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05.01.01 – Muhandislik geometriyasi va kompyuter grafikasi. Audio va video texnologiyalari
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05.01.05 – Axborotlarni himoyalash usullari va tizimlari. Axborot xavfsizligi
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05.02.00 – Mashinasozlik va mashinashunoslik
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05.03.02 – Metrologiya va metrologiya ta'minoti
05.04.01 – Telekommunikasiya va kompyuter tizimlari, telekommunikasiya tarmoqlari va qurilmalari. Axborotlarni taqsimlash
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05.08.06 – "G'ildirakli va gusenisali mashinalar va ularni ishlatish" (texnika fanlari)
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EFFECTIVE WAYS TO USE DEVICES OPERATING IN A MECHATRONICS SYSTEM

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Abstract: The article presents the results of experimental studies of innovatively designed light traps for controlling and monitoring the development stages of pest insects based on mechatronic light traps. The device, which operates on the mechatronic system, automatically monitors insects during the day, as a result of which types of harmful insect populations are studied. The mechanisms of the solar panel movement change depending on the movement of the sun have been studied. When darkness falls, the device is activated using light sensors. The light lamp attracts flying pest insects by affecting the light pathogen wavelength and calling them. The smell of the pheromone that kills the pest insects on the high-voltage wire mesh attracts the pest insects to fly through the high-voltage wire mesh, the butterflies burn as a result of contact and fall into the bag. When light falls, the sensors open the device. The solar panel is activated by the movement of the sun, which drives the mechatronic system. The charging device is fully charged with energy. It has been studied that the power of a solar battery depends on the semiconductor material, the design of the solar cell, and the number of elements in the battery.

Keywords: mechatronics, light trap, electricity, solar cells, light emitting diodes, light sensors, monitoring.

Annotatsiya: Maqolada mexatronik yorug‘lik tuzoqlariga asoslangan zararkunanda hasharotlarning rivojlanish bosqichlarini nazorat qilish va kuzatish uchun innovatsion tarzda ishlab chiqilgan yorug‘lik tuzoqlarining eksperimental tadqiqotlari natijalari keltirilgan. Mexatronik tizimda ishlaydigan qurilma kun davomida hasharotlarni avtomatik ravishda kuzatib boradi, natijada zararli hasharotlar populyatsiyasining turlari o‘rganiladi. Quyosh paneli harakatining mexanizmlari Quyoshning harakatiga qarab o‘zgaradi. Qorong‘i tushganda, qurilma yorug‘lik sensorlari yordamida faollashadi. Yorug‘lik chirog‘i yorug‘lik patogenining to‘lqin uzunligiga ta’sir qilish va ularni jalb etish orqali uchuvchi zararkunanda hasharotlarni o‘ziga tortadi. Yuqori kuchlanishli sim to‘ridagi zararkunanda hasharotlarni o‘ldiradigan feromonning hidi zararkunanda hasharotlarni yuqori kuchlanishli sim to‘ri orqali uchishga tortadi, kapalaklar aloqa natijasida yonib, sumkaga tushadi. Yorug‘lik tushganda, sensorlar qurilmani o‘chiradi. Quyosh paneli mexatronik tizimni boshqaradigan Quyoshning harakati bilan faollashadi. Zaryadlash moslamasi to‘liq energiya bilan zaryadlanadi. Quyosh batareyasining quvvati yarimo‘tkazgich materialiga, quyosh batareyasining dizayniga va batareyadagi elementlar soniga bog‘liqligi o‘rganilgan.

Kalit so‘zlar: mexatronika, yorug‘lik tuzog‘i, elektr energiyasi, quyosh batareyalari, yorug‘lik chiqaradigan diodlar, yorug‘lik sensorlari, monitoring.

Аннотация: В статье представлены результаты экспериментальных исследований инновационно разработанных световых ловушек для контроля и мониторинга стадий развития насекомых-вредителей на основе мехатронных световых ловушек. Устройство, работающее на мехатронной системе, автоматически отслеживает насекомых в течение дня, в результате чего изучаются типы популяций вредных насекомых. Изучены механизмы изменения движения солнечной панели в зависимости от движения солнца. С наступлением темноты устройство активируется с помощью световых датчиков. Световая лампа привлекает летающих насекомых-вредителей, воздействуя на длину волны светового патогена и вызывая их. Запах феромона, убивающего насекомых-вредителей на высоковольтной проволочной сетке, привлекает насекомых-вредителей, заставляя их пролетать сквозь сетку, бабочки в результате контакта сгорают и падают в мешок. С наступлением темноты датчики открывают устройство. Солнечная панель активируется движением солнца, которое приводит в действие мехатронную систему. Зарядное устройство полностью заряжается энергией. Было установлено, что мощность солнечной батареи зависит от полупроводникового материала, конструкции солнечного элемента и количества элементов в батарее.

