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Journal of
Electronics Technology Exploration

Homepage: https://shmpublisher.com/index.php/joetex
p-ISSN 3025-3470 | e-ISSN 3026-1066

Flying Trap (Fly-T): An Automatic Termite Trapping Based on IoT and Hybrid Energy System using NodeMCU

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Article Info

Article history:

Received Dec 18, 2023
Revised Dec 29, 2023
Accepted Dec 30, 2023

Keywords:

Flying trap
IoT
Hybrid system
NodeMCU
Telegram

ABSTRACT

This paper proposes an automated productive caste termite trap device based on a hybrid energy system and the Internet of Things called Flying Trap (Fly-T). This tool is equipped with ultraviolet light with a frequency of 365 nm which is used to attract termites to enter and trap into Fly-T storage tank until they die. Dead termites will be detected by an ultrasonic sensor with a certain limit value then the relay cuts off electric current so that the light turns off and the tank door automatically opens to expel dead termites. The automatic control system on Fly-T is built using the NodeMCU ESP32 microcontroller to optimize the performance of sensors, relays, servo, and wifi connections in recording data to an IoT-based cloud database. The Fly-T is also controlled by command via a Telegram Bot equipped with solar panels and a windmill turbine generator. The results show that Fly-T can run automatically, easily, and save time efficiently, and is environmentally friendly.

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https://doi.org/10.52465/joetex.v1i2.276

1. INTRODUCTION

Termites are pests that cause damage to agriculture [1], especially to crops, and damage to building components, especially those made of community wood [2]. With the ability to fly for reproductive caste termites, the intensity of termite attacks and the amount of damage to buildings continues to increase, causing high economic losses [3] so control of termite pests is needed. Termite control with chemicals tends to pollute the environment, so an environmentally friendly termite control device is needed to reduce the number of termites. As an alternative to the control that will be done by making a flying trap The Flying trap was developed using a light bulb supported by solar panels, solar charge control, and batteries [4]. Flying trap using an ultraviolet bulb [5] to attract reproductive caste termites.

This research aims to make technological innovations in flying traps is named the Fly-T which is to control reproductive caste termites by using certain light rays to attract termites, which can run automatically and use solar panels as a source of electricity. Flying Trap is also equipped with Internet of Things or IoT technology which will make it easier for users to monitor from a website and the data stored in the cloud can be analyzed in the future. The design and development of the Fly-T prototype were implemented using the NodeMCU ESP-WROOM-32D, which controls ultrasonic sensors, relays, and servo motors. NodeMCU programming uses the Arduino IDE application, sending data to the internet using PHP, and storing data using MySQL in a cloud database.

2. METHOD

2.1 Fly-T Based on Electricity Hybrid System

The use of renewable energy from the sun as a source of electricity in the trap is considered. So, there is an urgent need to switch to renewable energy sources. Sun and wind are available in all conditions so they can be a stable alternative source [6]. With the increasing need for renewable energy resources, better utilization of the combination of solar energy and wind energy look at Figure 1 is needed so that in turn it has given rise to a hybrid energy system [7]. Electrical energy from the sun is produced by solar panels when the sun is shining and windmill turbine generators stored in batteries [8] when the sun doesn't shine. To follow up on the important evolution of the hybrid energy system, it is necessary to apply the internet to assess and transmit any data collected from the various sensor components [9].

