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A study on the Beehive Door Opening and Closing System using a Hornet Sound Analysis

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Abstract

Recently, rapid climate change has had a significant impact on the ecosystem of honeybees. In addition, the problem of Vespa Hornets invasion of colonies has a fatal impact on the bee ecosystem, independent of climate change. Especially in late summer. This study relates to a method for preventing Vespa Hornets attack. In this study, we developed a Vespa Hornets sound detection device was developed by collecting and analyzing the sound of a Vespa Hornets and applying IoT technology. The developed device detects the sound of a Vespa Hornets when Vespa Hornets appears around the hive of the bees and sends a signal to automatically close the door of the beehive. The device that receives the signal drives the motor that controls the honeycomb door to close the beehive door. The Vespa Hornets sound detection device operates until no Vespa Hornets sound is detected. The system developed by us is expected to be installed in the beehives of actual beekeeping farms to dramatically reduce the damage caused by by Vespa Hornets.

Keywords: *Vespa Hornets, Sound, Automated Detection, Beehive Door Opening and Closing*

1. INTRODUCTION

Recently, interest in smart farms where various sensors have been developed and Internet of thing (IoT) technology using them is used in agriculture is increasing. Since IoT technology can acquire farm information in real time, various technologies are being developed for it [1]. In the field of beekeeping, smart IoT technology is being actively introduced to observe the situation inside the hive, which is difficult to observe with the naked eye. Honeybees entry/exit counter system is sometimes implemented to figure out the number of honeybees in the hive [2-4], some research was conducted to monitor honeybees through filming [5], the situation of bee colonies can be predicted by measuring the temperature inside the hive [6]. Research is conducted on how to monitor honeybees' condition and the hive's surroundings through acoustic measurement and frequency measurement [7]. Some people also developed a hive equipped with temperature/humidity, sound, and weight sensors for beekeeping management and detection of colony division and tried to apply Artificial Intelligence (AI) technology such as the Long Short-Term Memory models (LSTM) algorithm to the data recorded through this [8]. The biggest problem in late summer in bee management is colony damage by Vespa Hornets. Damage caused by Vespa Hornets has a huge impact on the bee ecosystem [9]. To minimize the

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damage from these Vespa Hornets, others also designed a prototype of an early warning system for Vespa Hornets attack [10]. This study aims to develop a system that detects the sound of a Vespa Hornets and closes the door of the beehive. This system refers to a system that can automatically open and close the door of the beehive as well as early warning of Vespa Hornets. The developed system will be installed in the beehives of actual beekeeping farms and will be able to dramatically reduce the damage caused by Vespa Hornets

2. RELATED WORKS

Figure 1 shows the configuration diagram of the beehive Door opening and closing system using Vespa Hornets sound analysis

