International Journal of Synergy in Engineering and Technology
IJSET
Journal homepage: https://tatiuc.edu.my/ijset/index.php/ijset/ e-ISSN: 2735-0622

Design and Innovation of a Solar-Based Mosquito Killer with UV Light Attraction

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KEYWORDS

Solar-powered device
Mosquito control
UV LED attraction
Air quality monitoring
Sustainable design

ABSTRACT

This study develops a solar-powered mosquito repellent that attracts ultraviolet (UV) light and has an integrated air quality monitoring system. The device uses four 2.5V solar panels connected in series to generate a 10V output for continuous battery charging. Blue UV LEDs serve as both mosquito attractants and circuit indicators. Eco-friendly materials and energy efficiency are given top attention in the design in order to offer rural or underserved areas a cost-effective and sustainable mosquito control solution. Performance tests that evaluated the prototype's energy consumption, environmental resilience, and mosquito attraction efficiency validated its viability and long-term usefulness.

Received 03 March 2025; Revised 22 June 2025; Accepted 31 December 2025; Published 01 April 2026

1.0 INTRODUCTION

Mosquito-borne diseases such as dengue, malaria, and Zika continue to pose serious threats to public health, particularly in tropical and subtropical regions. Traditional chemical-based mosquito control methods raise concerns regarding human health, environmental impact, and insecticide resistance [1]. Therefore, sustainable and innovative solutions are required to reduce mosquito populations without adverse ecological consequences.

Renewable energy technologies offer new avenues for sustainably addressing mosquito control. Solar technology, for example, provides an environmentally friendly alternative by harnessing renewable energy, minimizing reliance on electricity, and delivering cost-effective solutions for remote or low-income regions [2]. This work proposes a solar-powered mosquito killer with ultraviolet light-attracting system and battery monitoring system on a sustainability and efficiency basis. Front panel: High-powered blue UV LEDs attract male mosquitoes, energy-efficient, and also serve as indicators that the circuit is working. Furthermore, the design integrates air quality monitoring, which allows for a more holistic approach to pest management, making the device more relevant and effective.

The project uses green energy, sustainable materials, and innovative design, among others to support worldwide efforts to combat climate change and promote environmental stewardship. This testing can confirm the practicality and effectiveness of the device, marking it as a promising long-term solution to reduce mosquito-borne diseases and improve public health outcomes [3]. This exploration adds to the current advancements in the search of creative yet sustainable technologies to regulate pest management dynamically and holistically without compromising environmental and human health.

Several studies have introduced solar-powered mosquito control devices to address sustainability challenges. [4] highlighted that traps using specific light wavelengths significantly improved mosquito attraction rates. Similarly, [5] emphasized the integration of air quality sensors into mosquito traps. However, few devices simultaneously address energy sustainability, monitoring, and environmental protection.

Malaria, dengue, Zika, and chikungunya are just a few of the contagious diseases that mosquitoes can spread, making them a serious threat to public health despite their annoyance. Therefore, reducing the burden of these diseases requires effective mosquito population management. An improvement over earlier trap technology, the solar energy mosquito trap employed in the study uses light-emitting diodes to attract insects. Another way to improve the effectiveness of traps in preventing sickness is to incorporate UV light into them [6]. Compared to gadgets like insect repellents that work only at close range, mosquito mats—which are typically impregnated with chemicals like allethrin—are comparatively simple to use, low maintenance, and straightforward to use. The active ingredients in the mosquito killing tablet, esbiothrin and pyrethrin, either kill or repel mosquitoes when taken as directed [7 & 8].

According to [9&10], material selection for buildings that use microencapsulated citronella essential oil to control Aedes aegypti mosquitoes: manufacturing, application, and sustainability concerns. To create efficient mosquito killing devices, this will probably require several iterations of prototyping and testing. The prototypes will now be tested in a controlled laboratory setting to determine how well they attract and repel mosquitoes. Field tests in regions with high mosquito activity assess the devices' actual efficacy and robustness in practical situations. Research aimed at creating user feedback quality appropriate to inform continuous software evolution suggests that developers must be continuously aware of the kind of feedback they receive from users in order to adjust to their needs [11].