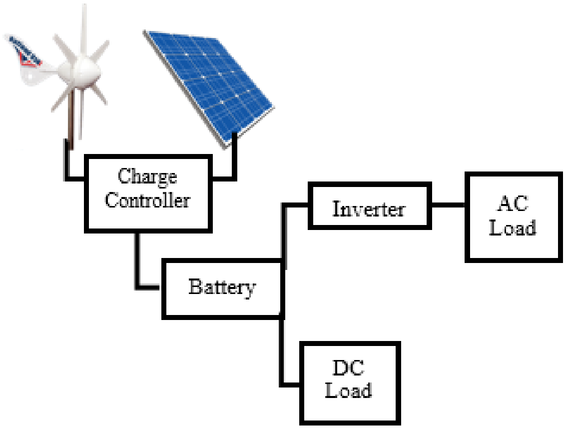

Figure 1. Hybrid energy system

By building a system capable of detecting, monitoring and regulating the operation of the tool will increase control efficiency [10] as well as significant maintenance of Fly-T so as to have a clear vision of the entire system in real time without the need to be physically in the installation area thereby cutting waiting times and reducing unnecessary costs. With hybrid system, it is expected to be able to reduce energy use efficiently and becomes environmentally friendly [11].

2.1 Fly-T Based on IoT

Fly-T developed based on IoT so that it allows each device to be able to run automatically, thereby reducing human interference in the process that must be done [12]. So that automation can be done with the role of a microcontroller, which has artificial intelligence to automatically execute several commands and process the collected data [13]. The IoT integrated from various electronic components, software, sensors, and network connectivity makes it capable of gathering information and exchanging data [14]. The NodeMCU ESP-WROOM-32D microcontroller is a main control of IoT service facility for the flying trap prototype [15], [16]. The NodeMCU ESP-WROOM-32D sends a command to the relay to turn on the light to attract the flying reproductive caste termites into the flying trap. The ultrasonic sensor, which is connected to a microcontroller, will be used to determine the volume height at a certain level. The ultrasonic sensor functions in measuring distance and range, the distance of objects is determined from the time interval of sound transmission and detection of the reflected sound [17]. The HC-SR04 ultrasonic sensor will identify the number of dead termites trapped at the bottom of the flying trap storage tank. The flying trap storage door is equipped with an MG996R sevo motor as a door drive. The servo was chosen because it has high control accuracy and low noise [18]. The design of the prototype automatic solar system flying trap can be seen in Figure 2.

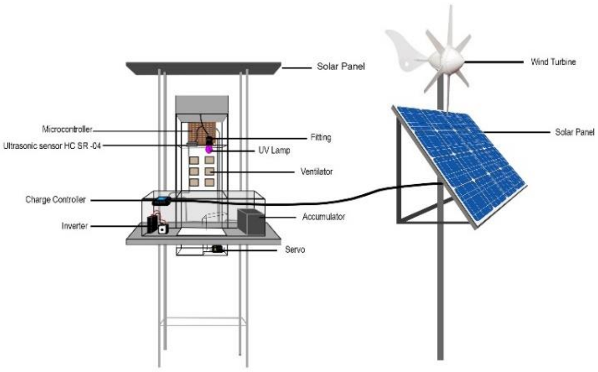

Figure 2. Fly-T based on Hybrid Energy System and IoT

The data read on the sensor will then be received by the microcontroller [19] those connected to the internet via a wifi network are sent to the cloud database on the server in real time. The ultrasonic sensor reading value is received by the NodeMCU ESP-WROOM-32D microcontroller as a reference for turning off the ultraviolet light via a relay and opening and closing the flying trap storage door via a servo motor.

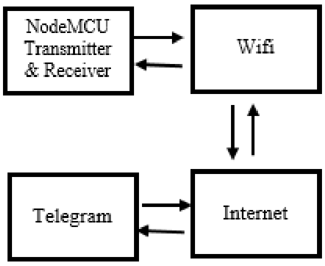

Figure 3. Control Section IoT Fly-T

The stored data will be displayed on a web page to monitor the performance of the flying trap. IoT also allows integration between the Telegram smartphone messenger application with a microcontroller using the Telegram Bot [20]. Telegram Bot helps in controlling the control of Fly-T devices connected to the IoT with the user's smartphone [21]. Telegram Bot in realtime is connected to a Fly-T via the internet so that the data received will always be up to date and control of the device can be carried out without being limited by time and place.

