Design of Ectropis Oblique Monitoring System Based on Internet of Things

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Abstract

Ectropis oblique quantity statistics do exist in the field monitoring pests not timely, artificial cost is high, field monitoring is difficult, now the high voltage electric shock technology, infrared sensing technology, and Internet technology, the combination of tea was developed inchworm field monitoring device automatically, achieve real-time monitoring of Ectropis oblique field populations, through environmental sensors at the same time, The monitoring of tea plantation environmental information was achieved, and a scientific decision foundation was supplied for tea plantation personnel.

Key words

Infrared induction technology; Internet of Things technology; Environment sensor; Real-time monitoring

1. Introduction

Currently, the collection of pest monitoring and meteorological early warning information in Chinese tea gardens is mostly based on manual observation, investigation, and statistics, which not only delays the process but also raises the cost of labor and material resources [1]. With the advent of Internet of Things technology, all autonomous persons may accomplish sharing and integration via the "Internet of things." The primary technology is used to successfully communicate and interact with data via radio frequency identification [2], infrared sensors [3-5], GPS[6], and other data sensing devices. As a result, more data storage space is available for big data and cloud computing [7-8]. So, this article designed the Ectropis oblique intelligent plant monitoring device based on the Internet of things, the Ectropis oblique sex pheromone trap trap Ectropis oblique [9], using the infrared counting of dual channel, remote data transmission, platform, data statistics, and so on real-time monitoring field Ectropis oblique population dynamics, through environmental sensors to collect meteorological parameters at the same time, the real-time control the field environment.

2. System Architecture Design

The pest monitoring system is designed with a hierarchical architecture. As illustrated in Fig.1, the pest monitoring system is separated into three tiers based on its technological framework: data perception layer, network transmission layer, and data application layer. Comprehensive, real-time, and dynamic monitoring of pest population density, air temperature and humidity, light, and plant diseases and insect pests occur position monitoring, the key parameters in the growth process of tea plant related people can see through the Web side real-time monitoring results, based on the Internet of things technology, upload sensor data collected in a timely manner to system platform, Data processing was carried out in order to better understand the tea growth environment and the incidence of pests and illnesses.

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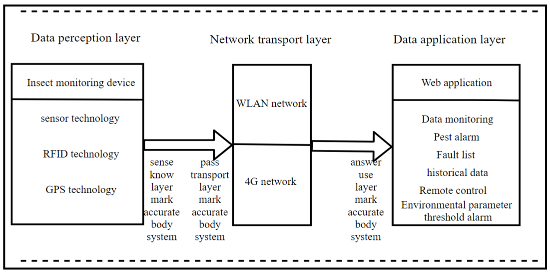

Fig.1 System architecture design

3. Terminal design of monitoring system

3.1. Overall design of the terminal of the monitoring system

Monitoring system terminal will pest traps and the Internet of things in the design of the control unit for effective integration, which trap agricultural pests, pest traps is primarily responsible for the Internet of things the control unit is responsible for killing of agricultural pests count and farmland environmental information collection, and data will be uploaded to the cloud platform application center via the wireless communication network, as illustrated in Fig.2, Tea inchworm pests enter the trap through the entrance, attracted by the tea inchworm sex pheromone, and a high-voltage electricity grid is established in the channel. When the tea inchworm comes into contact with the power grid, the intense pressure created by the high-voltage packet kills it and causes it to fall into the trap. During this procedure, when tea inchworms make contact with the power grid, the electric current in the circuit exceeds the no-load current and transmits electrical messages. To avoid counting errors caused by rains and leaves, the infrared counting device begins counting. Simultaneously, GPS is utilized to pinpoint the area of bug outbreaks in order to avoid calamities before they occur.

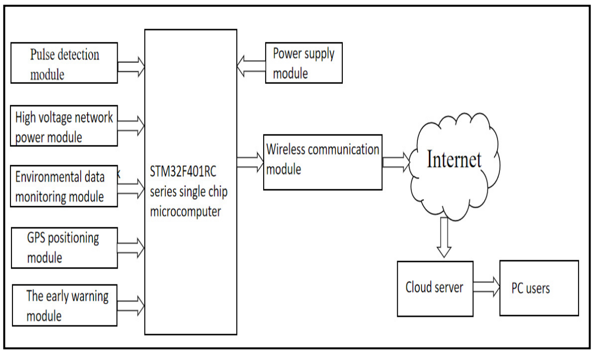

Fig.2 Overall Design Architecture of the Device

3.2. Internet of Things control unit design

This device requires a primary control module with high computational capability and low power consumption in order to perform operations such as high-precision pest monitoring, field environment data gathering, data exchange, and so on. As the system control core, a 32-bit single-chip STM32F401 embedded system based on an ARM Cortex-M4 kernel is now used. The chip has 16 channels 12 bit ADC channel, I2C, SPI, SDIO, USART and other rich interface resources, 256K flash memory, 8 timers, and the chip's maximum frequency up to 84MHZ, which may match the device's design requirements.