This study suggests a multipurpose solar-powered mosquito killer that incorporates UV light attraction, air quality monitoring, and real-time battery feedback systems in order to overcome the drawbacks of traditional mosquito control techniques and build upon recent developments in environmentally friendly pest management. The suggested design integrates sustainability, user adaptability, and environmental intelligence, in contrast to earlier models that only concentrate on mosquito elimination. This gadget not only lessens reliance on grid electricity but also improves mosquito control in enclosed and semi-open spaces by utilising renewable solar energy, high-efficiency blue UV LEDs, and intelligent monitoring features. Additionally, using iterative prototyping and user feedback guarantees that the solution stays feasible, scalable, and responsive to the vector-borne disease prevention.

2.0 METHODOLOGY

2.1 Experimental Procedure

The initial step in developing the solar-powered mosquito killer involved creating a conceptual design using Computer-Aided Design (CAD) software. During this stage, detailed schematics outlining both the structural and functional aspects of the device were drafted. These CAD models served as the foundation for the fabrication process.

Fabrication Process: Four circular solar panels, each rated at 2.5V, were arranged in series on a lightweight yet durable frame to produce a combined output of 10V. Each panel was 1 foot in length and strategically positioned to maximize energy capture. The device casing was fabricated using 3D printing with an eco-friendly, weather-resistant material to shield internal components from environmental damage. Blue UV LEDs were installed within the unit to attract mosquitoes, while a battery monitoring system was integrated to provide real-time battery percentage feedback, enhancing user convenience and ensuring efficient energy management.

Testing: After the prototype was assembled, it underwent comprehensive testing in both controlled laboratory settings and real-world environments. The evaluations focused on the device's ability to attract mosquitoes using UV light, its energy efficiency through solar panel performance, and its resilience to various weather conditions. The air quality monitoring function was also tested to verify its functionality and suitability. Data collected during the testing phase provided valuable insights into the device's performance and revealed areas for potential improvement and optimization.

(a) (b) (c)

Figure 1: CAD Design of the Solar-Powered Mosquito Killer Device.

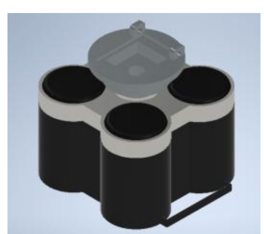

Figure 2: Assembly View of the Solar-Powered Mosquito Killer Device.

Using a 4800mAh battery, the solar panel was tested with different initial battery charge levels and in different sunlight intensities. Regardless of whether the battery started at 0% or 99%, the results showed that the panel continuously produced a 10V output, allowing for effective charging. It took about 5.2 hours to charge the battery from 0% to 100%. Higher initial charge levels resulted in a proportionately shorter charging time, demonstrating the system's efficient use of solar energy.

These results underline the potential of solar energy as a sustainable and renewable power source by confirming the viability of the solar setup—not only for powering the mosquito killer device but also for recharging small electronic devices like mobile phones.

The product efficacy test was conducted in two different indoor environments: a bedroom (12 m^2) and a living room (20 m^2). Each test ran for a duration of seven hours to evaluate the device's performance under varying spatial conditions. In the smaller, enclosed bedroom, the mosquito killer demonstrated high effectiveness, with a significant reduction in mosquito activity observed during the testing period. The optimized environment enhanced the performance of the UV light attraction system and heat coil mechanism, allowing mosquitoes to be quickly lured and eliminated. Users noted that the device contributed to a more comfortable and mosquito-free atmosphere, making it particularly suitable for use in sleeping areas.

(a) (b) (c)

Figure 3: Testing of product (a) Solar charging testing; (b) Environment observation testing (c) Battery percentage tester

3.0 RESULTS AND DISCUSSION

3.1 Test of Solar Power Charging for Battery Performance

The effectiveness and efficiency of the solar panel in charging a 4800mAh rechargeable battery served as the basis for evaluation. This testing proved that the mosquito killer device could be used in real-world settings, especially in remote locations without electricity. The charging time and solar panel output were recorded as the battery was charged from different starting points (such as 0%, 10%, 20%, and 25%) to 100%. The solar panel, which can produce a steady 10V output, was placed in direct sunlight during regular daylight hours (9:00 AM to 4:00 PM) to guarantee peak performance.

A living room and a bedroom, two typical indoor spaces with varying airflow and spatial features that might affect charging performance, were used for additional testing. Initial and final battery levels, charging times, and solar energy input were recorded for every trial. Environmental elements like shade and variations in sunlight intensity were also observed. The battery was successfully charged by the panel under all circumstances. The initial battery level determined how long it took to reach full charge; for example, charging from 0% to 100% took about 5.2 hours, but charging from 60% to 100% only took about 2.0 hours. These outcomes confirm the solar-powered system's dependability and effectiveness in a range of scenarios.