2.3 In Practice

The flying trap prototype gets sunlight for the solar panels and the movement of the wind mill turbine and converts it into electricity with the help of the charger controller. Solar charger stores electricity in the accumulator. Part of the electricity in the battery is used to turn on the 365 nm frequency ultraviolet lamp which requires AC current so that it is supplied first through a power inverter to convert the DC current to AC. Current also flows through the accumulator to the NodeMCU ESP-WROOM-32D microcontroller, the current is changed by going to the step down which previously had a voltage of 12V to 5V. The schematic block diagram of the prototype automatic solar system flying trap can be seen in Figure 4.

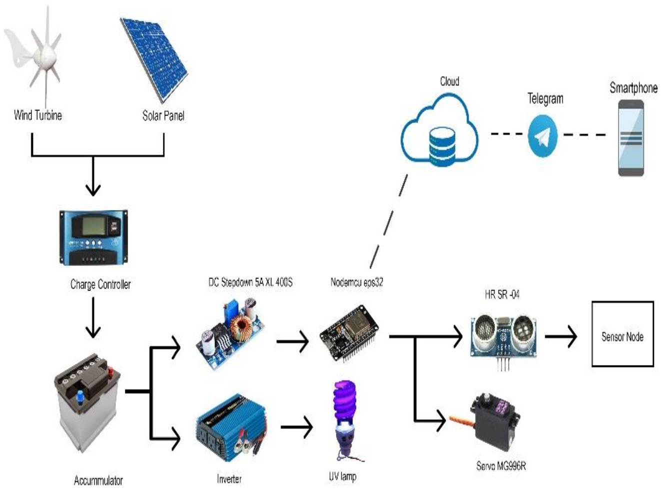

Figure 4. Fly-T Block Diagram

DC current flows through the battery and goes to the step down, the current is converted from a voltage of 12V to 5V. The 5V pin and the GND pin on the NodeMCU ESP-WROOM-32D are connected to the power IN+ pin and the power IN- pin in the step down via the PCB circuit board. Then the HC-SR04 ultrasonic sensor is connected to the PCB, the VCC pin is connected to the 5v line, the GND pin is connected to the GND line, the trigger pin is connected to the GPIO-16, and the echo pin is connected to the GPIO-17. The HC-SR04 ultrasonic sensor will transmit ultrasonic waves to the object in front of it, when the wave hits the bottom of the flying trap door, it is reflected and received back by the ultrasonic sensor to get a distance value as an identification of the flying trap storage tank capacity.

The relay is connected to the NodeMCU ESP-WROOM-32D microcontroller via a PCB circuit. The relay is connected to positive (+) and negative (-) posh bindings which will be connected directly to the light bulb electrical path, and posh binding to the input on the power inverter. Then the relay is connected to the GPIO-19 pin. After that the relay is also connected to a sensor which is useful for disconnecting or connecting the electric current which aims to turn on or turn off the bulb on the flying trap according to the sensor readings. When the distance reading value sent shows that the flying trap capacity is full, the NodeMCU microcontroller gives an order to the relay to cut off the electric current which aims to turn on or turn off the bulb.

On the underside of the flying trap, there is a MG996R servo motor which functions as the driving force for the flying trap discharge door. The servo is connected using a cable to pin to pin GPIO-12 of the NodeMCU ESP-WROOM-32D microcontroller via a port on the PCB circuit. The microcontroller gives commands to the servo motor to move to open the door to the flying trap storage tank to remove dead termites trapped until they run out. After the capacity becomes empty again, the servo will close the flying trap door and give a relay command to connect the electricity so that the bulb can turn on again. Flying traps are connected in real time to the internet via wifi, so users can monitor flying traps and find out the status of the tank capacity through a system monitoring website that is connected to a cloud database. Flying traps can also be controlled via the Telegram bot using commands that have been implanted into the system so that the microcontroller will respond and follow up on commands sent via telegram.