3.2.1. Power module

By using the sun's illumination, solar panels convert light energy into electrical energy, solar cells produce direct current into the battery storage first, then use BQ24650 synchronous switch mode power supply chip controller battery charge, BQ24650 for battery charging process is divided into three stages: pre charge, constant current and constant voltage charging, charging accept Photovoltaic panels have a voltage of 20 volts. Stabilize the output voltage at 12V to provide a 12V operational voltage for the system. Each module of the monitoring system has a distinct operating voltage. It is important to use a step-down conversion circuit to convert 12V to 4.2 and V5V steady output. TPS563201 is the DC/DC conversion chip, and the DC voltage drop circuit converts 4. 2V to 3.3V before the LDO.As indicated in Fig.3, 4.2V is converted to 3.3V, and the LDO conversion chip is NCP114A, which supplies power to the data acquisition end.

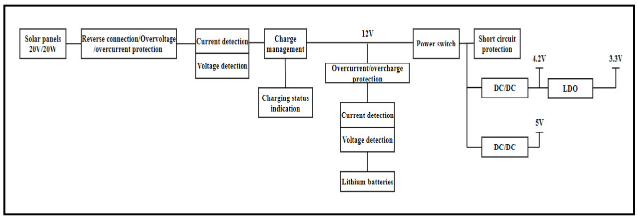

Fig.3 Schematic diagram of power circuit module

3.2.2. Infrared sensor monitoring module

The infrared sensor works by using an infrared transmitter tube with a wavelength of 940nm. The infrared transmitter tube and receiver tube are positioned on both sides of the insect mouth, allowing pests to enter the monitoring region, block the infrared monitoring layer, and produce differences in resistance characteristics. It is a many-to-one light-emitting diode laser structure, as illustrated in Fig. 4, with the infrared counting sensor located at the entrance above the collection box. A collection of infrared counting sensors positioned at the higher end of the intake was termed infrared monitoring layer A, while a group located at the lower end of A was named infrared monitoring layer B, and the distance between them was measured,with a gap of 1.2mm between them.

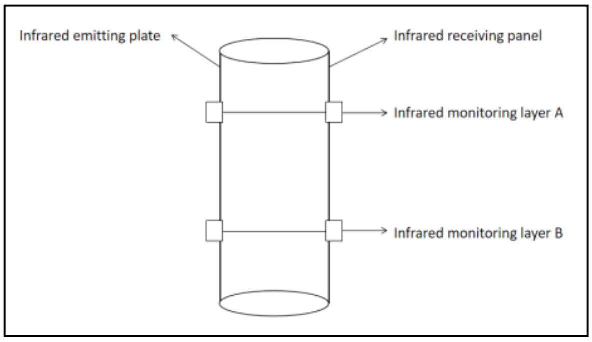

Fig.4 Infrared Monitoring Device

3.2.3. Meteorological sensor acquisition module

All sensors in the sensor monitoring node use the RS485 standard interface and connect with the controller over the RS485 bus, allowing for data transmission rates of up to 10Mbpsd. RS485 is a typical bus transmission channel in industrial and agricultural field monitoring applications that has good universality, high reliability, and strong anti-interference ability. The SP3485 contains four pins: positive power supply, negative power supply, 485-A, and 485-B. Fig.5 depicts the ports. The RS 485A/B of the single chip microprocessor and the sensor's RS 485A/B are linked. The main control board's half duplex RS 485 interface uses an SP3485E chip, therefore the receiving and sending states must be switched, and the high and low values of the RE and DE pins must be used to control the receiving and sending. When the two pins produce a low voltage level, the control unit's RS 485 interface is in the receiving state. When the two pins produce a high voltage level, the control unit's RS 485 interface is in the transmitting state.

