Sun shadow Location
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Keywords: Vector dichotomy exhaustive regression analysis

Abstract. This paper studies the changes of different time, place, rod length and shadow length. Use of existing video data, using mathematical vectors, linear programming, dichotomy, multi-stage euqal exhaustive and other methods, according to the laws and geographic relationship to establish true solar time and analytic geometry sun shadow length and the date, time, longitude , the relationship between latitude, describing a given date and geographical coordinates sun shadow length changes with time. Using MATLAB programming tools curves obtained relevant data, to determine its location and date in the shadow of the trajectory of the object through the sun. Followed by the establishment of the corresponding model, verify the availability of the model.

Introduction

In life, how to determine the location and shooting video of date, it is the key to determine the best shooting opportunity, but also an important aspect of video data analysis. Sun shadow positioning technology is through analysis of video sun shadow of objects change, a method of determining the video shooting location and date.

Figure I schematic view of the sun-Earth Coordinate

Figure II. Shadow schematic plan view of two sunlit pole
Derived.

Suppose the region do not move to the Earth as the center and radius for any field of an imaginary sphere, the imaginary celestial sphere is called. All the stars including the sun, including, both in this sphere to rotate about the axis.

Equatorial coordinate system is to extend the latitude and longitude coordinates on the Earth to the celestial sphere, in parallel to the equatorial plane of the Earth's latitude circle on the celestial sphere is called declination circle; in the north and south poles of the Earth by the accuracy circle on the celestial sphere is called when the ring . And when the angle of declination $\delta$ in $\Omega$ indicates the position of the sun. The so-called hour angle is the angle between the sun when the ring where the ring and through difficulties when constituted, in degrees. Since celestial North Pole, the clockwise direction of the needle is positive, the counterclockwise direction is negative. When the sun's azimuth angle indicates, because the celestial sphere in 24 hours a day, rotating 360 °, so an hour rotation 15 °.

Horizontal coordinate system is the basis of the horizon circle with solar elevation angle $h$ and azimuth $A$ to determine the position of the sun in the sky. The so-called solar elevation angle is the angle between the sun and direct light between the ground plane. Solar azimuth is the angle between the sun direct sunlight on the ground plane of the projection line and the ground plane to the south. Generally south of the point S is 0 °, the west is positive, negative east.

Let the Earth radius $R$, $\angle AOD = \alpha$, $\angle BOD = \beta$, $\angle AOB = \gamma$, $\alpha$ is the observation ground at A latitude, $-90^\circ \leq \alpha \leq 90^\circ$; latitude several $\beta$ position of the sun direct point B, $-23^\circ 26' \leq \beta \leq 23^\circ 26'$; $\theta$ is the solar direct point A to point B longitude difference, for a day to day A t the time (place, time is 12:00 noon) have $\theta = (t-12) * 15 / (0 \leq t \leq 24)$, where $t$ is the true solar time. As the sun's rays $OB$ corresponding vector OA and normal vector angle A to level the ground. Figure 3 shows the two places had great circle AB, because HF//BO, so $\angle AOB = \angle AHF = \gamma$, A the time to sun elevation angle of $90^\circ - \phi$. Figure A to O as the origin, OD where the straight line X-axis, ON where the straight line is the $Z$ axis coordinate system is established, there are:

$$\overrightarrow{AE} = (0,1,0), \overrightarrow{AR} = (-\sin \alpha, \cos \alpha);$$

$$A(R\cos \alpha, 0, R\sin \alpha), B(R\cos \beta \cos \theta, R\cos \beta \sin \theta, R\sin \beta);$$

$$\cos \varphi = \cos (\overrightarrow{OA}, \overrightarrow{OB}) = \cos \alpha \cos \beta \cos \theta + \sin \alpha \sin \beta;$$

Figure III, Rt$\Delta AHF$ in,$HF=AH/\cos \varphi$, set up with the angled, $\cos \delta = \cos(\overrightarrow{HF}, \overrightarrow{AE}) = \cos \beta \sin \theta . HF$ positive projective AJ on $AE, AJ = HF \cos \delta = \cos \delta / \cos \varphi * h$, Let the angle formed by the $\overrightarrow{HF}, \overrightarrow{AR}$

$$\cos \gamma = \cos (\overrightarrow{HF}, \overrightarrow{AR}) = \cos (\overrightarrow{BO}, \overrightarrow{AE}) = \sin \alpha \cos \beta \cos \theta - \cos \alpha \sin \beta$$

Using MATLAB to make the curve as follows:

October 22, 2015 Beijing time 9:00-15: changes in the sun's shadow length between 00 Tiananmen Square 3-meter-high straight bar graph.
3. Conclusion.

Establish equatorial coordinate system and horizontal coordinate system, according to changes in the equatorial coordinate system when the angle of declination and horizontal coordinate system and changes in elevation and azimuth calculated solar elevation angle and azimuth, the above derivation establish functional relationship by:

\[ I = \tanh b \]

\[ \sin h = \sin \alpha \sin \beta \cos \alpha \cos \beta \cos \theta \]

\[ \sin \beta = 0.39795 \cos [0.98563(N-173)] \]

\[ \theta = [(t-12) \times 15^\circ + \gamma - 120^\circ / 180^\circ \pi] \]

Note: Here t GMT;
N is the number of days, counting from 1 January each year

Effect of various parameters on the video length: (1) t ,, constant shadow graphics constant change, the graphics move around; (2) some other, smaller, the shorter the length of the shortest shadow.

References
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