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Technical Information Report #176

Computer Program for Lenticular Lens Coordinates

by L. A. Juhlin

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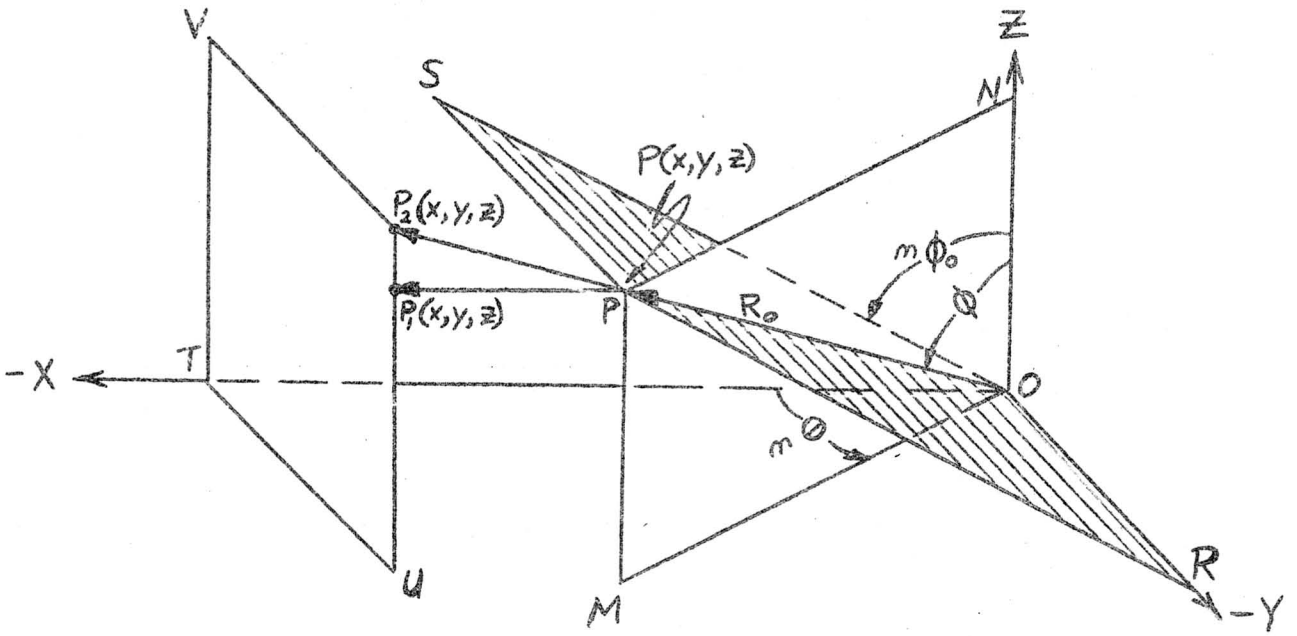
This program was written in Fortran for the IBM 1620 computer with tape system, 20K memory, and automatic divide. The program uses core locations 100-11060 and 19319-19999. All calculations are done with eight significant figures, but the results are truncated after the eighth figure in each operation and printed as a five-decimal number.

PROBLEM

The centers of the lenticules are defined by the intersections of two families of planes with a sphere, or with a third plane. (See Figure 1). This definition is such that the lenticule centers, when viewed from the center of the sphere, will have constant projected angles on the horizontal (XY) and vertical (XZ) planes respectively. The lenticule centers lie on arcs of great circles in both the horizontal and vertical directions, appearing as straight lines when viewed from the center of the raster.



In Figure 1, the plane MN is representative of the family of planes which define constant projected angles (integral multiples of θ_0) in the horizontal plane XY. The plane RS represents the family of planes defining constant projected angles (integral multiples of ϕ_0) in the vertical plane XZ. The intersections of the families of MN and RS with a sphere of radius OP are the desired loci of the lenticle centers.

If an orthographic (parallel) projection is made, then $P_1(x,y,z)$ are the projected coordinates onto the plane UV - a distance of OT from origin. If a gnomonic (radial) projection is made onto a plane UV perpendicular to the X (optical) axis, then $P_2(x,y,z)$ are the projected coordinates.

