Development of insect-trapping system implemented

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***Abstract*—This project is to develop and evaluate the effectiveness of the newly designed insect-trapping system, implemented with pest counting algorithm. We plan to integrate pest pheromone attraction mechanism with the developed algorithm, to detect the number of pests and environmental data. The results of this paper are expected to help rationalize the use of pesticides, enhance the production efficiency of organic agriculture, and reduce the usage of pesticides in agricultural production. Through a series of promotion and training activities, we try to provide farmers with an alternative choice for pest-control.**

***Keywords*—Pheromone, attractant, pest monitoring, agricultural technology, Internet of Things (IoT).**

1. Introduction

As the awareness to food safety and health grows, consumers start to pay attention to origin and production of agriculture products. Due to environmental sustainability, healthy agriculture, and market trend, integrated pest management, which aims to lower the use of pesticides, became the goal and trend of agriculture development. Recently, Internet of Things (IoT) and wireless sensor network [1] are widely applied in the agriculture to improve traditional agriculture, for instance, intelligent irrigation and pest control. Among the application, automated information services is the main trend now, using information service to help farmers lower the labor costs, resource costs, and planting risks [2]. In [3], an intelligence system, using methyl-eugenol, wireless sensor network, and embedded system, to trap Oriental fruit fly, is proposed and realized. However, the design can only trap one kind of pest. Moreover, in order to measure the number of pests, it has complicated hardware design. Therefore, the application and popularization is restrained. In this paper, we use sex pheromone of two crop pests and integrate both hardware and software. We propose a novel pest control system that captures two kinds of pests. We hope that this design can enhance the efficiency of capturing pests, improve food safety, and reduce environmental pollution due to overusing pesticides.

2. Proposed System

The original trapping-cage, as shown in Fig. 1, has several shortcomings. Firstly, it can trap only one kind of pest. Secondly, it requires farmers to count the number of pests and estimate the degree of damage with bare eyes. Thirdly, it cannot monitor and report in real time. Finally, it takes more effort and time for prevention when facing over one kind of targeted pest.

To overcome these problems, a compound trapping-cage, which captures more than one targeted pest. This new cage is a combination of original design, load-cell, and solar-cell supply system. Through data collection and algorithm, the compound system is featured with Internet of Things (IoT) and agriculture 4.0. In this way, farmers can spray crops for early prevention in a better timing and rational use. Moreover, damage by insects is no longer confined in fields. After one to two months of storage in the barn, the harvested crops will be damaged by insects. The wastage reaches about 2-5%. However, with this novel design, farmers can use it in the barn by swapping, lower the cost due to insect damage, and monitor and report in real-time.

2.1. Proposed design

We propose a way that can lower hardware cost and increase accuracy on detecting the number of pests captured. To realize it, we combine a low cost Arduino-uno board, as a platform with LED-module, various sensor nodes.

Fig.1 Conventional trapping-cage.

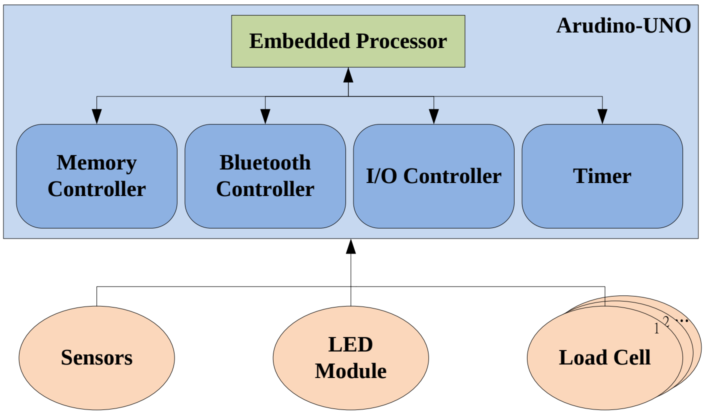

Fig.2 Function block of the proposed design for multi-pest trapping cage.

And then, we use bridge load-cell [4] to detect the total weight of the pests in the each trapping device and transfer weight into quantity. After that, the measured data will be transmitted to server through Bluetooth. The detail function blocks, program flowchart and total system blocks are shown in Fig.2, Fig.3 and Fig.4, respectively.

