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ORBIT OPTIMIZATION ACCORDING TO CALCULATE REVISIT TIME FOR OPTICAL AND RADAR CIRCULAR REMOTE SENSING SATELLITE

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ABSTRACT:

The orbit selection procedures are very essential and complex, concerning swap between a numbers of various parameters where the designer picks the best orbital parameters to meet the mission requirements. In this paper the orbit design of radars and optics circular remote sensing satellites is developed in accordance with the calculation of revisit time in both cross track and along track taken into consideration criteria of both payload constrains and orbit parameters such as the swath width, incident angle and finding the correct values of the six orbit fundamentals which called the kepler's elements which altered than the repeat coverage cycle which depends only on the orbit specification, a satellite on circular orbit visits the objective target at both the descending and ascending revisit revolution, The numerical and mathematical model of illumination condition of the target at the time of access and circular revisit orbit are constructed by MATLAB software under The gravitational second zonal harmonic effect. Finally, through different case studies, and by studding the illumination constraints a large number of orbit can be obtained which meet the operation and mission goal and the target functions can be selected among revisit time and off-nadir resolution, then the designers can observe the optimal orbit which come across the operation and mission requirement.

KEYWORDS: ground track of satellite, access times of satellite, illumination condition, orbit optimization.

1. INTRODUCTION:

The orbit selection process is complex, involving trades between numbers of various parameters. The orbit usually defines the space mission lifetime, cost, environment, viewing geometry, frequently and the payload performance. A comprehensive study was performed about mission-based trade-offs on the orbit selection of a remote-sensing satellite. Depending on the mission, several constraints from various disciplines enforce the orbit values to come across the requirement and also improve the mission performance. Each of these factors is taken into account to show how they can effect to the orbit parameters. At last, the operative orbit for the mission is selected regards to the mission cost function. The orbit selection and the criteria for LEO orbit are designed by selecting parameters for optical and radar remote sensing satellite under the effect of the payload constrains and mission requirement [1-2]. According to the ground track it should be recurrent and repetitive but free from gaps, to ensure that each point on Earth can be imaged again and again where the non-spherical shape of the earth caused the shift in the ground track, It is clear that the repeat cycle is comparative to the orbits of satellite different from the revisit time which comparative to both the orbits of satellite and the payload constraint such as swath width and incident angle, Many paper have pay their attention on the study of repeat ground track orbits which is periodic orbits [3-8]. Kim, et al, Xu and Huang [9-11] Presents the way to reduce the average revisit time of a particular target for the current mission in specified days by using a genetic algorithm, Circi, et al. [12] introduced a technique for sliding of ground track depend on small corrective maneuver to shift from ground track pattern to another which permit to completion of several targets in the same mission, Li, et al and Luo [13,14] proposed an optimization of orbit design model for revisit orbit to accomplish the best selection of orbit where the revisit time is computed related to the orbit and payload conditions and takes in calculation the gravitational second zonal effect.

This paper proposes a different and a new technique for calculating the revisit time of satellites for optical and radar circular remote sensing satellite taken into consideration all limitations and constraints of payload condition and orbit mission condition that affect in the computing of revisit time such as swath width, tilt angle and orbit parameters all the research in [13-14] conducted on the satellites orbit mission and payload limitations and did not take the illumination condition into consideration, but this paper introduced a mathematical model which calculates the illumination condition and sun elevation angle of the target at the time of shooting which is very important for optical satellites in addition to orbit and payload condition. Finally, at this paper the best design shape and type of circular revisit orbits which meet the mission requirement is selected by making a variation in the six classical orbits parameters (semi major axis (a), inclination (i), eccentricity(e), right ascension of ascending node(Ω), argument of perigee (ω), true anomaly(ϑ) , then the designers can pick the optimal orbits. This paper divided into four sections, section (2) illustrates the mathematical model of the ground track that have to be satisfied to obtain the sup satellites point of the ground track by computing the geodetic latitude and longitude of satellites every one second to draw the pattern of ground track for specific interval of time and calculate the repeat cycle under the effect of second zonal harmonics. Section (3) introduced recurrent ground tracks and mathematical model to calculate the time and number of access for a specific period of time taken into consideration the illumination condition, section (4) presented the results to select the optimal orbits to satisfy the mission and users requirements. Section (5) is the conclusion.

