Artificial intelligent device restricted nilaparvata lugens applied in clean agricultural production

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ABSTRACT

Towards a clean agriculture without the use of pesticides in the future, especially for wet rice, the use of insecticidal equipment is a direction that is receiving the most response. Therefore, teachers and students of Faculty of Electronics - Thai Nguyen University of Technology and Industry have researched, designed and successfully tested a smart device with basic features such as trapping, killing Nilaparvata lugens, estimate the number of Nilaparvata lugens, monitor and remotely monitor the working process of the equipment. The article presents the structure, working principle, features and applicability of the product in practice

Keyword *Clean agriculture, Nilaparvata lugens, smart devices to eliminate planthoppers, estimate Nilaparvata lugens, clean agriculture, remote monitoring*

1. INTRODUCTION

Referring to Vietnam, we immediately think of an agricultural country, in the process of industrialization and modernization. One of Vietnam's key export products is rice exports, according to statistical data in 2021, our country ranks third in rice exports after India and Thailand [1]. The growth of rice in particular and crops in general, is greatly affected by pests and diseases, especially in tropical countries like Vietnam. Pests and diseases affect the growth and development of plants, destroy crops and reduce crop yields. In order to limit the development of pests and diseases, farmers use pesticides, but the situation of pesticide use in our country is alarming, on average in the past 5 years, Vietnam spends from 500-700 million USD to import pesticides, of which, 48% are herbicides, equivalent to 19 thousand tons, the rest are pesticides and disease control, about over 16 thousand tons. The volume of active pesticides per hectare per year grown in Vietnam is up to 2kg, while some other countries in the region are only from 0.2-1 kg/ha [2]. This fact is causing the environment in rural areas to deteriorate rapidly. Not only that, the rampant use of pesticides and fertilizers also has many potential risks to human health as well as seriously destroys the land and fields, causing the land to harden, keeping Poor water availability and reduced soil fertility threaten sustainable agriculture. Nowadays, the field of clean agriculture is a matter of top concern because people's health is increasingly improved, so products from clean agriculture are always welcomed by everyone. When learning about wet rice plants, it was found that there is a type of insect called brown planthopper (BPH) (scientific name: Nilaparvata lugens) which is an insect that eats rice plants [3]. Brown planthopper is a pest that causes damage by sucking the sap of rice, transmitting viral diseases, aphids can cause damage from the sowing stage to the time of harvest. Nilaparvata lugens live and cause damage mainly at the base of rice. Aphids infected with rice-sucking virus in less than 1 hour can transmit the disease to healthy rice, one individual brown planthopper can transmit both yellow dwarf and leaf curl diseases, on the same rice bush can carry both diseases. Dwarf and dwarf twisted leaves [4], [5].

There have been many different research directions to detect and limit the damage caused by BPH in agriculture such as studying gene mapping with resistance [6], [7]. The method of studying gene mapping to prevent brown planthopper has the advantage of bringing high efficiency against planthoppers, but has the ability to change the characteristics of rice varieties. In addition, when used for a long time, Nilaparvata lugens will adapt to these genes, thereby reducing the effectiveness of planthopper resistance. Another research direction is to monitor Nilaparvata

lugens by applying information technology, specifically based on image signal processing [8], [9] or based on digital signal processing [10]. These studies can basically detect Nilaparvata lugens automatically, but the cost is high compared to the income of farmers due to the use of cameras in the research. Another research direction is the design of environmentally friendly aphids [11], [12], these studies use light to attract leafhoppers and eliminate leafhoppers by high voltage, the advantages of these studies. This is a reasonable price, high efficiency against hoppers. However, there is no remote monitoring system of the device's working process so that it can be handled and repaired in time.

In this article, we also propose to design a device to attract leafhoppers by light and kill leafhoppers by high voltage, but the system can remotely monitor parameters such as the location of the device. equipment, equipment theft warning, battery voltage, density of planthoppers... and the system uses renewable energy (solar batteries) so as not to pose a danger to farmers and to be environmentally friendly.

The article is divided into 5 parts: (1) Introduction; (2) Design solutions; (3) Hardware and software design; (4) Experiments and results; (5. Conclusion.