In spherical coordinates (θ,ϕ,R) the equations of the surfaces are:

(1) MN: $\theta = n\theta_o$, $n = 1,2,3,\cdots$

(2) RS: $\tan \phi = \tan n\phi_o \sec \theta$, $n = 1,2,3,\cdots$

(3) Sphere: $R = R_o = OP$

(4) Plane: $R = \dfrac{X_o}{\sin \phi \cos \theta}$, $X_o = OT$

These are converted to (x,y,z) by the relations:

(5) $x = R \sin \phi \cos \theta$

(6) $y = R \sin \phi \sin \theta$

(7) $z = R \cos \phi$

PROGRAM RESTRICTIONS

The program assumes that the corners of the four central lenticules touch the optical axis. All spherical surfaces are concentric about the origin. Angles must be entered in milli-radians, and distances in inches.

PROGRAM OPERATION

1. Clear memory (Insert 160001000000, RS, Instant Stop)
2. Load tape, type 360000000300, RS.
3. After the program title has been printed out, the 1620 will be waiting to read from the typewriter. The typewriter must be manually shifted to upper case in order to type in numeric data.
4. If an orthographic projection is desired, put C.S 1 OFF and go to Step 5. If a gnomonic projection is desired, put C.S.1 ON and go to Step 8.
5. Type:

   XX.00000 RS (radius of intersecting sphere, R = OP)

   XX.00000 RS (distance from origin to plane of projection, X = OT)

   XX.00000 RS (horizontal angle subtended by one lenticule at origin)

   XX.00000 RS (vertical angle subtended by one lenticule at origin)

   XX RS (no decimal, number of lenticules in horizontal direction)

   XX RS (no decimal, number of lenticules in vertical direction)

   (The number of lenticules must always be two digits, e.g. 15,01,09)

6. The program computes x,y,z according to eqs. 1,2,3,5,6,7, and prints x,y,z relative to the plane UV, (x-axis translated by OT).

7. The program may be reinitiated by pressing START after completion of type out. C.S.2 ON omits type out of title.

---

8. Gnomonic Projection, C.S.1 ON

   Type the data as shown in Step 5, except that the first two entries may be omitted by using the RS key twice.

   In addition, type

   XX.00000 RS (distance from origin to plane of intersection X = OT)

9. The program computes (Y,Z) (X is constant) according to equations 1,2,4,6,7, and prints (Y,Z) relative to the origin.

10. After completion of type out, go to Step 7.

The program may be reinitialized at any time by STOP, RESET, INSERT, 4908300, RELEASE, START. (use 4908324 to omit title). The type out is spaced as horizontal rows of lenticules. Changes in this program may be most easily made by changing the source program (listed at the end of this report) and generating a new Fortran object program.

```
 1 PRINT 60
 2 ACCEPT 61,RTC,REF,THM,PHG,LH,LV
   THM=.001*THM
   PHG=.001*PHG
   PHI0=3.1415926/2.0-(PHG/2.0)
   THE0=THM/2.0
   PHI=PHI0
   THE=THE0
   M=LH
   N=LV
   IF (SENSE SWITCH 1) 4,3
 3 PRINT 62
   PRINT 63
   DO 20 J=1,N
   DO 10 K=1,M
   TANPH=(SIN(PHI)/COS(PHI))/COS(THE)
   PH=ATAN(TANPH)
   X=RTC*SIN(PH)*COS(THE)
   Y=RTC*SIN(PH)*SIN(THE)
   Z=RTC*COS(PH)
   X=REF-X
   PRINT 64,X,Y,Z
10 THE=THE+THM
   THE=THE0
   PRINT 69
20 PHI=PHI-PHG
   PAUSE
   IF (SENSE SWITCH 1) 4,30
 4 ACCEPT 65,BRP
   PRINT 66
   PRINT 67
   PHI=PHI0
   THE=THE0
   DO 40 J=1,N
   DO 50 K=1,M
   TANPH=(SIN(PHI)/COS(PHI))/COS(THE)
   PH=ATAN(TANPH)
   RHO=BRP/(SIN(PH)*COS(THE))
   Y=RHO*SIN(PH)*SIN(THE)
   Z=RHO*COS(PH)
   PRINT 68,Y,Z
50 THE=THE+THM
   THE=THE0
   PRINT 69
40 PHI=PHI-PHG
30 PAUSE
   IF (SENSE SWITCH 2) 2,1
60 FORMAT (35HLENTICULAR LENS COORD.  11-3-62 LAJ)
61 FORMAT (F9.5/F9.5/F9.5/F9.5/I2/I2)
62 FORMAT (//23HTOOL CENTER COORDINATES/)
63 FORMAT (27H    X              Y              Z/)
64 FORMAT (F8.5,F11.5,F11.5)
65 FORMAT (F9.5)
66 FORMAT (//15HBAR REF. COORD./)
67 FORMAT (16H    Y            Z/)
68 FORMAT (F8.5,F11.5)
69 FORMAT (1H )
   STOP
   END
```