2. SATELLITE GROUND TRACK

2.1 THE MATHEMATICAL MODEL OF GROUND TRACK:

The orbit projection on a surface of the rotating Earth is referred to as ground track. A geographical latitude and longitude of a sub satellite point are calculated with a mathematical equation depend on initial data of six classical orbital parameters The points resulting from the calculations are plotted on a map and connected by a free line, which is a flight track. There are other requirements that is very essential in the orbit selection that the ground track should be recurrent and repetitive, to ensure that each point on Earth can be imaged again and again. Clearly the orbits should be circular; to achieve a constant spacecraft altitude, furthermore, identical illumination conditions are very important for studies and analysis of images. By solving the equation of motion of Kepler's starting by six classical orbital parameters the geodetic latitude and geodetic longitude of satellite can be calculated then the ground track for any interval of time can be drawn. And a variety of orbits can be accomplished which can be polar orbits, geosynchronous, synchronous, etc .then the designers can select the best six orbit elements which describe the path and trajectory of ground track, The orbit of the remote sensing satellite should be designed to fulfill the mission requirements completely, the 6 elements of the Keplerian Element are designed as start point to select the best choice of orbit type and shape.

The mathematical model of the ground track is established by varying these orbital elements so the motion of satellite can be achieved for various orbits. Where the circular orbits can be assumed, i.e. (e=0). Consequently there are four orbits elements(a, Ω , i, ϑ) are required to computed the sub-satellite points of the ground track taken into consideration the limitation and constraints that affected on the selection of altitude, eccentricity and inclination.

Altitude constraints Often, the key factor in the altitude selection is the radiation environment. Over 1000 km the radiation depth is high. The lifetime of spacecraft components can be reduced by the high level of trapped radiation. Under this height the atmosphere will rapidly clear out charged particles. Most mission orbit consequently separate naturally into both low-Earth orbits (LEO), below 1000 km, and geosynchronous orbits (GEO), which are well over the Van Allen belts. Generally, low altitudes accomplish good instrument function because the closest to the Earth's surface. It also requires less energy to reach to the orbit. Alternatively, higher orbits have longer lifetimes and present better Earth coverage to earth surface. Higher orbits are moreover survivable for the applications of military satellites.

Eccentricity constraints This paper concentrated on circular orbit where the advantages and disadvantage of using the eccentric orbits should be taken into consideration. These concentric orbits have lower speed at apogee, which makes extra time available there and extra time for coverage. Unluckily, the eccentric orbits give non-uniform coverage and irregular range. Additionally, the radiation environment affected on the higher apogee altitude, that's will increase the cost of satellite and decrease the life time of satellite. Also the perturbation and atmospheric environment effect on the lower perigee altitude. Eccentric orbits are more influenced by Moon and Sun. Finally, eccentric orbits have an extra disadvantage where the perigee rotate was done by the oblates of the Earth (non-spherical shape).This rotation leads to fast changes in the position of apogee compared with the Earth's surface.

Orbit plane inclination constraints Selection of the inclination of orbit can be depended on various factors such as (the location of the ground segment, the geographical location of area of interest, launch capability …) the designers can pick a special case of inclination, such as sun-synchronous orbit or Molniya orbit (in case of eccentric orbit). Where the designers take the advantages of non-spherical shape of earth (oblate shape) to create sun synchronous orbits which have the same angle between the sun and the orbit plane then the constant illumination condition for the target site achieved from one observation to the next. The inclination can be selected for a given altitude where the regression of the node is equal to the motion of the sun about the earth (1 degree per day, eastward), the sun synchronous orbits for low earth orbits is between 96° to 100° as shown in (fig.1).

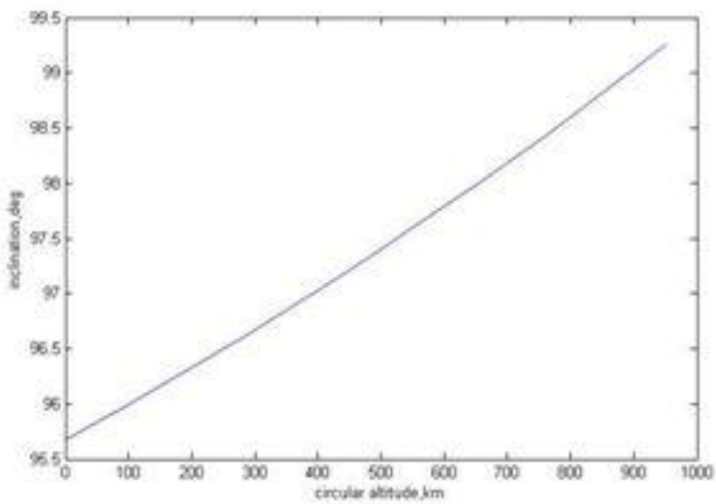


Figure (1) Satellite altitude and inclination for SSO

2.2 ALGORITHM FOR GROUND TRACK

The ground track algorithm can be described by the following flow chart fig (3). Where the geodetic latitude and geodetic longitude can be obtained from the given classical orbital elements (a, e, ω, i, Ω , ϑ)) by computing angles of the orbital plane as shown in fig (2) for a specified interval of time ΔT at start time (Ts) and end time (Te).

