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THE INVESTIGATION OF EQUATION AND ALGORITHM OF THE MIRROR CONCENTRATING SYSTEM MOVEMENT

Abstract. For optimal control of the mirror concentrating system the automated control system of heliostat identified for its possible errors. The equations of motion are considered tracking object, taking into account the geographical coordinates of the mirror concentrating system, the real situation of axes of rotation and accuracy is characteristics of the rotary support.

There are analyzed equations of mirror concentrating system motion on the basis of which it was concluded that motion algorithm must necessarily take into account the mirror concentrating system non vertical (the exact vertical position of bearing) azimuth (stationary) axis of rotation or θ and ψ angles describing the angle of the axis of rotation relative to the vertical space.

Keywords: automatic system, mirror concentrating systems, vector, coordinate system, heliostat, rotation.

Introduction. Most of the objects tracking can be divided into two types: the first type are objects that are moving relative to the Earth (airplanes, spacecraft, earth, moon) in its field of attraction; the second type are objects on the celestial sphere, apparent motion (Sun, stars). The difference between them is that the first types of movement are determined by the characteristics of the object itself, the second movement types defined by the law of motion of the Earth around its axis, the movement of the Earth around the Sun and the Sun in outer space. Great distance from the Earth to the stars, cause that tracking of the Sun or other stars should in principle is carried out according to the motion of the Earth around its axis. The equations of motion of the Earth are quite complicated, due to precession, and nutation of the Earth's axis of rotation.

There are known different approximation equations of motion of the Earth, by tabular in astronomy and approximate analytic equations [1-6].

Approximate analytical equations define the daily law of motion of the Earth (it is assumed that the decline permanently) or the apparent movement of the Sun around the Earth. These equations are simply transferred to the local geographic coordinate system (CS) (one of the axes is directed along the vertical space). To determine the feasibility of the algorithm for motion program control of mirror concentrating systems (MCS), it is necessary to assess its probable error. The automated management system heliostats (AMSH) may include the following errors: - error of determining the base (label) - Δ_N (independent error includes the pointing of the reflected beam on the receiver - Δ_{NO}, the error of the angle sensor EDI- Δ_{NY}), error of the gear - Δ_P and manufacturing errors and placing the axes of rotation MCS - Δ_O and errors of law of motion of the object Δ_M. These errors result duringthe software control of MCS to errors in the orientation of MCS in azimuth Δ_A and Zenith Δ_h.

$$\Delta_A = A_P - A \quad (1)$$

$$\Delta_h = h_P - h, \quad (2)$$

where A, $A_P$andh_P, h – valid (with respect to the real axis) and calculated (relative to the local CS) azimuthal and zenithal angles of rotation of the hub.

There was analyzed the equations motion of object tracking (in particular, the Sun) according to the geographical coordinates of the MCS, the real position of the axes of rotation and accuracy characteristics of the rotary support. The relationship between the angular position of the Sun, MCS and its mode of operation (direct tracking of the Sun, or the direction of the rays to a given receiver) occurs through the vector reflection equation [7-10].

$$n = (b + c)/ [2^* (1+b^*c)]^{0.5}, \quad (3)$$

where, the vector n determines the angle position of the MCS. For clarity, in (3) with the unit vector that defines the position of the Sun, directed to the Sun, the unit vector b determines the position of the reflected beam is directed from the MCS to the receiver. If the vectors c and b are given, then from (3) is uniquely determined by the position of the vector n or the MCS position in space. When looking through the optical sensor (incident or reflected beam of the Sun) needed in the equation and its solution fall away. For automated control of equation relative angles of rotation of the MCS (of heliostat)must be represented in explicit form.

The research part. The equation (3) shows that the position of the vector n in space or orientation does not depend on the type and scheme of the axes of rotation (equatorial, azimuthal-zenithal, etc.). However, it is obvious that the position of the rotation axes depends on the projection of the vector n or the angles and the angular velocity MCS (heliostat). Therefore, in order to specify the equations of motion of MCS, its axis of rotation must be specified. And to solve the problem, the laws of transformation of vectors b and c in timeobviously must be known.

The denotation ofthe main parameters have characterized the position of the hub on the surface of the Earth and the basic coordinate system of the task (Figure 1).