3. RESULTS AND DISCUSSIONS

The development of a Fly-T prototype that has been running in accordance with the required design will be tested for the performance of the prototype. Users can operate and control Fly-T via telegram bot by giving commands to microcontrollers connected to the internet in Figure 5.

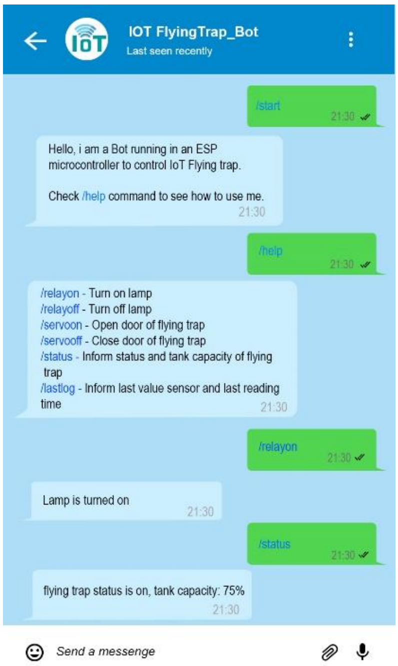

Figure 5. Command Control Telegram Bot

Testing is done to test the flying trap prototype that have been made according to the function and without problems. The experimental results will display the ultrasonic sensor reading values accurately as shown in Table 1.

Table 1. Experimental Results of Ultrasonic Sensor Performance

Value Sensor	Capacity(%)	Reading Time
34	0	14/08/2020 17.35
33	6	14/08/2020 17.40
33	6	14/08/2020 17.45
32	12	14/08/2020 17.50
32	12	14/08/2020 17.55
32	12	14/08/2020 18.00
28	37	14/08/2020 18.05
28	37	14/08/2020 18.10
25	56	14/08/2020 18.15
25	56	14/08/2020 18.20
24	62	14/08/2020 18.25
22	75	14/08/2020 18.30
21	81	14/08/2020 18.35
19	93	14/08/2020 18.40
19	93	14/08/2020 18.45
18	100	14/08/2020 18.50
34	0	14/08/2020 18.55

According of Table 1, in the first row when the value sensor is 34 cm will display a capacity of 0%. The value sensor will decrease when the flying trap is caused by capacity of the flying trap will be fuller. In the sixteenth row, while the distance value of 18 cm will display a capacity of 100% it means termites are fully trapped in the storage. Data of value sensor reading stored in the database can also be displayed on the monitoring website system. The monitoring system will display a line chart history that shows the flying trap capacity data at a certain time. Line chart history can be seen in Figure 6.