At this paper there are two kind different of satellite are presented for different inclination to verify the method, the first orbit is orbit **A** (inclined orbit) with classical orbital elements (a=7107 km, i=51.6°, Ω=105°, e = 0°, ω = 0°, ϑ = 0°) and the second orbit is orbit **B** (sun synchronous orbit) with classical orbital elements (a=7107 km, i=98.2°, Ω=105°, e = 0°, ω= 0°, ϑ = 0°), where many orbits can be obtained by changing in these orbits, between all these orbits the designers can select the (which matching with the customer and mission requirements.

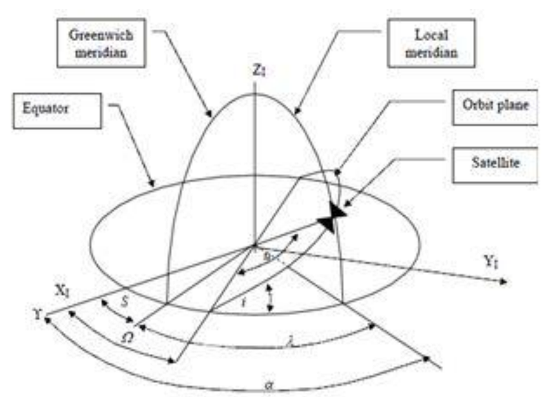


Fig (2)

- Calculate Eccentric anomaly, deg (E)

$$\tan\frac{E}{2} = K.\tan\frac{\vartheta}{2} \qquad \text{Where.........} K = \sqrt{\frac{1-e}{1+e}} \qquad (1)$$

-Time from perigee, sec (τ)

$$\tau = (E - e\sin E)\,/\,n \qquad (2)$$

$$n = \sqrt{\frac{\mu}{a^3}}$$

Where

(n) is the mean motion of satellite rad/sec

μ is the Earth's gravitational constant = 398600 km^3 / s^2

-Argument of latitude, deg (u)

$$u = \omega + \vartheta \qquad (3)$$

-Geocentric latitude, deg (ϕ_c)

$$\sin\phi c = \sin i \sin u \qquad (4)$$

-Geodetic latitude, deg (ϕ_g)

$$\phi_g = (1-\zeta)^{-2}\tan\phi_c) \qquad (5)$$

Where (ζ) is flattening coefficient (elliptical of the earth), 0.003353

-Change in longitude, deg (Δλ)

$$\Delta\lambda = (\omega_e - \frac{180}{\pi}\dot{\Omega}\ )\,\tau \qquad (6)$$

ω_e...........angular velocity of earth=0.729211515.10^{-4}

$\dot{\Omega}$ ....is the regression rate of the orbit plane

$$\dot{\Omega} = -\frac{3}{2}.J_2\, n\,(\frac{R_e}{a(1-e^2)})^2 \cos i \qquad (7)$$

R_e..........is the earth's radius=6378.14 km

-longitude (λ), deg

$$\lambda = \alpha - S_G(0^h) - \omega_e t - \Delta\lambda \qquad (8)$$

$S_G(0^h)$.........right ascension of the Greenwich meridian at 0^h UTC

And α is the right ascension.

And by solving equations (5), (6), (8) the geodetic latitude and geodetic longitude of the satellite can be calculated. The points resulting from the calculations are plotted on a map and connected by a free line, which is a flight track. The track shapes are highly diversified and depend on a type of orbit (circular, elliptical) and their specific parameters. The track shape of a circular orbit is determined by orbit inclination (i) and orbit altitude (h). Then drawing the pattern for ground track for specified interval of time where the time of scenario is selected from 01 July 2017 10:00:00 UTC to 02 July 2017 10:00:00 UTC. For orbit (A) and orbit (B) respectively as shown in fig (4), fig (5).