2. DESIGN SOLUTION

2.1. Design ideas

Through the process of learning about Nilaparvata lugens, growth characteristics, and measures to kill Nilaparvata lugens, the research team has designed a smart planthopper killing device with the following features:

Mechanical Features

- Easy to disassemble and move
- Withstands in water.
- Easy to plug into the field and secure

Electrical features

- Attract and kill Pests with electricity;
- Equipped with a solar power system;
- Locating the device and monitoring alerts when someone tries to steal or move the device via mobile phone;
- It is possible to monitor and monitor leafhoppers remotely, estimate the total number of planthoppers in the trap to take appropriate response measures...
- Notify the farmer that the battery is running out, when it rains for a long time, the solar battery cannot be charged through the phone
- Save energy when in use.

2.2. Block diagram and working principle

From the design ideas to the problem, we build the block diagram of Intelligent eradication device 'Nilaparvata lugens' applied in clean agricultural production as shown in Figure 1.

In Working principle of the product

In daytime working mode: the device automatically cuts off the power supply to the leafhopper net and the electric bulb to save energy. Then the circuit will charge the Lithium battery from the solar battery.

In night work mode: The device automatically powers the net to catch leafhoppers and turns on the electric light to attract leafhoppers and kill planthoppers.

During the operation of the device, the control circuit will calculate an estimate of the number of hoppers caught, to send information to the farmer via phone so that the farmer can capture the destructive activity of the plant. and take appropriate measures.

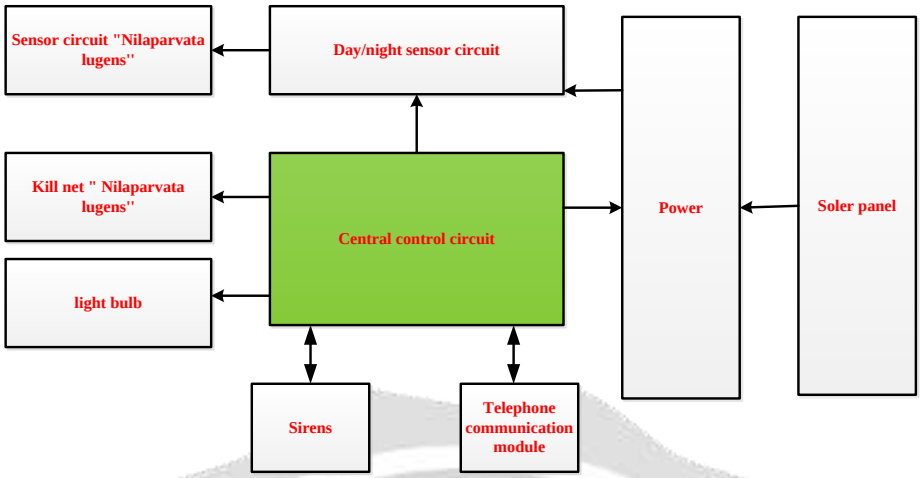

Fig -1: The diagram of equipment

3. DESIGNING HARDWARE AND SOFTWARE

3.1. Mechanical design

Mechanical equipment consists of the following basic components:

1. Legs to plug into the field: Includes 3 legs with a length of 60cm, 3-pin tripod form to plug the device deeply and firmly into the field.
2. Control cabinet: Mounted on the body of the device, the control cabinet contains the control circuit, high voltage circuit and battery.
3. Aphids net: is a place to kill planthoppers, the size of the net is 48 * 80.
4. Electric lamp: is an LED light, which has the effect of attracting leafhoppers to the net to kill planthoppers.
5. Solar battery aims to maintain energy for the entire working system.
6. Cover: Cover the device affected by rain and sun