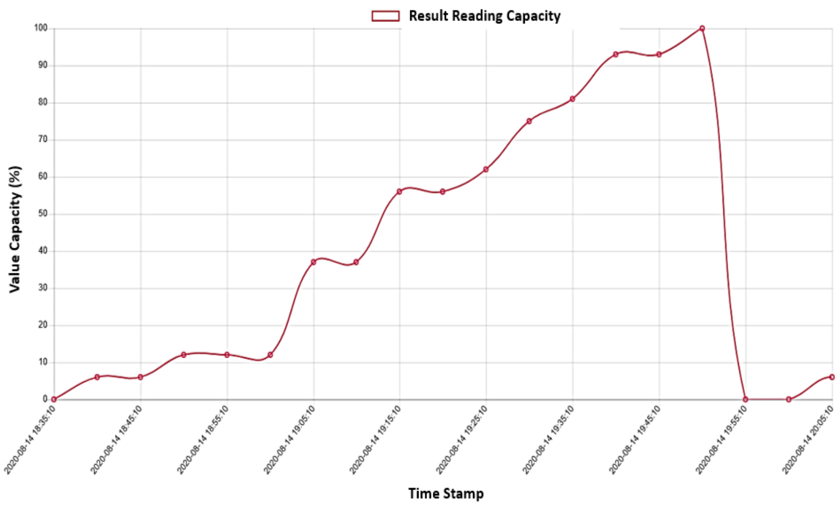

Figure 6. Line chart history from capacity of Fly-T

4. CONCLUSION

The design of an IoT Fly-T based hybrid system and IoT, it can be shown by implementing the use of solar power and windmill turbine generator as a source of electrical energy from the flying trap prototype by utilizing a charger controller to charge the battery can supply the power supply to the microcontroller for control the flying trap, so that the flying trap has an independent power source and environmentally friendly. In addition, the application of IoT to a flying trap using an ultrasonic sensor connected to microcontroller is able to identify value of sensor readings from termites caught in the flying trap storage tank so that the automation process to open and close the flying trap door when full can be done. The data obtained from the sensor is processed by the microcontroller and sent to the database via the internet with a wifi network so that users can monitor the prototype via the website. The flying traps are controlled via telegram using commands available on the telegram bot, making it easier to use and reducing user operational time. In the future, the research is developed so that the Flying Trap can be developed with an integrated function with high electric voltage so that it can directly kill trapped termites.

REFERENCES

[1] J. J. Anyango *et al.*, “The impact of conventional and organic farming on soil biodiversity conservation: A case study on termites in the long-term farming systems comparison trials in Kenya,” *BMC Ecol.*, vol. 20, no. 1, pp. 1–15, 2020, doi: 10.1186/s12898-020-00282-x.

[2] N. Subekti, B. Priyono, and A. N. Aisyah, “Biodiversity of Termites and Damage Building in Semarang, Indonesia,” *Biosaintifika*, vol. 10, no. 1, pp. 176–182, 2018, doi: 10.15294/biosaintifika.v10i1.12832.

[3] N. Subekti and Saniaturrohmah, “Toxicity of essential oils against termite Macrotermes gilvus Hagen (Blattodea: Termitidae),” *J. Phys. Conf. Ser.*, vol. 1567, no. 3, 2020, doi: 10.1088/1742-6596/1567/3/032053.

[4] S. A. Meshram, S. A. Kapade, A. D. Chaudhari, and K. B. Nagane, “IRJET-Design a Solar Light Trap for Control of Field Crop Insects DESIGN A SOLAR LIGHT TRAP FOR CONTROL OF FIELD CROP INSECTS,” *Int. Res. J. Eng. Technol.*, p. 1252, 2018, [Online]. Available: www.irjet.net

[5] E. P. Mwanga *et al.*, “Evaluation of an ultraviolet LED trap for catching Anopheles and Culex mosquitoes in south-eastern Tanzania,” *Parasites and Vectors*, vol. 12, no. 1, pp. 1–12, 2019, doi: 10.1186/s13071-019-3673-7.

[6] N. Q. Mohammed, M. S. Ahmed, M. A. Mohammed, O. A. Hammood, H. A. N. Alshara, and A. A. Kamil, “Comparative analysis between solar and wind turbine energy sources in iot based on economical and efficiency considerations,” *Proc. - 2019 22nd Int. Conf. Control Syst. Comput. Sci. CSCS 2019*, no. June, pp. 448–452, 2019, doi: 10.1109/CSCS.2019.00082.

[7] P. Srivastava, M. Bajaj, and A. S. Rana, “IOT based controlling of hybrid energy system using ESP8266,” *2018 IEEMA Eng. Infin. Conf. eTechNxT 2018*, no. March, pp. 1–5, 2018, doi: 10.1109/ETECHNXT.2018.8385294.

[8] T. Kaur, J. Gambhir, and K. Sanjay, “Arduino Based Solar Powered Battery Charging System For Rural SHS,” *2016 7th India Int. Conf. Power Electron. IEEE*, pp. 1–5, 2016.

[9] M. Salhaoui, M. Arioua, A. Guerrero-González, and M. S. García-Cascales, “An IoT control system for wind power generators,” *Commun. Comput. Inf. Sci.*, vol. 855, pp. 469–479, 2018, doi: 10.1007/978-3-319-91479-4_39.