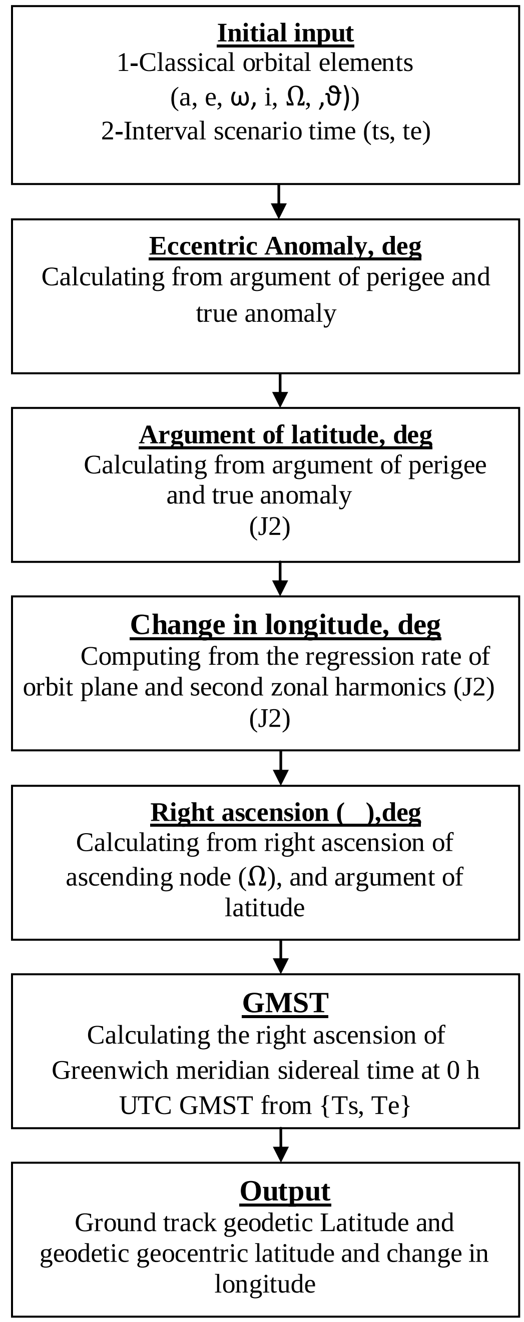
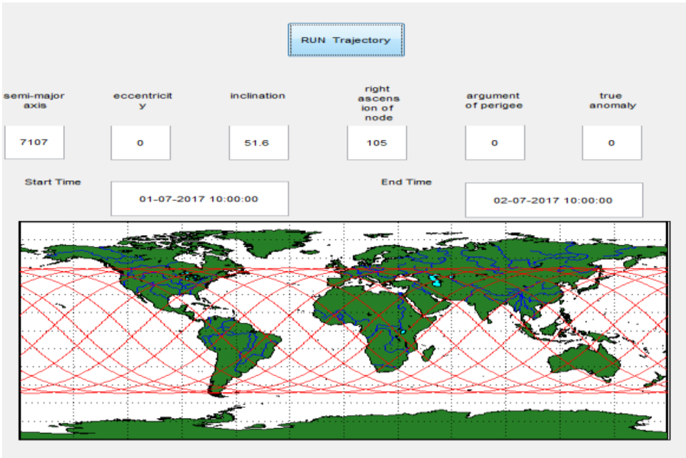
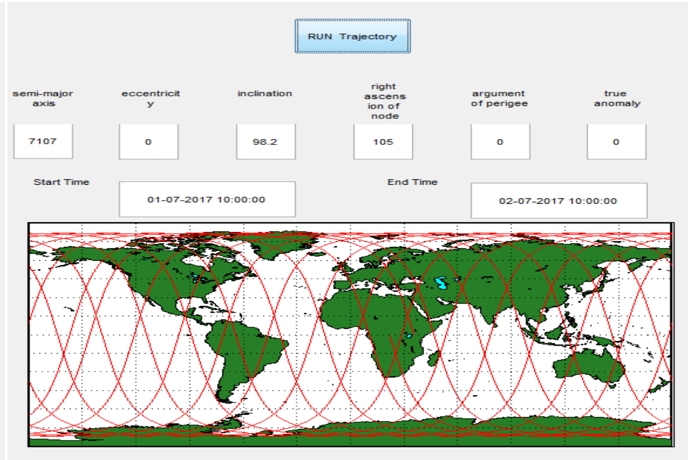