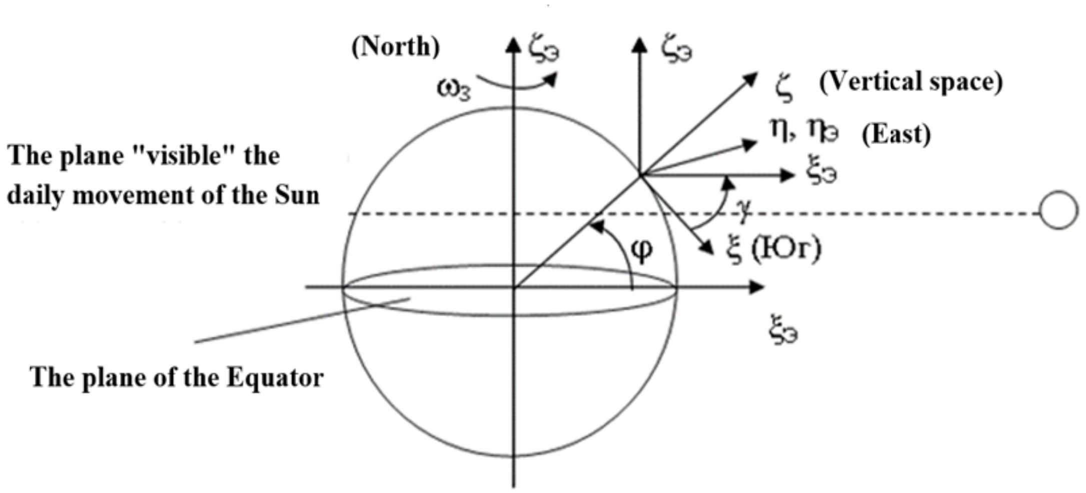

Figure 1 - Position of the hub on the surface of the Earth

Figure 1 shows that there are two main systems of coordinates – equatorial (CS_E), which determines the “visible” position and movement of the Sun in space depending on the location of installation of the hub on the Earth's surface – latitude φ and longitude λ_0 (if the reference of the longitude is relative to the local meridian it is obvious $\lambda = 0$) and local coordinate system (CS_M), which determines the orientation angles of the Sun, hub, and the reflected beam on the ground.

Because of the distance to the Sun, it is believed that the centers of these coordinate systems coincide. There are considered the equations of motion of MCS taking into account factors such as the inaccuracy of placing the axes of rotation. There are practically not considered the problem of the influence on the movement MCS inaccuracies of the position in space of the azimuthal and zenithal axes of rotation of MCS. Taking into account the method proposed in [8] - application of the matrix of rotations in general case of the problem is considered.

To describe the vectors c, b, n the following coordinate system (CS) are presented:

“equatorial” - CS_E, with the direction of the axes $O\xi_E$ - to the South, $O\eta_E$ - on East and $O\zeta_E$ - along the axis of rotation of the Earth (Figure 2);

"local" – CS_L, with the direction of the axes $O\xi$ to the South, $O\eta$ - East, and $O\zeta$ - vertical space (figure 2);

"initial" – CS_I, the coordinate system that defines the initial position of the axes of rotation relative to the CS_L, with the directions of the axes OZ - stationary or azimuthal rotation axis, OY is movable along the "zenithal" of the axis of rotation and OX so directed that it forms with the axes OY and OZ right coordinate system;

"connected" – CS_C associated with the hub or its central normal n, the axis directions OX_H – normal hub (heliostat), and OY_H and OZ_H form OX_H right cartesian CS.

In the initial moment of time, CS_H and CS_I are the same. These two CS, in general, is sufficient for the analysis of the kinematics of the hub and in the general case, when there is an "inclination" of the horizontal axis of rotation at an angle of χ. Thus, even with the χ formally, we can apply the same sequence of transitions between the CS, or

$$\begin{gathered}\gamma\theta,\psi\chi,\alpha,\beta\\ CS_E\rightarrow CS_L\rightarrow CS_I\rightarrow CS_H\end{gathered}\tag{4}$$

Where γ, θ, ψ, χ, α, β - the angles of crossing between the CS (Figure 2). It is noted that in contrast to [9-12], corners θ, ψ, do not characterize the directional inclination of the vertical axis, and the inaccuracy of its position with respect to the vertical.

As can be seen in contrast to (1) the need to consider the more general case, account for the angular inclinations of the horizontal axis of rotation about a vertical axis of rotation of the hub (heliostat). In this scheme, the transition between CS_H and CS_I, which includes the angular deviation of the horizontal axis of rotation is advantageously carried out in the form of a single rotation of the horizontal axis of the MCS at a constant angle χ.