Ключевые слова: мехатроника, световая ловушка, электричество, солнечные элементы, светодиоды, датчики света, мониторинг.

INTRODUCTION

Nowadays, the use of monocrystalline and polycrystalline silicon solar cells is very effective. Such solar cells are environmentally friendly, require little maintenance, and are lightweight. Therefore, they can provide a reliable power supply for biophysical sensors used in agricultural fields. Such a study was conducted by a group of scientists, Professor A. Abdurakhmonov and Associate Professor M. Aliboyev, resulting in Application No. FAP 20230363, dated 03.01.2024. [1]

Device for Destroying Harmful Flying Insects. Intellectual Property Agency of the Republic of Uzbekistan. Application No. FAP 20230363/2, received on 15.10.2023.

The results obtained showed that the use of solar cells not only increases the efficiency of biophysical trapping but also improves its convenience and economic efficiency, saves the costs of electrical cables, and provides complete protection against life-threatening situations. The use of monocrystalline and polycrystalline silicon solar cells in agricultural fields is highly effective in increasing the yields of cotton and cocoons, which are among our national treasures.

REVIEW OF LITERATURE ON THE SUBJECT

Currently, the creation and implementation of energy-saving devices based on alternative energy sources in production enable the introduction of scientifically based methods and intensive technologies. In recent years, it has been practically proven that the use of biophysical traps [1,2], developed by scientists at the Andijan State Technical Institute, makes it possible to eliminate chemical methods in the control of insect pests, particularly the mulberry moth, the main pest of the cocoon industry, and to establish a scientifically based, environmentally friendly system. This device operates by destroying insect pests attracted to the light-emitting diode (LED) optical radiation source through a high-voltage transistor system. One of the main problems in the use of such devices under field conditions is the issue of energy supply. This problem can be solved through the use of solar energy. A solar cell is a power source based on semiconductor photocells that converts solar radiation directly into electrical energy. The operation of solar cells is based on the phenomenon of the internal photoelectric effect. The first solar cell was developed in **1953–1954** by the American scientists G. Pearson, K. Fuller, and D. Chapin. [2]

The power of a solar cell depends on the semiconductor material, the design of the solar cell, and the number of elements in the battery. Materials based on silicon (Si), gallium (Ga), arsenic (As), cadmium (Cd), sulfur (S), antimony (Sb), and tellurium (Te) are used to manufacture solar cells. A solar battery is usually made in the form of a flat panel with a glossy coating. The number of solar cells in a battery can reach several thousand, the panel area can be several tens of square meters, the current can be hundreds of amperes, the voltage can be several tens of volts, and the generator power can reach several tens of kilowatts. Solar cells are mainly used in astronautics to provide electrical energy for Earth satellites. On Earth, solar cells are used as power sources for portable automatic radio stations and radio receivers.

In Uzbekistan, the Institute of Physics and Technology of the Academy of Sciences of Uzbekistan is engaged in research on the use of solar energy. [3] In particular, efforts are focused on creating and introducing into production environmentally friendly, safe, and highly efficient biophysical traps powered by alternative energy sources that can replace imported technologies. At present, the use of alternative, environmentally friendly energy is one of the most pressing issues because chemical and biological methods of controlling harmful insects in the field are often ineffective and may cause environmental damage. Therefore, the use of biophysical traps is considered a more effective solution.

The use of solar-powered devices eliminates the need for laying electric wires in agricultural fields, reduces risks to human life, and minimizes the environmental impact of SO□ emissions from thermal power plants. This device is powered by solar batteries, and the battery charging indicators are shown in Figure 1 (Figure 1).