Fig (3) Algorithm for ground track



Figures (4) orbit A



Figures (5) orbit B

The beginning of orbit is taken to be a satellite pass above the equator. A distance in longitude Δ L between the initial and final orbit points equals the Earth's rotation angle per one satellite revolution. Distance Δ L is a satellite displacement in longitude per orbit pass. This displacement is measured from the east to the west, namely towards the East longitude decay. All subsequent orbits of a satellite ground track can be obtained by an iterated ground track displacement to the west by value Δ L relating to the first orbit. The nearest integral relation 2 π / Δ L is called a daily number of orbits If 2 π / Δ L=n/m is a rational fraction, then after n orbits a satellite returns to the initial position (i.e. approximately after m days). Such orbits are called orbits m – daily order.

2.3 Recurrent ground tracks

The orbital design is a major task in the mission design process. Usually in the remote sensing satellites, recurrent of ground tracks is one of the mission requirements. Using RGT (Recurrent ground track) orbits provides a time table of satellite passes on specific points on the Earth, i.e. ground stations. Also, the position of the satellite pass relative to the ground stations is constant where, the perturbation affect on the orbital elements the ground track of satellite moves gradually then, the maneuver is required for the orbit correction

the earth coverage is defined not only by size of equatorial section of the swath, but also the factor of track In recurrent orbits a spacecraft has a similar pass of a ground track relating to the Earth after one or several days. For this purpose it is necessary that a sum of orbital periods of (j-orbits) shall be exactly equal to duration of (k-days).

-Repetition factor ($\frac{j_{orbits}}{k_{days}}$)

$$j_{orbits} \cdot T_{\Omega} = k_{days} \cdot T_{s} \qquad (9)$$

Where $T_s = 86400s$

This repetition factor shows, how many revolution (j) the satellite has to fulfill, so that at the subsequent (j+1) revolution the track has coincide with the track of the first revolution.

-Nodal period (T_{Ω})

$$T_{\Omega} = \frac{2.\pi}{\dot{u}} \qquad (10)$$

$\dot{u}$ …………is Rotation rate of the position-vector, rad/s

$\dot{u} = \dot{M} +$

-angular rate of rotation of the line of apsidal

$$\dot{w} = 0.5.k.a^{-\frac{7}{2}}.(5\cos^2 i - 1).(1 - e^2)^{-2} \qquad (11)$$

-Change of mean anomaly (anomalistic rate), rad/s

$$\dot{M} = n + \frac{k}{2} a^{-\frac{7}{2}} (3\cos^2 i - 1)(1 - e^2)^{-1.5} \qquad (12)$$

The repetition factor depends on orbit altitude and inclination, for each value of the repetition factor it is possible to find the functional dependence between orbit altitude and orbit inclination .table (1) shows some example of such dependence for the repetition factor more than 14 and less 15 for sun synchronous orbit, this figure is based on the equation (9).

Table (1) sun synchronous orbits with recurrent ground track

Altitude, km	Inclination, deg	Period, min	Number of orbit, days	Recurrence interval j/k
790	98.560	100.78	14.28	100/7
770	98.476	100.36	14.34	86/6
750	98.39	99.940	14.40	72/5
720	98.27	99.3114	14.499	29/2
690	98.14	98.683	14.60	73/5
660	98.02	98.05	14.66	44/3
640	97.94	97.640	14.75	59/4

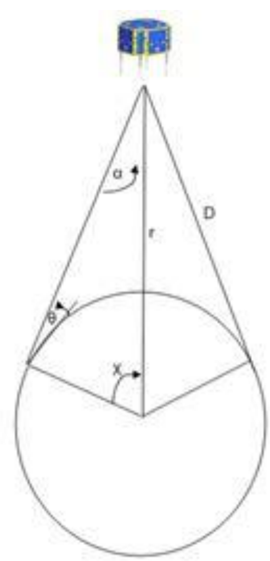
For example, the ground track of the satellite with the repetition factor 29/2, if the track on the first revolution lies through specified location, then the track on the thirtieth revolution will pass through the same location too after 2 days. At this repetition of sun synchronous the orbit inclination equals 98.27°, and then the orbit altitude has to be equal to 720 km.

Distance between consecutive tracks at equator, shift of the first track through the j-revolution cycle, minimum distance in the net of tracks passed by the satellite in the j revolutions are completely defined by the repetition factor .For example, if the repetition factor of an orbit is equal 29/2=14.5, then the distance between consecutive tracks at equator is equal 25°. Through 14 revolutions the first track of series will shift on 12.5°.

