these new coordinates and finite element method is used to compute the spherical harmonics approximately by solving the eigenvalue problem of the Laplace-Beltrami operator.

The non-polar grids are almost uniform in the entire spherical surface and the symmetric structure of the coordinate system reduces computational cost. The problem can be easily implemented in parallel and hence further reduction of computational cost is possible.

It is shown numerically that the method is efficient in terms of computational cost and parallelism.