THE EFFICIENCY OF SUN TRACKING SYSTEMS

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Abstract: *The paper considers the effectiveness of the application of tracking systems. It is shown the effectiveness of the use of solar tracking systems, for further application of the results obtained in the design of a software and hardware complex for monitoring and controlling a photovoltaic station.*

Key words: *tracing system, solar radiation, monitoring, photovoltaic station.*

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Эффективность систем слежения за солнцем

Аннотация: *В статье рассматривается эффективность применения систем слежения. Показана эффективность использования систем слежения за солнцем, для дальнейшего применения полученных результатов при проектировании программно-аппаратного комплекса мониторинга и управления фотоэлектрической станцией.*

Ключевые слова: *система слежения, солнечная радиация, мониторинг, фотоэлектрическая станция.*

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Quyoshni kuzatish tizimlarining ahhamiyati

Annotatsiya: *Maqolada kuzatuv tizimlarini qo'llash samaradorligi ko'rib chiqilgan. Fotoelektr stantsiyani kuzatish va boshqarish uchun dasturiy-apparat kompleksini loyihalashda olingan natijalarni kelgusida qo'llash uchun quyosh energiyasini kuzatish tizimlaridan foydalanish samaradorligi ko'rsatilgan.*

Kalit so'zlar: *kuzatuv tizimi, quyosh radiatsiyasi, monitoring, fotoelektr stantsiyasi.*

Introduction

Among renewable energy sources, solar energy is of the greatest interest. Solar energy is characterized by maximum ease of use, the greatest resources, environmental friendliness and ubiquity. However, the high cost of energy systems limits the widespread use of solar energy. Another factor limiting the spread of solar energy is the conversion factor of incident solar energy: it does not exceed 20%. The solution to this problem can be a tracking system for the sun. When using available solar energy, the use of various tracking systems can increase the efficiency of installations up to 80%.

The paper considers the effectiveness of the application of tracking systems. The purpose of the work: to study the effectiveness of the use of solar tracking systems, for further application of the results obtained in the design of a software and hardware complex for monitoring and controlling a photovoltaic station.

A certain amount of energy is constantly supplied to the surface of the Earth from the Sun. For 1 m^2 of the earth's surface, perpendicular to the direction of the sun's rays, there is a fairly constant amount of energy. Thus, the power of the light flux at the Earth's surface at the equator reaches 1.1 kW/m^2, and at our latitudes - about 0.7 kW/m^2. Approximately 20% of this energy can be converted into electrical energy by solar panels [1].

The maximum performance of solar panels is achieved by precisely orienting the photovoltaic modules to the sun. In this case, the task of the tracking device is to reduce the angle of incidence of the sun on the working surface of the photovoltaic modules. The position of the solar modules can be changed by means of a drive.

There are several ways to control the orientation of solar panels:

- Manual way of orientation to the sun;
- Passive way of orientation (position of modules is determined by control algorithms);
- Active methods.

Active systems have an advantage over passive and manual orientation methods. Active systems not only focus on the maximum solar flux, but also take into account the reflected energy [2]. Therefore, today the active method is the most effective way to target modules. The flux of direct solar radiation S to the surface located at an angle φ (Figure 1) to this flux is equal to:

$$S = S_m \cdot K \cdot \cos\varphi \quad (1)$$

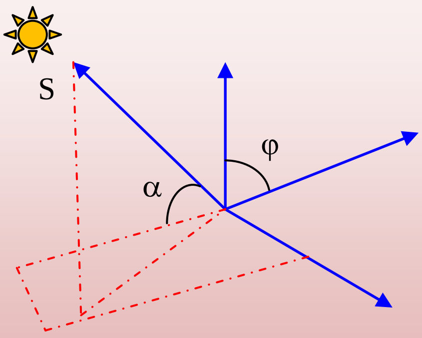

Figure 1 - Solar angle for the observer

S_m is the amount of radiation that comes from the Sun to the Earth, φ is the reduced angle of incidence of the sun's rays on the insolate surface, K is the correction factor for the air mass that the beam needs to pass

$$K = 1.125 - \frac{0.14}{\sin h};$$

$$\cos\phi = \sin h \cdot \cos\alpha + \cos h \cdot \sin\alpha$$

α is the angle of inclination of the FM plane to the horizon, h is the height of the solstice. This is the angle that determines the height of the Sun above the horizon at a given time. When using a biaxial positioning system, the surface of the photovoltaic panels is directed towards the Sun, therefore, the angle φ between the surface normal and the sun's rays is 0, and then the power of the solar panels is maximum, which is consistent with the formula:

$$S = S_m \cdot K. \quad (2)$$

When using a single-axis system, the module rotates only in one plane, and the second is static [3]. For a uniaxial orientation system, the formula has the form:

$$S = S_m \cdot K \cdot \cos(\theta\text{-}h),$$

For a static panel installed at an angle to the horizon, the formula is

$$S = S_m \cdot K \cdot \cos(\theta\text{-}h) \cdot \cos(90^{o}\text{-}t) \cdot$$

Figure 2 shows the results of power gain with the use of two- and one-axle systems relative to a system installed at an angle to the horizon. From this histogram, we can conclude that the most gain in power collection is observed in summer when using tracking systems. This is due to the fact that the fixed system is directed to the south and cannot capture solar energy falling towards it at an angle greater than 90 °. This is exactly the time of year in which tracker tracking systems give the greatest effect. However, it should be taken into account that this is a mathematical model that does not take into account all factors, but it can be concluded from it that solar panel orientation systems are effective.

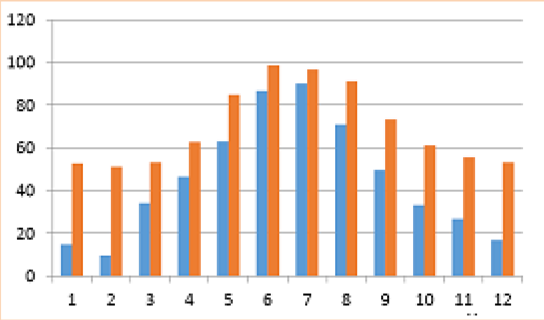

Figure 2. Dependence of the power gain with the use of tracking systems relative to the one installed at an angle

Conclusion

We study the effectiveness of the use of solar tracking systems, for further application of the results obtained in the design of a software and hardware complex for monitoring and controlling a photovoltaic station.

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