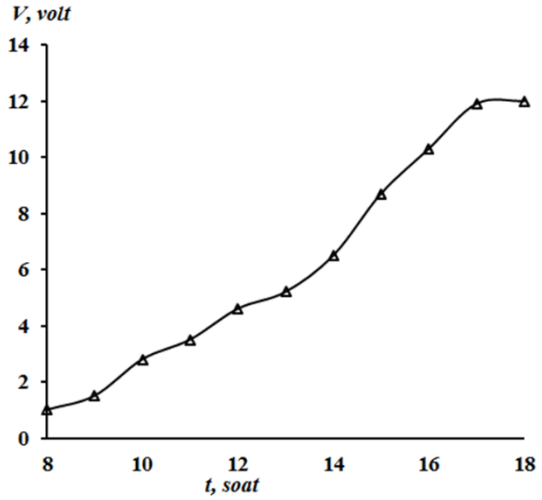

Figure 1. Battery charging v/t[1]

From Figure 1, it can be seen that the biophysical trap is powered by solar energy during the day and operates at night. The device is equipped with electrical and environmental safety features, allowing it to start automatically and eliminate harmful pests. It provides significant economic benefits, does not harm the environment, and ensures electrical safety. Therefore, the use of this device offers considerable advantages.

RESEARCH METHODOLOGY

The research methodology was carried out as follows. Previous studies led to the development of a biophysical trap designed to control moths that damage cotton and silk fiber, for which the following patent was filed. The performance of this device was evaluated under field conditions, and the results obtained are presented in Table 1 (Table 1).

Table 1. Comparative table of Uzbek and Chinese handles[2]

№	Handle name	Types and number of insects caught			
		Mulberry moth butterfly	The caterpillar butterfly	Beneficial insects	Experiment time
1	The People's Republic of China's handle	40 41 33	50 50 41	30 25 20	From 11:00 to 20:05 From 12:00 to 20:05 From 13:00 to 20:05
	Average	>34	>47	>25	
2	ADU's biophysical grip	40 51 60	200 153 141	2 10 20	From 11:00 to 20:05 From 12:00 to 20:05 From 13:00 to 20:05
	Average	50>	164>	10>	

In order to obtain these results, the electricity supply relied on the conventional **220 V** power system, which required the installation of electrical cables across agricultural fields. This process involved additional labor and posed potential safety risks to farmers. Therefore, the use of mechatronic systems has become increasingly important under modern agricultural conditions.

A group of scientists developed an innovative biophysical insect trap integrated into a mechatronic system. The performance of the device was evaluated under different solar charging conditions to determine its operating efficiency, battery voltage, operating time, and the number of insect pests captured. The experimental results are presented in Table 2 (Table 2).

1 Source: Compiled by the authors.
2 Source: Compiled by the authors.

Table 2. Performance characteristics of the biophysical insect trap operating in a mechatronic system[3]

Device	Date of the experiment	Solar charging period	Battery voltage (V)	High-voltage circuit and LED operating time (h)	Number of insect pests captured	Device operating time (h)
Biophysical insect trap integrated into a mechatronic system	12.08.2023	06:30–13:00	7	7	20	4
	13.08.2023	06:30–14:00	8	8	50	5
	14.08.2023	06:30–15:00	9	9	121	6
	15.08.2023	06:00–16:00	10	10	134	7
	16.08.2023	06:00–17:00	11	11	152	9
	17.08.2023	06:00–18:00	12	12	160	12
	18.08.2023	08:00–20:00	12	12	165	12

The experimental results presented in Table 2 demonstrate that the biophysical insect trap integrated into the mechatronic system operates effectively under solar-powered conditions. As the duration of solar charging increased, the battery voltage rose from 7 V to 12 V, resulting in longer operating times of both the high-voltage circuit and the LED lighting system. Consequently, the number of insect pests captured increased from 20 to 165, confirming the high operational efficiency and reliability of the proposed device for pest control under field conditions.

ANALYSIS AND RESULTS

A biophysical trap device operating on a mechatronic system—after being transported to the field and installed, the battery is charged using solar panels. When darkness falls, the device is activated by light sensors. The lighting lamp attracts flying pests according to the wavelength of the emitted light. The scent of pheromones attracts pests to fly through the high-voltage iron mesh. When the insects touch the high-voltage mesh with their wings, they are electrocuted and fall into the collection bag. At dawn, the light sensors deactivate the device. The solar panel is activated, and the mechatronic system automatically adjusts the panel according to the movement of the sun. As a result, the battery is fully recharged. [4]

The biophysical trap device operating on a mechatronic system (Fig. 1), surrounded by transparent glass on three sides, protects beneficial insects from harm. As a result, millions of dollars can be saved by reducing the need to produce beneficial insects in the bio-laboratories of our Republic. If introduced into production, the device will increase the yield of cultivated crops and significantly improve the economic efficiency of the silkworm feed base.