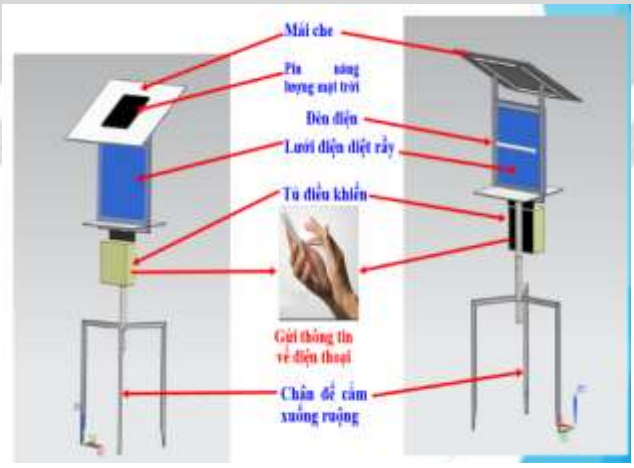

Fig - 2: 3D drawing of the device

3.2. Electrical circuit design

3.2.1. High voltage generating circuit

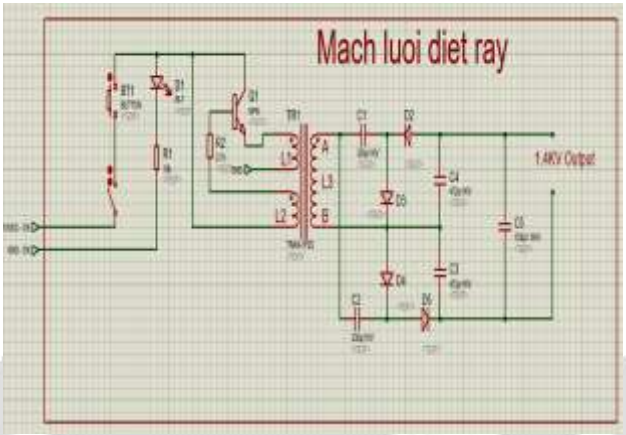

Fig - 3: High voltage generator circuit

Similar to the previous power supply of the ATX power supply, using a muffled oscillator circuit.

However, here only need to take the voltage out, no need for voltage stabilizer and isolation, so the circuit has only 1 transistor (usually D965 or D882). BA consists of the primary coil L1, the feedback coil L2 creates an oscillation, the secondary coil L3 takes the voltage after the transformer, but this voltage is not enough to kill the hoppers, so a voltage multiplier circuit is used. The first multiplier circuit includes C1, D1, C3, D2 and the second multiplier circuit includes C2, D3, C4, D4. To create a voltage 4 times the voltage after the transformer to kill hoppers.

3.2.2. Source circuit

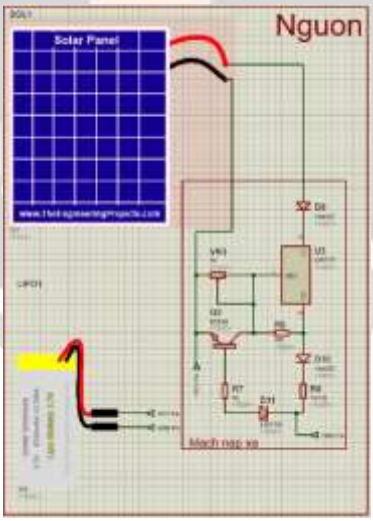

Fig - 4: Power circuit

The power circuit here uses a solar battery to store energy for the battery. To charge the battery with a voltage of 3.7V, here we use the mIC LM317 to generate a voltage of 3.7V at the output to the battery. In charging mode Transistor Q3 will open and the battery is charged, when in night mode Q3 will lock to avoid the voltage running back to the solar battery (then the battery will become a load, consuming energy).

3.2.3. Light sensor circuit

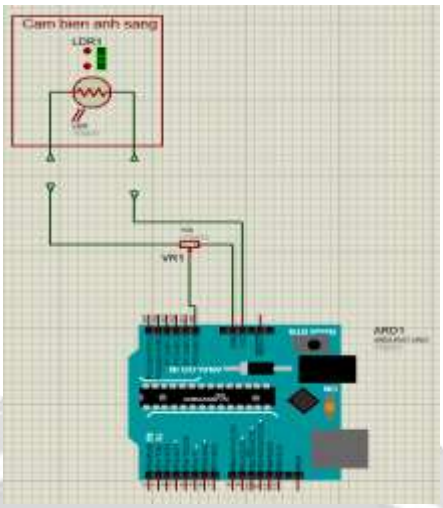

Fig - 5: Light sensor circuit

This circuit uses LDR photoresistor to detect day and night, thereby switching the equipment to work, avoiding energy loss. The basic principle is that when the light source changes, the internal resistance of the LDR changes, causing the voltage on A0 of the microcontroller to change, thereby determining day and night.