For the algorithm of the movement of mirror concentrating systems, in principle there is no need in detailing the schemes of transition or angle of crossing between the CS, however in practice it matters because you need to snap these angles to possible bases of reference and to take into account the native playback capabilities of the corners, large 90^0. There is assumed that a positive reference angle is clockwise, the other samples will be discussed. In view of the general schemes, transitions $CS_E\rightarrow CS_L\rightarrow CS_I$ will remain unchanged. Thus, the subject taken in [5,8,9] of the rules of rotations, transitions between CS are of the form (Figure 2).

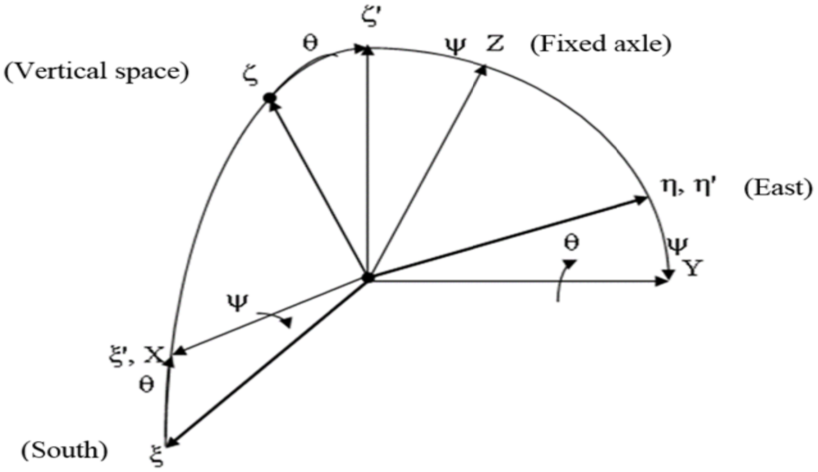

Figure 2 - Scheme of the transition from CS_L to CS_I

There are presented briefly these transitions. The transition from equatorial system CS_E to local CS_Ltaking into account that $\gamma = 90 - \varphi$ is the following:

"direct transition"

$CS_E \rightarrow CS_L$

	ξ_E	η_E	ζ_E
ξ	$\sin\varphi$	0	$-\cos\varphi$
η	0	1	0
ζ	$\cos\varphi$	0	$\sin\varphi$

"reverse transition"

$CS_L \rightarrow CS_E$

	ξ	η	ζ
ξ_E	$\sin\varphi$	0	$\cos\varphi$
η_E	0	1	0
ζ_E	$-\cos\varphi$	0	$\sin\varphi$

(5)

The transition from SC_L to SC_I (figure 2) connected with the vertical axis of MCS (heliostat) it is necessary to consider that in this case the angles θ and ψ are small (determine the actual position of the vertical axis of rotation relative to vertical), or

"direct transition" -$CS_L \rightarrow CS_I$

	ξ	η	ζ
X	1	0	θ
Y	$\theta*\psi$	1	$-\psi$
Z	$-\theta$	ψ	1

(6)

The following is correspondingly obtained:

"reversetransition" – $CS_I \rightarrow CS_L$

	ξ	η	ζ
X	1	$\theta*\psi$	$-\theta$
Y	0	1	$\sin\psi$
Z	θ	$-\psi$	1

(7)

There is considered the scheme of transition from CS_I to SC_Htaking into account the angle of inclination of the horizontal axis of rotation at an angle of χ (figure 3).

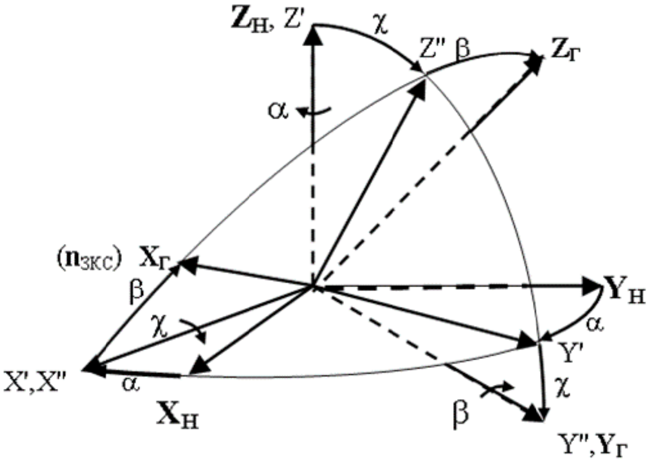

Figure 3 - Diagram of turning angles from CS_I to CS_H

There is the following matrix of transition between CS_I and CS_H from figure 3.