3. SATELLITE REVISIT TIME

3.1 MATHEMATICAL MODEL OF SATELLITE REVISIT TIME

At this section the mathematical model is constructed to compute the revisit time of a satellite for a specified target site where the revisit time can be defined as the time between the double surveillance of the same target site by both the attitude capability of the satellites (off –nadir or maneuver capability) and orbit condition, which altered than the repeat coverage cycle which depends only on the orbit specification, then it is obvious that the payload of the satellite can view a specified target site in off-nadir by either the swath width of sensor is wide enough to cover the target or by using tilt maneuver capability of the satellite with a narrow swath width. The revisit time is calculated by solving the equations of orbit of the six classical orbital elements (a, e, ω, i, Ω, ϑ), and the position vector of satellite can be obtained at any time of orbit which is converted to sub satellite points of satellite and by calculating of slant range between the satellite and target site the time and number of access over the target site can be calculated.



Figures (6)

-Slant range (D)

$$D = ((R_e)^2 + (r)^2 - 2.R_e.r\cos\chi)^{1/2} \qquad (13)$$

r…….is the radial position of satellite $r = R_e + H$

R_e…...is the earth's radius

-Earth central angel between target and sub satellite point (χ)

$$\chi = \frac{R_e}{r} \qquad (14)$$

$$\cos\chi = \sin\phi_p, \sin\phi + \cos\phi_p,. \mathrm{Cos}\phi. \cos\left|\lambda_p - \lambda\right|$$

Where ϕ_p, λ_p ……………. are ground point (target) latitude and longitude

Where φ, λ ………………… are sub satellite point latitude and longitude

(Computed before in previous section)

-Half width of the satellite swath (R_{sat})

$$R_{sat} = R_e . \sin\chi$$

Where χ_{sat} …………………is the earth centered angel

3.2 SUN ELEVATION ANGLE

The angular elevation of the sun in the sky which measured from the horizontal is defined by the sun elevation angle, this elevation angle changes over the day depending on the day of the year and the latitude of the target position's where this angle at sunrise is equal to 0°and when the sun is overhead is equal 90°, at any point of the surface when the elevation angle is in the range between 10° to 90° it is mean that the observation is possible. The light region moves from east to west with velocity of 15 degree per one hour on the earth surface, in the case of prograde orbit the satellite moves eastward but if case of retrograde the satellite moves westward in the second case the direction of the movement of the light stain coincides with the direction of rotation of the satellite and the maximum duration of earth coverage is more in this case.

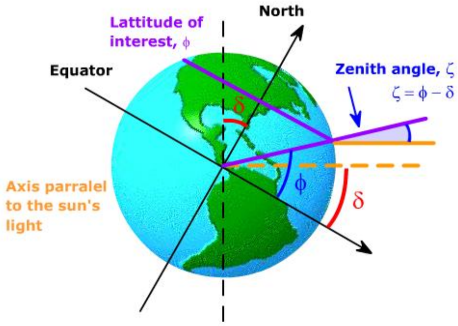


Figure (7)

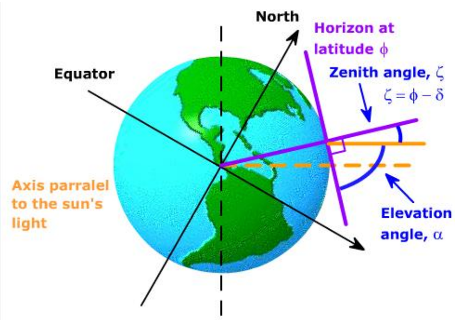


Figure (8)

-The zenith angle (ζ) is the angle between the sun and the vertical. This angle is measured from the vertical different than the elevation angle which is measured from the horizontal.

$$\zeta = 90 - \alpha$$

From figures (7,8) a formula for the elevation angle at solar noon can be determined according to the formula

$$\alpha = 90 + \varphi - \delta \qquad \text{if } \delta > \varphi \qquad (16)$$

$$\alpha = 90 - \varphi + \delta \qquad \text{if } \delta \leq \varphi$$

Where:

φ ……… is the latitude of the location of interest (+ve for the hemisphere and -ve for the southern hemisphere).

δ ………. is the declination angle, which depends on the day of the year.