Table 1: Charging Duration of a 4800mAh Battery Using a 10V Solar Panel at Various Initial Battery Levels

Test No.	Starting Battery Level (%)	Ending Battery Level (%)	Charging Duration (Hours)	Solar Power Output (W)
1	0	100	5.2	10.2
2	10	100	5.0	9.8
3	20	100	4.3	10.4
4	25	100	4.0	9.5
5	30	100	3.7	10.0
6	35	100	3.4	10.3
7	40	100	3.1	10.1
8	45	100	2.8	9.5
9	50	100	2.5	10.1
10	60	100	2.0	10.0

3.2 Evaluation of Product Performance in Two Distinct Room Settings

Two indoor spaces—a living room (20 m^2) and a bedroom (12 m^2)—were used to test the mosquito killer device's efficacy. To evaluate the device's performance in various spatial and environmental conditions, each test lasted seven hours. The device was highly effective in the smaller, enclosed bedroom, as evidenced by a discernible decrease in mosquito activity. The enclosed area improved the effectiveness of the heat coil and UV light attraction systems, making it possible to swiftly attract and kill mosquitoes. The gadget is ideal for use in sleeping areas because users said it helped create a more comfortable and mosquito-free atmosphere.

In contrast, there were more difficulties because the living room was bigger and more open. While the device was successful in reducing the number of mosquitoes, it was not as effective as it was in the bedroom. Increased airflow and a more dispersed area probably reduced the UV light and heat concentration, necessitating a longer operating time to produce a similar effect. Notwithstanding these drawbacks, the device continued to function dependably, indicating that it could be used in wider regions when combined with more units or stronger UV lighting. These results suggest that in order to maximise performance in a range of room sizes and configurations, additional design improvements are required, such as modular configurations or adjustable power settings.

Table 2: Charging Time for a 4800mAh Battery Using a 10V Solar Panel at Various Initial Battery Levels

Test Location	Room Size (m^2)	Test Duration (Hours)	Observation/Notes
Bedroom	12	7	The product functioned consistently throughout the night, and the presence of mosquitoes was noticeably reduced.
Living Room	20	7	The product worked effectively, though the larger room size required more time to observe a significant reduction in mosquitoes.

4.0 CONCLUSION

A major advancement in environmentally friendly pest control technology has been made with the creation of a solar-powered mosquito killer that uses energy-efficient blue UV LEDs. Through the integration of environmentally friendly materials, renewable energy sources, and creative design elements, the device tackles major mosquito management challenges. For deployment in isolated or underserved areas with limited access to electricity, it provides a workable and financially viable solution. Adding real-time battery monitoring improves energy management and user convenience even more.

According to field tests, the device has a high potential to lower mosquito populations and, as a result, the spread of diseases carried by vectors. Although the prototype worked well in more constrained settings, more advancements are advised to improve performance in more expansive or open areas. Features like enhanced durability in severe weather conditions, adjustable UV intensity, and more sophisticated air quality monitoring could be included in future design iterations. Long-term ecological research is also required to make sure the device doesn't negatively affect local ecosystems or non-target species. The technology's scaling and design improvement will be the main priorities going forward in order to integrate it more widely and methodically into sustainable pest management programs.

Additionally, long-term ecological studies are necessary to ensure the device does not adversely impact non-target species or local ecosystems. Moving forward, efforts will focus on scaling the technology and refining the design for broader, systematic implementation in sustainable pest management initiatives

Author Contribution

N. Norsilawati: Conceptualization, methodology, investigation, visualisation, writing and editing. S. N. Azinee: Investigation, supervision, writing and editing. A. M. Efendee: Methodology, writing and editing. Alias Mohd: Investigation and technical support. N. Bahiyah Baba: Data curation and validation. H.S.S. Amirah: Visualisation and manuscript preparation support. Aon M.M. Fazreen: Investigation, data analysis, writing and editing.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors would like to express their sincere gratitude to Ts. Norsilawati Binti Ngah and Mr. Effeende for their valuable guidance and continuous support throughout the course of this project. Special appreciation is also extended to University College TATI for providing the necessary resources, facilities, and a conducive environment to carry out this research successfully.

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