"direct transition"-$CS_I \rightarrow CS_H$

	x	y	z
x_H	$\cos\alpha * \cos\beta$	$-\sin\alpha * \cos\beta$	$\sin\beta * \cos\chi$
y_H	$\sin\alpha * \cos\chi$	$\cos\alpha * \cos\chi$	$-\sin\chi$
z_H	$-\cos\alpha * \sin\beta$	$\sin\alpha * \sin\beta$	$\cos\beta * \cos\chi$

(8)

"reversetransition" – $CS_H \rightarrow CS_I$

	x_H	y_H	z_H
x	$\cos\alpha * \cos\beta$	$\sin\alpha * \cos\chi$	$-\cos\alpha * \sin\beta$
y	$-\sin\alpha * \cos\beta$	$\cos\alpha * \cos\chi$	$\sin\alpha * \sin\beta$
z	$\sin\beta * \cos\chi$	$-\sin\chi$	$\cos\beta * \cos\chi$

(9)

Since all these matrices are singular, then the reverse transition is realized by simple rotation matrix elements around the diagonal of its left diagonal. It is noted that the angles of rotation of the hub (heliostat) - α, β must be found from a solution of equations, usually given are the vector of incident solar radiation and its direction after the reflection, or the vector b. There are various ways of determining rotation angles α, β – spherical triangles, the scalar product, the trigonometric functions, but the easiest way is the definition of rotation angles from matrix equations in [6] is stated. The essence of the method concluded in the following: the position of the vector n in the two systems of coordinates, then transition matrices of the resulting joint system of equation for determination of angles of rotation of the hub α and β in the rotation axes.

Results and discussion. This scheme is applicable for determining the angles of rotation of the hub. The first go the vectors b and c. When using the matrix of transition between CS these vectors, it is desirable to determine in the CS, where their representation is most clear and simple [14-16]. So for the vector c is equatorial CS (figure 4), from which it follows that in CS_E

$$c_{\xi E} = \cos\lambda * \cos\delta\,;\; c_{\eta E} = -\sin\lambda * \cos\delta\,;\; c_{\zeta E} = \sin\delta\,; \qquad (10)$$

whereλ - width of the Sun, is

$$\lambda = \omega_{Earth} * \mathrm{t} \qquad (11)$$

where ω_{Earth} - angular velocity of rotation of the Earth and t is the time of day, measured from noon δ - longitude of the Sun.

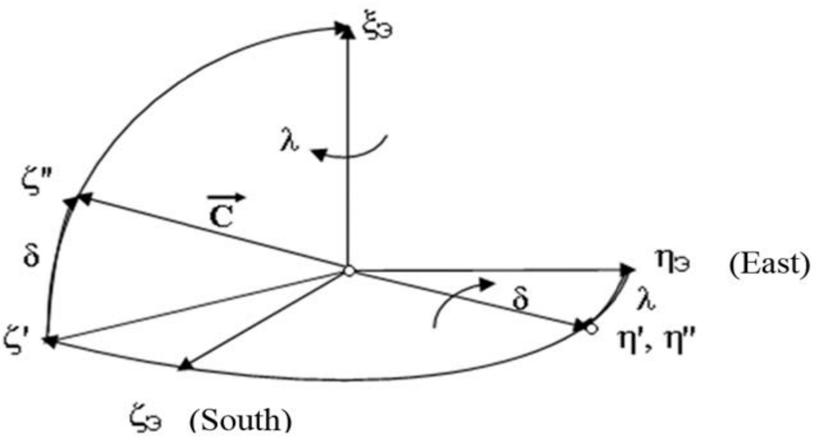

Figure 4 - Definition of the components of the unit vector of the Sun in the equatorial coordinate system CS_E

The unit vector of the reflected beam b is conveniently set in the CS_L and its components, such as peer - to- b_ξ, b_η, b_ζ.