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Erratum: Technical Information Report #176

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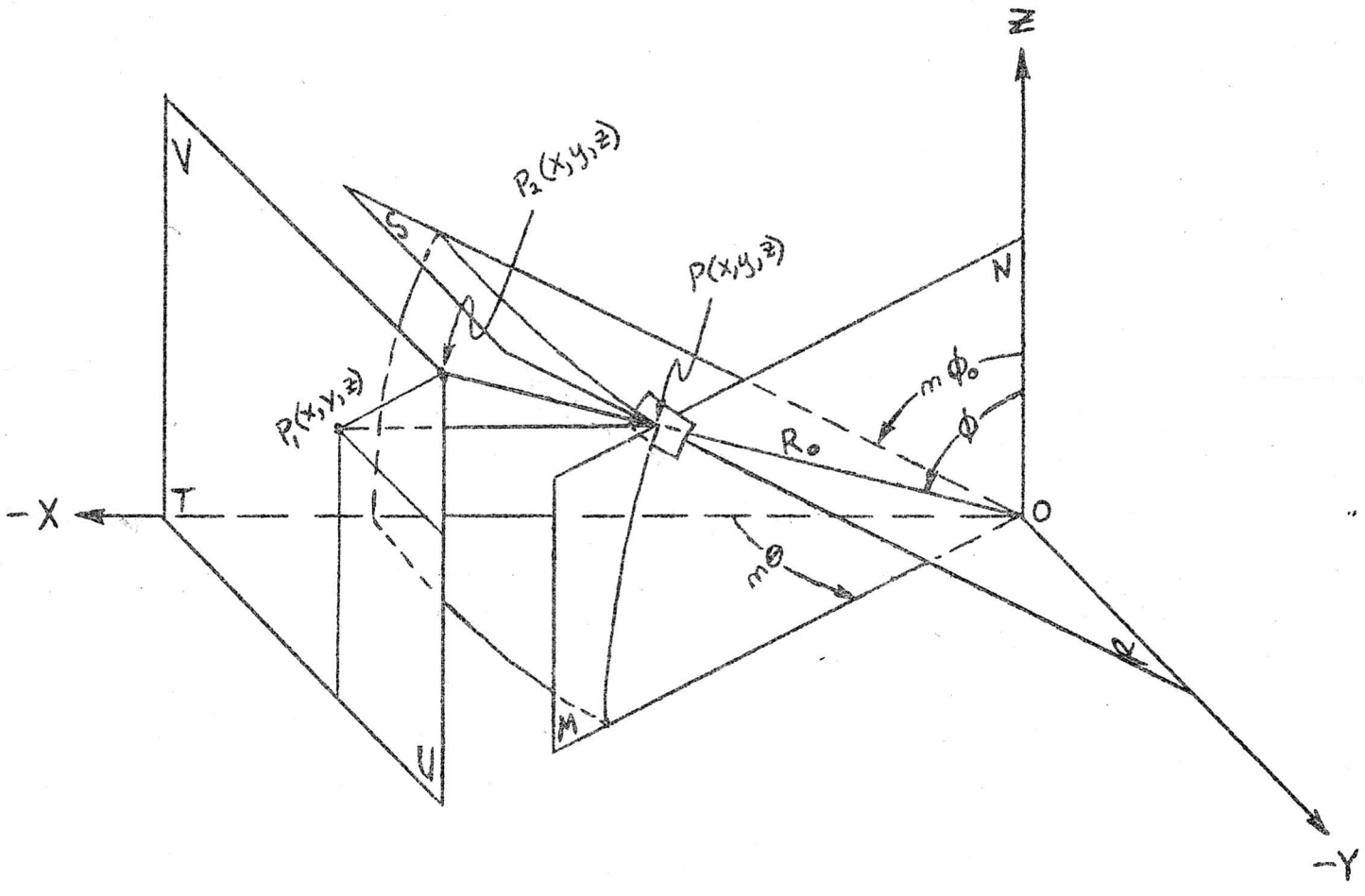
The figure below more accurately and clearly shows the geometry of the lenticules and the two projections.



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