A FAST METHOD TO RETRIEVE DATA FROM A LARGE STAR CATALOGUE FILE

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ABSTRACT

A method optimized for the access from a large catalogue of stars lying in a given cap of the celestial sphere is described. The performances of the method applied to the SAO catalogue are presented.

1. THE CELESTIAL CUBE

A very frequent type of request to a star catalogue is the access to all stars lying within a cap of a given radius and centered on a given point on the celestial sphere. A partition of the sphere is hence desirable. Identical areas can be obtained by central projection of a regular polyedre inscribed in the sphere. Out of the five regular (platonic) polyedres namely the tetra-, hexa-, octa-, dodeca- and icosaedre, the hexaedre (alias cube) is selected because of the trivial trigonometric formulation involved.

The projection of the cube onto the sphere is called the celestial cube. The cube being oriented such that the centres of the faces are aligned with the 3 reference axes, the faces can be named +X, +Y, +Z, -X, -Y, -Z or 1, 2, 3, 4, 5, 6 respectively, see fig. 1.

2. PARTITION OF THE SPHERE INTO ZONES

A further partition of the faces is required in order to obtain zones of size compatible with the area to be most frequently accessed. On each face of the cube a grid is formed from two sets of equi-distant great circles called 'meridians' as depicted in fig. 1 .

The partitioning factor N defines the number of segments on a vertice. Each face is then formed of $N * N$ zones, the distance between two adjacent 'meridians' being $DA = 90^\circ /N$. It should be noticed that these zones are not identical.

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3. SYSTEM OF CO-ORDINATES

It is here convenient to define a direction S by the following parameters:
- face identification (+X, +Y, +Z, -X, -Y, -Z);
- two azimuth angles.

On fig. 1 the direction S may then be defined by:
- face +Y;
- azimuth angle A1 measured from +X towards +Y;
- azimuth angle A2 measured from +Z towards +Y.

The conversion from unit vector (X, Y, Z) to face and azimuth is trivial: The face number is driven by the greatest component in absolute value and by the sign of that component while the azimuths are simply arctangent functions of the components.

4. ZONE IDENTIFICATION

A zone is identified by face number I (1 to 6), line number J (1 to N) and column number K (1 to N) or by a unique number NZ.

$$NZ = ((I - 1) * N + J - 1) * N + K \quad (1)$$

Given a direction S (face, A2, A2) the zone number is computed by (1) using: I = corresponding face number (1 for +X, 2 for +Y,...)

$$J = (A2 - 45^{\circ})/DA + 1 \quad (2)$$

$$K = (A1 - 45^{\circ})/DA + 1 \quad (3)$$

5. ACCESS BY CAP

In order to fix a maximum admissible radius RM for a cap and hence to limit the number of zones covered, the following constraint is defined: For a given partitioning factor N a cap centered on any direction S should cover at most the zone containing S and its eight contiguous zones.

It can be shown on fig. 1 that the worst case is when S is on the middle of a vertice of the cube where:

$$RM = \text{arcsine (sine DA sine } 45^{\circ}) \quad (4)$$

Under this constraint the identification of zones covered by a cap of direction S and half-angle R involves the following steps:
- identify the zone (I,J,K) containing the direction S (face, A1,A2)
- compute the half-angles DA1, DA2 subtending the cap from +Z and +X resp. $DA1 = \text{arcsine (sine R/sine A2)}$ (5)
  $DA2 = \text{arcsine (sine R/sine A1)}$ (6)
- compare the azimuths of the meridians tangent to the cap ($A1 \pm DA1$, $A2 \pm DA2$) with the azimuth of the meridians of the grid surrounding S and retain eventually 'lateral' zones of the form ($I, J \pm 1, K$), ($I,J,K \pm 1$).

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- If zones of both forms are retained check also if 'diagonal' zones of the form (I,J $\pm$ 1, K $\pm$ 1) are covered by the cap.

6. ACCESS BY BAND

The access by band or wedge is a generalisation of the access by cap. The band defined by a pole, tilt angle, half-width and azimuth limits is overlapped by a set of caps, the scan step being equal to the radius of the cap, see fig.1 .

The relation between half-width and radius is:

$$\text{cosine}(HW)=\text{cosine}(R)/\text{cosine}(R/2) \tag{7}$$

7. PERFORMANCES

The SAO catalogue (260000 stars) was used to create a file containing for each of the 339 x-ray sources of the 4th UHURU catalogue all stars lying in a cap of 1.5° radius. The total task required on a CII-10070 computer 16 min. of resident and 150 sec. of CPU time.

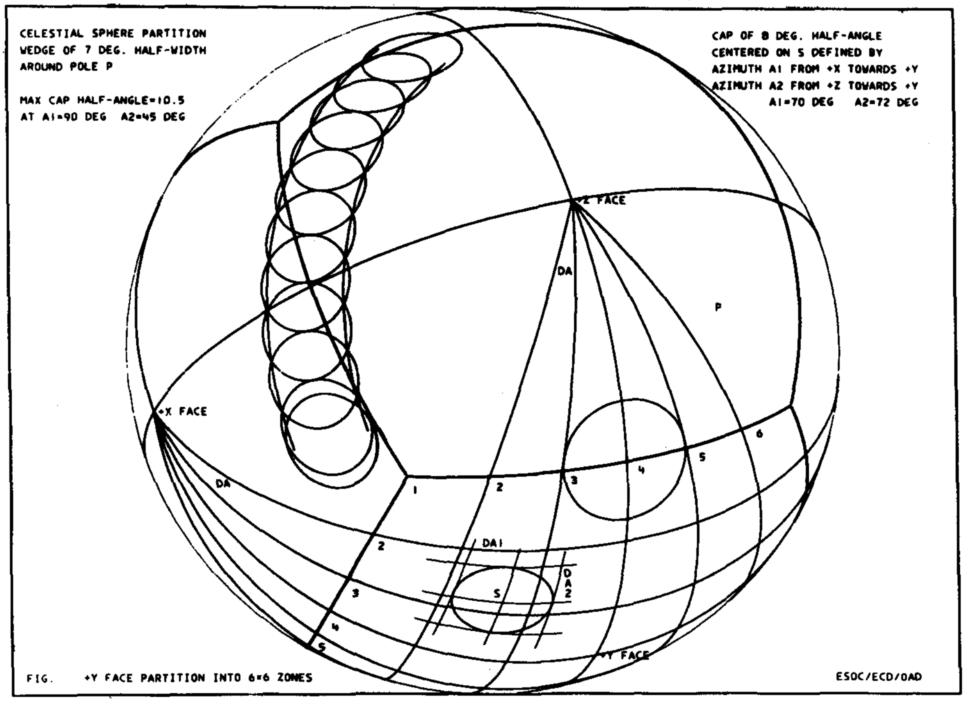

FIG. +Y FACE PARTITION INTO 6×6 ZONES

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