Translate in CS_L and the vector **c**, using the transition matrix

$$c_\xi = \cos\lambda * \cos\delta * \sin\varphi - \sin\delta * \cos\varphi$$

$$c_\eta = c_{\eta E} - \sin\lambda * \cos\delta \qquad (11)$$

$$c_\zeta = \cos\lambda * \cos\delta * \cos\varphi + \sin\delta * \sin\varphi$$

the components of the vector n in the CS_L are equal,

$$n_\xi = (b_\xi + c_\xi)/\mathrm{M};\; n_\eta = (b_\eta + c_\eta)/\mathrm{M};\; n_\zeta = (b_\zeta + c_\zeta)/\mathrm{M}, \qquad (12)$$

where, for brevity, denoted by M = $(2*(1+ bc))^{0.5}$. Further, from matrix, the smallness of the angles θ and ψ is given, that the components of n in CS_I is equal to the next equations:

$$n_X = n_\zeta + n_\eta * 0 + n_\zeta * \theta$$

$$n_Y = n_\zeta * \theta * \psi + n_\eta - n_\zeta * n\psi \qquad (13)$$

$$n_Z = -n_\zeta * \theta + n_\eta * \psi + n_\zeta$$

On the other hand, from the CS_H, we know that in CS_H components n is equal to: 1, 0, 0, or turning them into CS_I with matrices the next equations are obtained:

$$n_X^* = \cos\alpha * \cos\beta$$
$$n_Y^* = - \sin\alpha * \cos\beta \qquad (14)$$
$$n_Z^* = \cos\chi * \sin\beta$$

Since it is one and the same vector, the left parts of (13) and (14) are equal to

$$n_X = n_X^*$$
$$n_Y = n_Y^* \qquad (15)$$
$$n_Z = n_Z^*$$

whence, it follows that the right parts (13) and (14)must be equal, or get a system of three equations:

$$\cos\alpha * \cos\beta = n_X = n_\zeta + n_\eta * 0 + n_\zeta * \theta \qquad (16)$$

$$-\sin\alpha * \cos\beta = n_Y = n_\zeta * \theta * \psi + n_\eta - n_\zeta * n\psi \qquad (17)$$

$$\cos\chi * \sin\beta = n_Z = -n_\zeta * \theta + n_\eta * \psi + n_\zeta \qquad (18)$$

Given that the angle of χ horizontal axis relative to vertical is constant, from (17) the expression for the angle of rotation of the MCS around the horizontal axis β is obtained,

$$\beta = \arcsin(n_Z / \cos\chi) \qquad (19)$$

and for the "azimuth" angle MCS around the vertical axis of rotation α

$$\alpha = \arcsin\{- n_Y /([1 - (n_Z / \cos\chi)^2]^{0.5} \} \qquad (20)$$

In the particular case when $\chi = 0$, at the expression is obtained as (1) equation.

Conclusion.

Thus, from the analysis of the obtained equations of motion of MCS it can conclude that the algorithms of the movement MCS to consider nevertheless (the exact vertical location of the support) azimuthal (fixed) rotation axis, or the angles θ and ψ characterizing the angle of inclination of the axis of rotation relative to the vertical. Also,it was noted that the influence of the angle of inclination of the horizontal (zenithal) axis of rotation on the equations of motion is negligible and may be ignored. In general, from the analysis of the equations of motion of MCS, it follows that the equations of motion of all stellar bodies (except satellites) will be the same and in fact are determined by the equation of motion of the Earth. This means that software control of the orientation of the MCS at the Sun or any other star will be the same.

REFERENCES

[1] Archer B. 1980. Comments on "Calculating the position of the Sun", Solar Energy 25, 91.

[2] Ismailov S.U., Musabekov A. A.2013. Management tasks Research orientation solar MCS The scientific journal "Bulletin KazATC them M.Tynyshpayev" No 3. Almaty, 49-54 pp.

[3] R. Walraven. Calculating the position of the sun. // Solar Energy, 1978. 20, P.393-397

[4] Joseph J. 1988. The Astronomical Almanac's Algorithm For Approximate Solar Position Solar Energy. Vol. 40. No. 3, 227-235 pp.

[5] Saribayev S.A., Abdurakhmanov A., Akbarov P.Y., Fayzeyev S.A., Klitshev S., Abdel-Majid A.A., Abdel-Salam A.F. . 2006. The High Temperature Solar Furnace of Tabbin Institute for Metallurgical Studies, Ministry of Industry and Technological Development, ARE. Bulletin-TIMS, Volume 82 July 2003, Total page 12, Egipt, Cairo.

[6] S.A.Saribayev, Abdurakhmanov A.,Bakhramov S.A, Klitshev S.I. 2010. Method definitions not verticality azimuthal axis of the rotation mirror concentrating systems. "Applied Solar Energy" No 2, 67-70 pp.