The yield of cultivated crops is expected to increase by 12–15 times, while labor costs will decrease by 1.5–2 times. The device is powered by solar cells, which store electrical energy in a battery. Its operation is fully automated through a system of sensors. Equipped with wheels, the device can move freely from one location to another.

The biophysical trap device is a mobile automatic system designed to improve both the quality and quantity of raw materials used in agriculture and the silk industry. Existing analogue devices do not consider the protection of beneficial insects and do not incorporate a mechatronic system powered by alternative energy sources.

The primary objective of the invention is to achieve a substantial improvement in the quality of agricultural products and silk fiber without causing harm to nature or the environment.

If introduced into production, the device will increase agricultural crop yields and raise the volume of agricultural products by 1.2–1.5 times. At the same time, the use of chemical pesticides will decrease by 5–10 times. To date, no technical solution describing such an improved biophysical trap device operating on a mechatronic system has been reported in the literature. Therefore, this invention is fundamentally different from existing technical solutions. The device operates on solar energy, automatically adjusts the position of the solar panel according to the movement of the sun through a mechatronic system, and functions based on a programmed automatic control scheme. Although the closest analogue devices also use solar panels, they do not employ mechatronic systems, which limits their efficiency under field conditions (Figure 2) [3].

3 Source: Compiled by the authors.

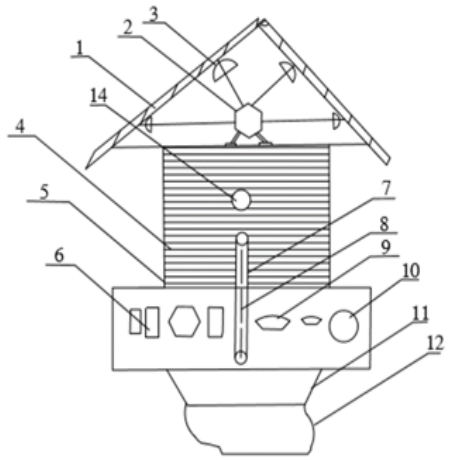

Figure 2. The biophysical trap device operating on the mechatronic system consists of the following parts[4]

1-solar panel (roof part); 2-gear drive for driving the solar panel; 3-breakers; 4-high-voltage wire mesh (mesh); 5-transparent window; 6-energy storage device (battery); 7-light bulb; 8-diodes; 9-voltmeter; 10-light sensors; 11-tilt guide; 12-bag.

A brake device is used to keep the system stationary in one position. Motion is transmitted through shaft 2 to bevel gear 3. Using pheromones, harmful flying butterflies are attracted, separated, and captured during the period when they cause damage. The captured butterflies are collected and counted through bag 7. The device can capture 50–150 harmful insects during a single period of operation. Each butterfly lays approximately 500–3,000 eggs, and the resulting larvae can damage crops and orchards covering up to 100 hectares of land. [5,6]

CONCLUSIONS AND SUGGESTIONS

A biophysical trap device operating on a mechatronic system is transported to the field and installed, after which its battery is charged using solar panels. At night, the device is activated automatically by light sensors. The lighting lamp attracts flying pests according to the wavelength of the emitted light, while pheromones lure them toward the high-voltage iron mesh. When the insects come into contact with the mesh, they are electrocuted and fall into the collection bag. At dawn, the light sensors deactivate the device. The solar panel is then activated, and the mechatronic system automatically adjusts its position according to the movement of the sun, ensuring that the battery is fully recharged. [4]

The biophysical trap device (Fig. 1), operating on a mechatronic system and enclosed by transparent glass on three sides, protects beneficial insects from harm while effectively controlling harmful pests. This reduces the need for producing beneficial insects in the bio-laboratories of the Republic, resulting in significant economic savings. The introduction of this device into agricultural production can substantially increase crop yields and improve the economic efficiency of the silkworm feed base. Crop productivity is expected to increase by 12–15 times, while labor costs may decrease by 1.5–2 times. Powered by solar cells, the device stores electrical energy in a battery and operates automatically through a system of sensors. Equipped with wheels, it can be moved easily from one location to another under field conditions.

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