2.2. Pheromone

Agricultural land in Taiwan adjoins one another, planted with a variety of crops. After visit and evaluation, we discovered that tobacco cutworm and sweet potato weevil are the two pests that frequently harm the sweet potato at the same time. we successfully design pheromone for both insects simultaneously and ensure no interference on attraction effect with each other. Therefore, the two pests are chosen as the targeted pests in this work. The applied pheromone in the research is sex pheromone [5], which is secreted by insects for intercourse and reproduction. When the sex pheromone evaporates and spreads, it will attract male bug insects far away for intercourse. In this way, male insects are lured and trapped, which leads to fewer intercourse and controlled number of pests. The pictures of tobacco cutworm and sweet potato weevil, and the chemical formula of their pheromone are shown in Fig.5(a) and Fig. 5(b), respectively.

3. Experimental Results

The experiments of this paper took place in the fields in Chia-yi city and Taichung city of Taiwan, started from August 2016 to September 2016. The gathering in total lasts about one month. The outcome is shown in Fig.6 (the detail location is also shown in Fig. 7), in which the horizontal axis shows time (days), the vertical axis on the right hand side shows weight (milligram), and vertical axis on the left hand side shows the number of the pests, after being transferred with algorithm. Thus, this system can integrate and analysis the detail data without extra labor cost.

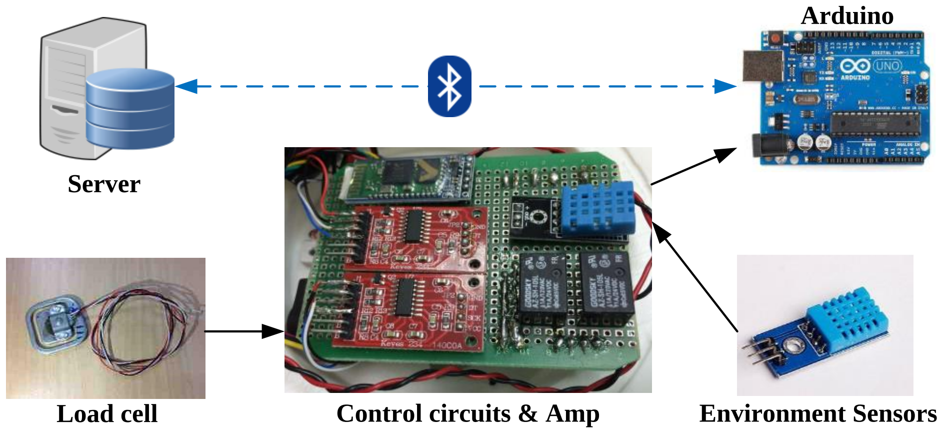

Fig.3 The proposed system (main board, load cell and sensors).

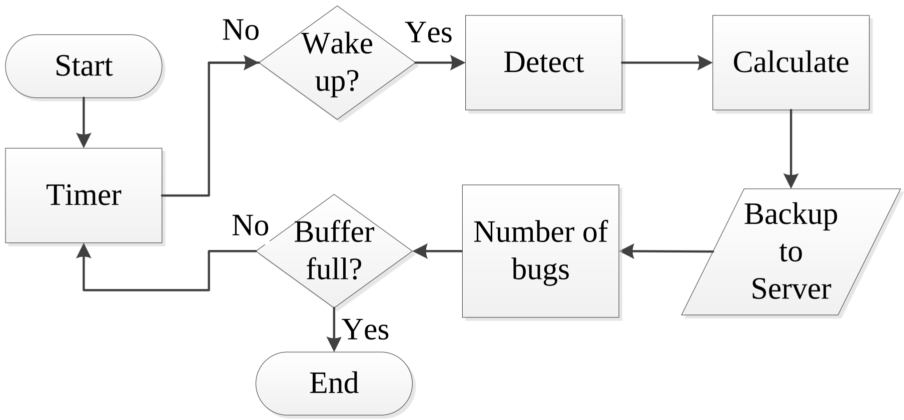

Fig.4 The flowchart of weight is conversion grams to number of bugs.

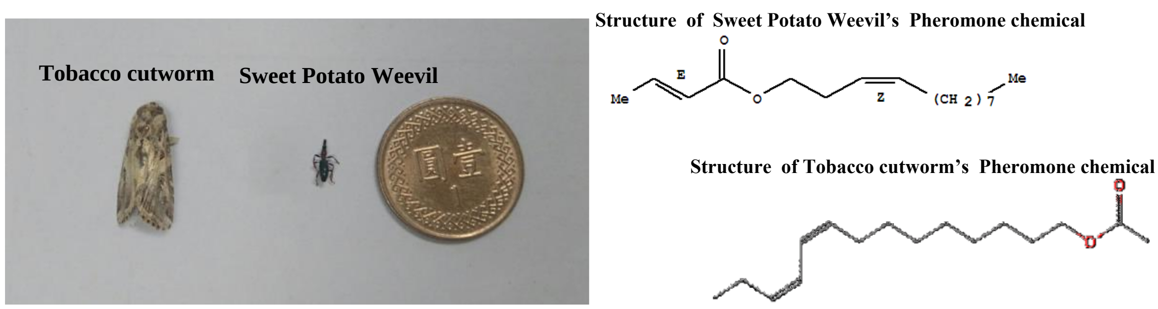

Fig.5 (a)Photo of sweet potato weevil and tobacco cutworm. (b)Chemical formula of both pests.

both two targeted pests were successfully captured. The detriment to the crops is lowered. This shows that the proposed design is more thorough in prevention than the original one.