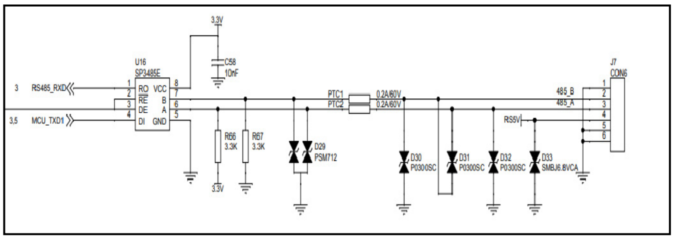

Fig.5 RS 485 Serial Port Transmission Circuit

3.2.4. Communication interface circuit design

The communication interface circuit is implemented by the 4G LTE CAT1 communication module EC-600S-CN, which enables LTE-EDD, LTE-TDD, EDGE, and GPRS network data connections. Good coverage is obtained with ultra-low power consumption and minimal latency by relying on the current 4G network. Supports a maximum downlink rate of 10Mbps and a maximum uplink rate of 5Mbps. The EC-600S-CN supports a wide range of network protocols such as TCP/UDP/MQTT, as well as several industrial standard interfaces and a number of driver and software features. It supports 3.4-4.5V power supply voltage input, standard SIM card interface, and OTA remote online upgrading.

4. The system software

The monitoring system is built on the B/S architecture and consists of a system server, a background database, and a PC side. To complete access to the pest database, meteorological environment parameter database, and early warning release database, the PC side is linked to the cloud server. Fig.6 demonstrate how the PC side is used for pest monitoring, and early warning. Several measuring and reporting equipment of tea inchworm sex were set up in the field in accordance with the monitoring scope. Connect to a distant server via the Internet using wireless. Field surveillance data is delivered in real time. To achieve crop growth and disease and insect pest monitoring in farmland, we may make a preliminary judgment on the population density of field pests by analyzing diseases and insects.

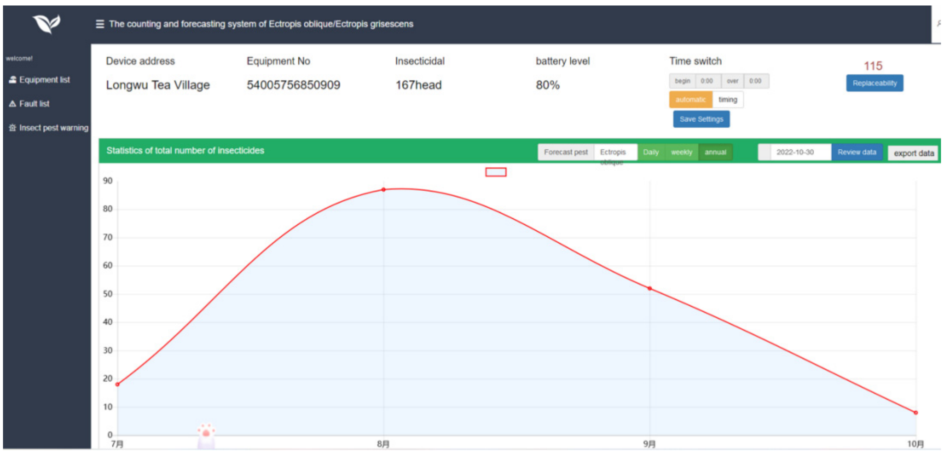

Fig.6 Insect Monitoring Interface

5. The system test

5.1. Insect monitoring test

The field test of the Ectropis oblique worm monitoring device based on the Internet of Things was carried out in Longwu Tea Village, Hangzhou City. The device and lure core were provided by

Hangzhou Yihao Agricultural Science and Technology Co., Ltd. On August 27, 2022, the pest monitoring device and boat trap were placed in the central area of the tea field. The pest monitoring device was used to observe the population dynamics of Ectropis oblique, and the number of Ectropis oblique trapped by software counting and boat trap was recorded every 1 day. Fig.7 shows the change curve of the population number of Ectropis oblique trapped by software counting and boat traps. There was a peak period of adults on September 7 and September 15, with the number of adults being 13 and 15 head. The trend of the number of Ectropis oblique adults trapped by software counting and boat traps was basically the same.