-The elevation angle varies during the day. The elevation (α) can be found using the following formula:

$$\alpha = \sin^{-1}[\sin\delta\sin\varphi + \cos\delta\cos\varphi\cos(\mathrm{HRA})] \qquad (17)$$

HRA……………. is the hour angle

$$\mathrm{HRA} = 15\,(\mathrm{t} - 12) \qquad \text{if } \mathrm{t} > 12 \qquad (18)$$

$$\mathrm{HRA} = 15(-\mathrm{t} - 12) \qquad \text{if } \mathrm{t} \leq 12$$

RESULTS AND DISCUSSION:

By creating model of software depending on the mathematical equation the difference between SSO and inclined orbit can be studied in the number and time of revisit time according to specific time as case study where the time of scenario is selected from 01 July 2017 10:00:00 UTC to 20 July 2017 10:00:00 UTC. For inclined orbit (A) and sun synchronous orbit (B) respectively taken into account the capability maneuver of satellite for maximum incident angle (45°),Table (2) and Table (3) shows the access report for target site latitude (φ =30°) and target site longitude (λ =31°).

Table (2) Revisit time for orbit (A) with inclination 51.6 and altitude 729 km

Access	Date/Time	Sun elevation	Sub sat Lat	Sub sat Long	Access	Date/Time	Sun elevation	Sub sat Lat	Sub sat Long
1	01/07/2017 11:49:37	82.771055	28.394372	33.024620	18	10/07/2017 19:54:58	-11.24385	29.732217	30.661555
2	01/07/2017 20:35:26	-17.63694	29.136678	29.913875	19	11/07/2017 12:02:18	82.12790	33.8168501	26.807248
3	02/07/2017 12:42:48	78.207072	34.458619	26.233354	20	11/07/2017 19:04:19	-1.871941	34.710948	36.069837
4	02/07/2017 19:44:48	-8.948521	34.111815	35.450944	21	12/07/2017 11:11:40	76.47016	28.866042	32.428708
5	03/07/2017 11:52:09	82.786841	29.463208	31.677428	22	12/07/2017 19:57:29	-11.85794	28.666248	29.320717
6	03/07/2017 20:37:56	-18.13524	28.107531	28.515298	23	13/07/2017 19:06:53	-2.515572	33.588117	35.016682
7	04/07/2017 19:47:22	-9.502512	32.978892	34.376538	24	14/07/2017 11:14:11	76.71494	29.929868	31.092605
8	05/07/2017 11:54:40	82.729099	30.520457	30.355821	25	14/07/2017 19:59:59	-12.48337	27.632508	27.911906
9	05/07/2017 20:40:26	-18.65537	27.068525	27.094710	26	15/07/2017 19:09:26	-3.16827	32.487807	33.876082
10	06/07/2017 11:04:12	75.53202	25.829984	36.789992	27	16/07/2017 11:16:42	76.92121	30.981784	29.782692
11	06/07/2017 19:49:55	-10.06766	31.869474	33.216489	28	16/07/2017 20:02:28	-13.12603	26.632837	26.439055
12	07/07/2017 11:57:12	82.599582	31.606901	29.108446	29	17/07/2017 10:26:14	67.06537	26.268516	36.127912
13	07/07/2017 20:42:55	-19.18936	26.064105	25.611158	30	17/07/2017 19:11:58	-3.83642	31.412965	32.653828
14	08/07/2017 11:06:41	75.876857	26.836307	35.302140	31	18/07/2017 11:19:16	77.08513	32.103595	28.595950
15	08/07/2017 19:52:27	-10.65008	30.786412	31.976461	32	19/07/2017 10:28:43	67.39338	27.271250	34.648164
16	09/07/2017 11:59:45	82.398165	32.720066	27.940354	33	19/07/2017 19:14:30	-4.516705	30.324064	31.401103
17	10/07/2017 11:09:10	76.187550	27.834234	33.833209					

Table (3) Revisit time for orbit (B) SSO (i=98.2, altitude=729 km)