4. Conclusions

In this paper, we proposed a solution on pest control technology, and provide implementation guidelines on the combination of IoT and pheromone technology in agriculture application. With pest and environment monitoring, the use of pesticides will be rationalized and lowered. We hope this research can help agriculture with an improved pest monitoring system in the future.

Acknowledgment

This work was supported by the Ministry of Science & Technology, Taiwan under contract No.105-2221-E-324 -023 -.

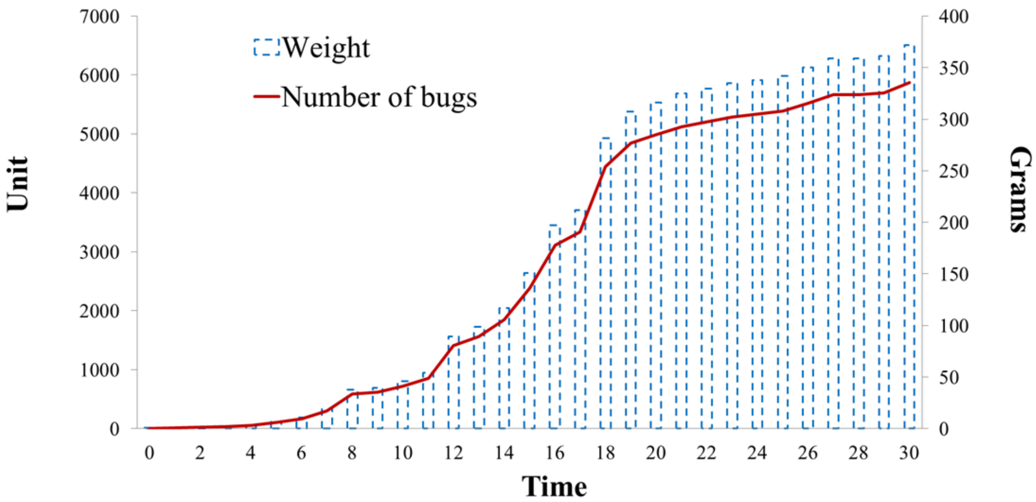

Fig.6 Experimental results by using proposed system.

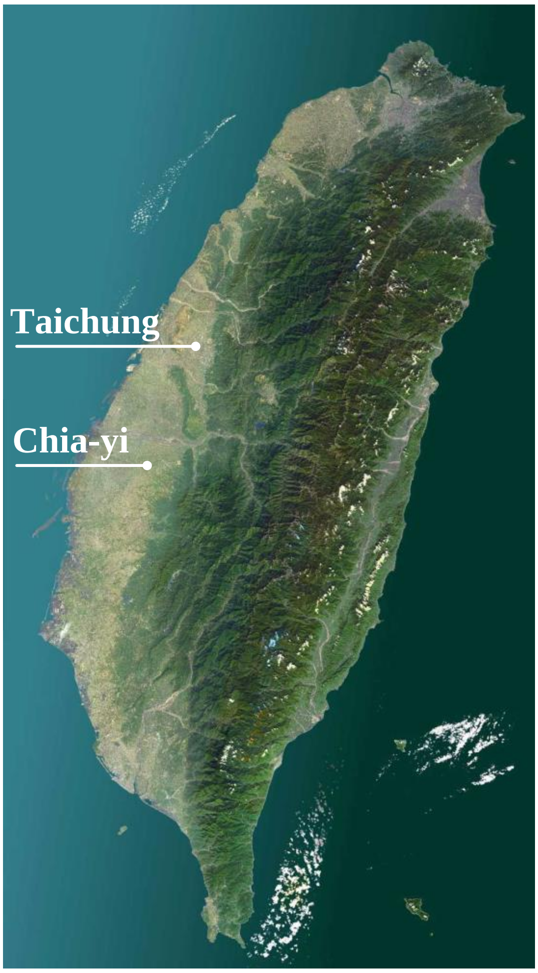

Fig.7 Geographic location of the monitoring stations deployed in Taiwan.

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