[7] Saribayev S.A., Abdurakhmanov A.A, Fazilov A.A, Orlov S.A. 2010. Influence non vertical azimuth axis of rotation of the concentrtor (heliostat) the accuracy of the software tracking. The "Applied Solar Energy" No 4, 80-82 pp.

[8]Saribayev S.A., Abdurakhmanov A.,S.ABakhramov, S.I. Klitshev., Orlov S.A. Method definitions not verticality azimuthal axis of rotation. Patent IAP 04953, No 9.

[9] Serik U. Ismailov, Abdushukur S. Sarybaev, Akhmetbek A. Musabekov, Serik K. Dossybekov, Gani A. Besbaev2014. Application of Wireless Means of Communication and Independent Power Supply for Centralized Control and Monitoring Heliostatic Units International Conference of Industrial Technologies and Engineering (ICITE), Shymkent, 322-325 pp.

[10] Satybaldiyeva, F.A., Beysembekova, R.N., Sarybaev, A.S., Esenbekova, G.J. 2017, Journal of Theoretical and Applied Information Technology 95(21), 5848-5858 pp.

[11] Abdullin, E., B. Automation of coordinate measurements in mechanical engineering: Tutorial / EB Abdullin. SPb., 2016. - 160 P.

[12] Borodin, I. F. Automation of technological processes and automatic control systems (ACS) / I. F. Borodin. M.: Koloss, 2006. 352 P.

[13] Klyuev, A. S. The automation of configuration management systems / A. S. Klyuev, V. J. Rotach, V. F. Kuzishin. Moscow: Alliance, 2015. 272 P.

[14] Skhirtladze, A. G. Automation of technological processes and production: Textbook / A. G. Skhirtladze, A. V. Fedotov, V. G. Khomchenko. Moscow: Outline, 2012. 565 P.

[15] The question, K. P. Automation of measuring, testing and control / K. P. Question. - Moscow: , 2006. 312 P.

16. Martakov, A. I. automation of technological processes and production. Fundamentals of professional activity / A. I. Martyanov. - Moscow: MGIU, 2010. 384 P.

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АЙНА ШОҒЫРЛАНДЫРУШЫ ЖҮЙЕНІҢ ҚОЗҒАЛЫС ТЕҢДЕУІ МЕН АЛГОРИТМІН ЗЕРТТЕУ

Аннотация. Айна шоғырландырушы жүйені оңтайлы басқару үшін оның мүмкіндік қателіктері автоматтандырылған гелиостатты басқару жүйесінде анықталды. Айна шоғырландырушы жүйесінің геграфиялық координатты ескере отырып, нысананың ізіне түсу қозғалыс теңдеуі, айналу білігінің айқын орналасуы және тірек-бұрылыс құрылғының дәлдік сипаттамалары қарастырылды.

Айна шоғырландырушы жүйенің алынған қозғалыс теңдеулері оның қорытындысы негізінде жасалғаны талдалған. Айна шоғырландырушы жүйенің қозғалыс алгоритмінде келесі аталғандарды міндетті түрде есепке алу керек: тіктік еместік (оның тіктік тіректің орналасуы), азимутттық (қозғалыссыз) айналу білігі немесе θ және ψ бұрыштар біркелкі тік орнына айналу білігінің көлбеу бұрышын сипаттаушы.

Түйін сөздер: автоматты жүйе, айна шоғырландырушы жүйе, вектор, біріктіру жүйесі, гелиостат, айналу.

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ИССЛЕДОВАНИЕ УРАВНЕНИЯ И АЛГАРИТМА ДВИЖЕНИЯ ЗЕРКАЛЬНОЙ КОНЦЕНТРИРУЮЩЕЙ СИСТЕМЫ

Аннотация. В автоматизированной системе управления гелиостатом для оптимального управления зеркальной концентрирующей системой определены её возможные погрешности. Рассмотрены уравнения движения объекта слежения с учетом географических координат зеркальной концентрирующей системы, реального положения осей вращения и точностными характеристиками опорно-поворотного устройства.

Проанализированы полученные уравнения движения зеркальной концентрирующей системы, на основе которого сделан вывод. В алгоритмах движения зеркальной концентрирующей системы необходимо обязательно учитывать следующее: не вертикальность (точное вертикальное расположение опоры) азимутальной (неподвижной) оси вращения или углы θ иψ, характеризующие угол наклона оси вращения относительно вертикали места.

Ключевые слова: автоматическая система, зеркальная концентрирующая система, вектор, координирующая система, гелиостат, вращение.

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