[10] S. Tedeschi, J. Mehnen, N. Tapoglou, and R. Roy, “Secure IoT Devices for the Maintenance of Machine Tools,” *Procedia CIRP*, vol. 59, no. TESConf 2016, pp. 150–155, 2017, doi: 10.1016/j.procir.2016.10.002.

[11] B. Prasetiyo, Alamsyah, and M. A. Muslim, “Analysis of building energy efficiency dataset using naive bayes classification classifier,” *J. Phys. Conf. Ser.*, vol. 1321, no. 3, 2019, doi: 10.1088/1742-6596/1321/3/032016.

[12] C. Vashi, S., Ram, J., Modi, J., Verma, S., & Prakash, “Internet of Things (IoT) A Vision, Architectural Elements, and Security Issues,” *2017 Int. Conf. I-SMAC (IoT Soc. Mobile, Anal. Cloud)(I-SMAC) IEEE*, pp. 492–496, 2017, doi: 10.1109/ICECCT.2017.8117893.

[13] M. Al-Kuwari, A. Ramadan, Y. Ismael, L. Al-Sughair, A. Gastli, and M. Benammar, “Smart-home automation using IoT-based sensing and monitoring platform,” *Proc. - 2018 IEEE 12th Int. Conf. Compat. Power Electron. Power Eng. CPE-POWERENG 2018*, pp. 1–6, 2018, doi: 10.1109/CPE.2018.8372548.

[14] D. Misra, G. Das, T. Chakrabortty, and D. Das, “An IoT-based waste management system monitored by cloud,” *J. Mater. Cycles Waste Manag.*, vol. 20, no. 3, pp. 1574–1582, 2018, doi: 10.1007/s10163-018-0720-y.

[15] X. Wang, Y. Dong, M. Chen, F. Su, and L. Ling, “Research on real-time temperature control method for multi-visualization of hot runner system based on internet of things,” *J. Appl. Sci. Eng.*, vol. 22, no. 4, pp. 683–690, 2019, doi: 10.6180/jase.201912_22(4).0010.

[16] P. Eliopoulos, N. A. Tatlas, I. Rigakis, and I. Potamitis, “A ‘smart’ trap device for detection of crawling insects and other arthropods in urban environments,” *Electron.*, vol. 7, no. 9, 2018, doi: 10.3390/electronics7090161.

[17] W. P. Lai and W. Y. Chung, “Designing an ultrasonic ranging front-end integrated circuit architecture for dual-mode operation with ringing effect reduction,” *J. Chinese Inst. Eng. Trans. Chinese Inst. Eng. A*, vol. 38, no. 7, pp. 878–886, 2015, doi: 10.1080/02533839.2015.1047796.

[18] P. Li and G. Zhu, “IMC-based PID control of servo motors with extended state observer,” *Mechatronics*, vol. 62, no. June, p. 102252, 2019, doi: 10.1016/j.mechatronics.2019.102252.

[19] M. S. Kamalesh, B. Chokkalingam, J. Arumugam, G. Sengottaiyan, S. Subramani, and M. A. Shah, “An intelligent real time pothole detection and warning system for automobile applications based on iot technology,” *J. Appl. Sci. Eng.*, vol. 24, no. 1, pp. 77–81, 2021, doi: 10.6180/jase.202102_24(1).0010.

[20] M. A. Rosid, A. Rachmadany, M. T. Multazam, A. B. D. Nandiyanto, A. G. Abdullah, and I. Widiaty, “Integration Telegram Bot on E-Complaint Applications in College,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 288, no. 1, 2018, doi: 10.1088/1757-899X/288/1/012159.

[21] Y. Findawati, A. Idris, Suprianto, Y. Rachmawati, and E. A. Suprayitno, “IoT-Based Smart Home Controller Using NodeMCU Lua V3 Microcontroller and Telegram Chat Application,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 874, no. 1, 2020, doi: 10.1088/1757-899X/874/1/012009.