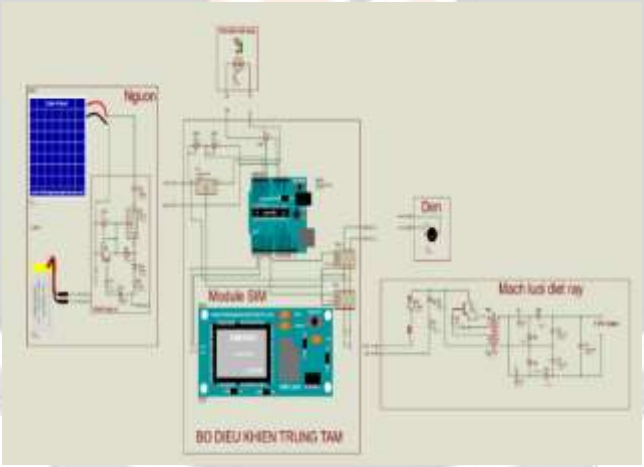

Fig - 6: Overall principle diagram of the device

3.3. Algorithm flowchart

The main algorithm flowchart to write the control program for the system control cabinet is as follows:

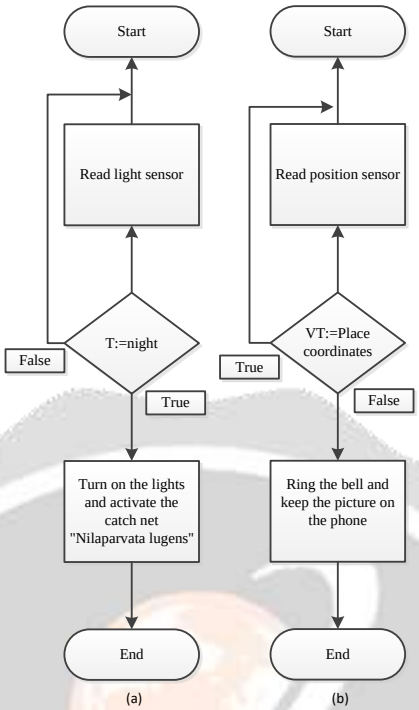

Fig - 7: (a) Flowchart of algorithm to determine day/night to turn on the lights and activate the net to catch leafhoppers; (b) Flowchart of the algorithm to locate the device to sound the alarm and send a phone alert to the farmer

4. EXPERIMENT AND RESULT

After conducting experiments in the practice room and in the rice field for a while, the authors have completed the "Intelligent hopper catching device applied in clean agricultural production" with all the features set out. , the specifications of the device.

- Product size: 1.8m high, 60cm wide
- Working voltage: 12VDC
- Dimensions of the Tray catcher net: 45cm x 60cm

Fig - 8: Construction and installation of electrical systems and electrical cabinets

Fig - 9: Finishing the mechanical part of the product and testing the product in the rice field

5. CONCLUSIONS

The smart pest catching device applied in clean agricultural production has been tried and tested in practice and has worked perfectly and gave good results. BPH catching device helps to drastically reduce the density of planthoppers in rice fields with brown planthopper infestation, helping to improve rice yield, providing peace of mind and confidence in a good crop. The equipment used to make an environmentally friendly hopper catcher is not too complicated. Convenient in installation as well as in use. The device has a remote monitoring section to support people during the use of the product. The group's next research direction is to improve the determination of leafhopper density more accurately at a reasonable cost. The project also aims to propagate the message of clean agriculture and apply smart technology to agricultural development. In the future, our group will further improve the quality of the product, as well as find a way to reduce the cost of the equipment so that the product can spread further, being an effective assistant for farmers in the production. agricultural export.

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