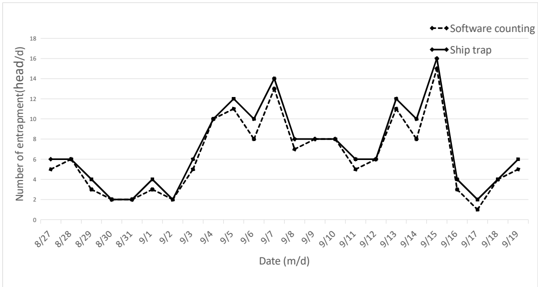

Fig.7 Dynamic trend of population number of Ectropis oblique

5.2. Environmental monitoring test

After the establishment of environmental sensors, power supply systems, gateways, etc., the stable operation of the system is finally achieved. Table 1 lists the data measured in the field test.

Table1 Field Experiment Data

Time	Environmental sensor			
	air temperature /℃	air humidity/%	carbon dioxide/ppm	Illuminance/Lux
8:00	18.2	98	512	15286
12:00	23.4	66	428	62382
16:00	20.0	70	450	36582
20:00	18.6	78	476	0

6. Conclusion

This research combines the Internet of Things technology, infrared sensing technology, sexual attraction technology and sensor technology to achieve the trapping and counting of the Ectropis oblique. Because the association between insect sex pheromone and insect is a particular response, using sex pheromone for pest monitoring offers a high degree of accuracy. Compared with the traditional monitoring system, the infrared counting Ectropis oblique intelligent pest monitoring system saves the labor cost and improves the monitoring efficiency. The recurrence period and population number of pests may be mastered by employing sex pheromone to attract pests, and time and amount information can be supplied for pest management. The software count was somewhat lower than the number of tea inchworms captured by the boat trap in the field test, but the curve of adult tea inchworms trapped by the two techniques was practically the same, as was the peak value. As a result, the insect monitoring equipment could count Ectropis oblique, and the system software assisted users in processing and summarizing Ectropis oblique trapping data. It can detect the occurrence region of Ectropis oblique, grasp its occurrence time and peak, make a scientific judgment for the ecological control of Ectropis oblique, and also monitor the environmental data of tea gardens, providing tea garden employees with a scientific decision-making foundation. Currently, the system is largely tested in tea gardens, and future testing should be performed in complicated contexts to continually enhance the system's stability and accuracy.

7. Acknowledgments:

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8.References:

[1] Chen, X.M., Yang, X.Y., Shi, B.C., Li, W.Y., Du, X.W., Li, M., Sun, C.H. (2015) Research progress and prospect of technologies for automatic identifying and counting of pests[J]. Journal of Environmental Entomology, 37: 176-183.

[2] Li, Y.J. (2021) Research on monitoring and control of air pollution environment based on Internet of Things technology[J]. Energy and Environment, 43: 12-16.

[3] Lin, F. (2021)Design and implementation on intelligent monitoring device of rice leaf folder based on infrared sensor[J]. Journal of Zhejiang Agricultural Sciences., 62: 1451-1454.

[4] Liang, Y. (2020)Design of a real-time monitoring device for fruit fly pests based on infrared sensors[J]. Jiangsu Agricultural Sciences, 48: 230-234.

[5] Tian, R., Chen, M.X., Dong, D.M, Li, W.Y., Jiao, L.Z., Wang, Y.Z., Li, M., Sun, C.H., Yang, X.Y. (2016)Identification and counting method of orchard pests based on fusion method of infrared sensor and machine vision[J]. Transactions of the Chinese Society of Agricultural Engineering, 32: 195-201.

[6] Chen, J.B. (2022)Application of GPS in Forestry Investigation[J]. Forestry Science and Technology Information, 54: 59-62.

[7] Song, J.K., Fang, D.H., Zheng, X., Yang, B.M., Wei, S.G., Zeng, H.Y.(2019)Design of environmental monitoring system for agricultural industrial park based on Internet of Things[J]. Intelligent Computer and Applications, 9: 136-139.

[8] Zhao, R.Y., Wang, B., Jiang, C.R., Deng, J. (2021)Design of Agricultural Greenhouses Monitoring System for Production Environment Based on IOT[J]. Journal of Agricultural Mechanization Research, 43: 131-137.

[9] Ji, H.H., Hu, J.Z., Lan,J.J., Yang, Y.Z., Zhong, X.Y., Bian, L., Luo, Z.X. (2022)Development and Application of Electric Shock Type Sex Pheromone Ectropis grisescens Traps[J]. China Tea, 44: 38-41