Acces s	Date/Time	Sun elevation	Sub sat Lat	Sub sat Long	Access	Date/Time	Sun elevation	Sub sat Lat	Sub sat Long
1	01/07/2017 10:08:11	64.156568	29.5359718	28.647225	13	10/07/2017 21:37:04	-27.41596	29.017982	36.485824
2	01/07/2017 22:17:14	-31.39489	29.2571007	35.169015	14	12/07/2017 09:30:00	55.45357	29.356658	27.610442
3	03/07/2017 10:10:12	64.516265	29.1773307	26.278300	15	12/07/2017 21:39:03	-27.89419	29.436422	34.132167
4	03/07/2017 22:19:13	-31.72041	29.675493	32.815725	16	13/07/2017 08:42:00	45.00855	31.6268098	38.238179
5	04/07/2017 09:22:09	54.132145	31.328251	36.939513	17	14/07/2017 09:32:00	55.76083	28.9979878	25.241281
6	05/07/2017 10:12:12	64.866787	28.8186301	23.908906	18	14/07/2017 21:41:02	-28.39181	29.8547799	31.779156
7	05/07/2017 22:21:12	-32.06802	30.0938042	30.463091	19	15/07/2017 08:43:57	45.30294	31.0893727	35.919858
8	06/07/2017 09:24:06	54.474736	30.7907335	34.620532	20	16/07/2017 21:43:00	-28.91078	30.3328010	29.442487
9	07/07/2017 22:23:10	-32.43931	30.5717700	28.126865	21	17/07/2017 08:45:54	45.58995	30.5517902	33.600358
10	08/07/2017 09:26:03	54.810044	30.2530717	32.300392	22	18/07/2017 21:44:58	-29.44863	30.8107109	27.106710
11	09/07/2017 22:25:08	-32.83096	31.1093471	25.807408	23	19/07/2017 08:47:52	45.86570	30.0738198	31.264094
12	10/07/2017 09:28:01	55.134074	29.7750323	29.963578	24	19/07/2017 20:56:53	-22.65475	28.8386263	37.818186

From Table (2) and Table (3) it seems that the numbers of access times on ground point which ground latitude is (30°) and longitude (31°) for inclined orbit with inclination 51.6 are more than the sun synchronous orbit with inclination 98.2.

Although that the sun synchronous orbit has some advantages than inclined orbit for optical satellite that make it the first option for system engineers during the orbit selection in an observation space missions. Some of these advantages are given as follows:

- The good resolution of image for earth surface
- The angle between orbital plane and sun remains constant that make the revisit time for a certain location has the same local time every day.
- The constant illumination condition helps the user in the processing, mosaic, interpretation and good resolution of earth surface imaging.
- The good observation of the whole Earth particularly for high latitudes.
- The repetitive feature of sun synchronous orbit allows satellites to cover most of the Earth's surface over a certain period of time.

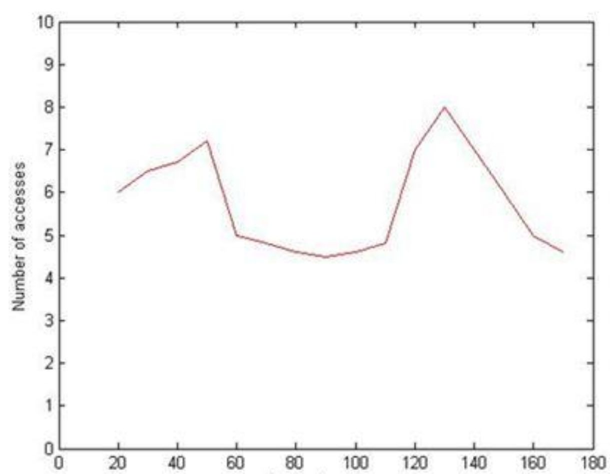


Fig (9)

Figure 9 indicates average number of accesses a target with coordinates (30°, 31°) and satellite during a day for satellite at altitude 729 km. then by varying the six elements of orbit the designers have a lot of solutions of orbits between these orbits they can pick the optimal orbit according the users and mission requirements.

CONCLUSIONS:

At this paper anew algorithm is introduced to analysis and designs the circular orbits for remote sensing satellite by computing the revisit time takes into consideration the maneuver capability of satellite (tilt angle), the orbit and the lighting condition (sun elevation angle for the target at the time of shooting). the six orbit parameters (semi-major axis, inclination, argument of perigee, true anomaly, eccentricity, right ascension of the ascending node) are proposed as initial condition and by varying in these orbital elements a lot of orbits can be obtained, then by computing the sub-satellite points of satellite every one second under the effect of gravitational second zonal harmonic, the ground track can be mapped for a specified interval of time and the position of the satellite in its orbit can be obtained, after all the revisit time is modeled and established of the target site for interval of time. Between these orbits solutions the optimization of the orbit can be done by the designers which meets the mission and customer requirements. Finally the results were analyzed by satellite tool kit (STK) to verify and evaluate the performance of the new algorithm.

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