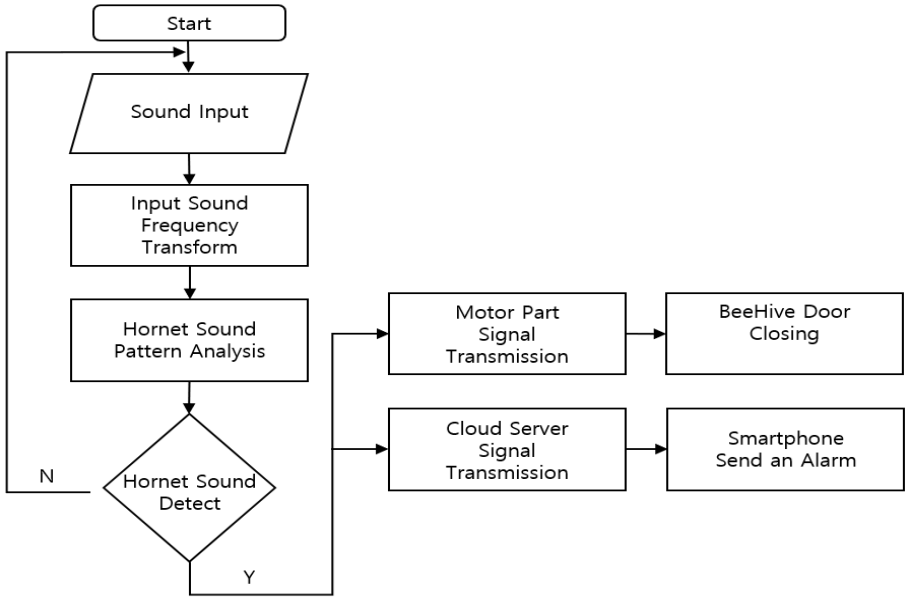

Figure 1. Beehive door opening system configuration diagram

Received the sound of a wasp outside the hive and analyzed the sound pattern through frequency analysis of the sound. Currently, the Vespa Hornet flapping wave consists of frequency components in the 100, 200, 300, 400, 500, 600, 700, 800, 900, and 1000 Hz bands. In addition, when the Vespa Hornet flies, frequency components below 300 Hz band are continuously configured [9]. By analyzing the Vespa Hornet sound in this study, it was confirmed that a specific pattern continuously occurred in the 150 Hz band. Therefore, it was possible to detect the Vespa Hornet pattern in the input sound based on a specific pattern in the 150 Hz band. When the Vespa Hornet pattern is detected, it sends a signal to the motor module, and the motor operates to close the door of the beehive. In addition, the generation of a signal is transmitted to the cloud server to raise an alarm on the smartphone and close the door of the beehive remotely.

Figure 2 shows the result of the development of the beehive door opening and closing system. To effectively receive the sound of the Vespa Hornet, a microphone that receives sound of 300 Hz or less was produced. This can make the input sound frequency transform speed faster. The sound analysis board compares and analyzes the input sound and the standard the Vespa Hornet sound pattern in the 150Hz band. And when the Vespa Hornet sound pattern is detected, the LED turns on, and it serves to transmit a signal to the motor module and the cloud server. The beehive door opening and closing module receives a signal to close the beehive door. The beehive door opening and closing module is equipped with a bee entry and exit counter sensor developed by

this research team. So we can know the number of bees that enter and exit the beehive. The signal sent to the cloud server triggers an alarm in the Staff Phone mobile app to notify of an emergency situation, and the beehive manager can remotely close the beehive door.

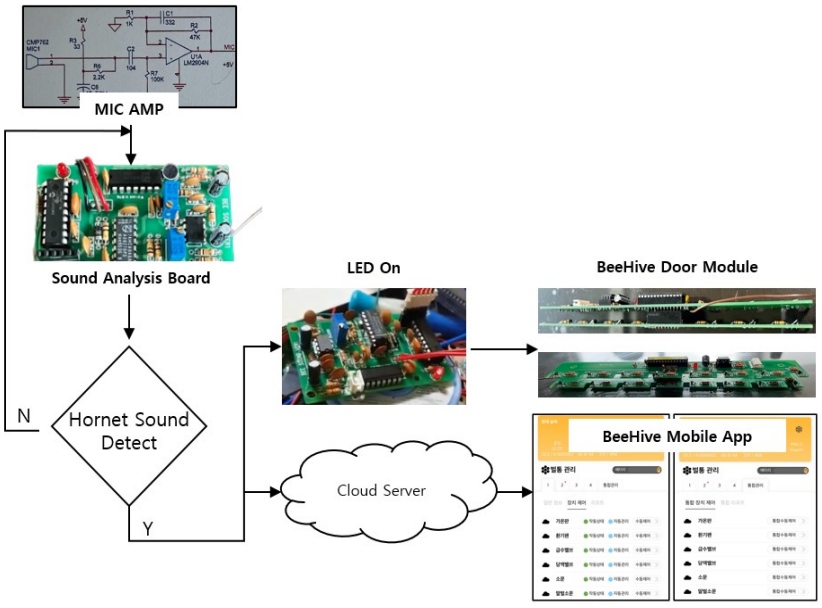

Figure 2. Development result of beehive door opening and closing system

Figure 3 shows a futuristic beehive called SolarBeeHive in which the developed system is installed. SolarBeeHive was developed to be powered by sunlight and to remotely control all aspects of the beehive. The beehive door opening and closing system using the Vespa Hornet sound analysis developed in this study is installed in SolarBeeHive. SolarBeeHive enables real-time monitoring on the mobile web.

Figure 3. SolarBeeHive with the Vespa Hornet detection door opening system

3. CONCLUSION

We have developed a system that automatically opens and closes the door of the beehive by detecting the sound of a Vespa Hornet. The sound of a Vespa Hornet is made up of various frequency components. However, because of analyzing the flapping wave and the wave when flying, a specific pattern was found in the 150 Hz

band in common. Based on the discovered pattern, we were able to develop an algorithm that could detect a Vespa Hornet among various field sounds. Thus, it was possible to automatically open and close the honeycomb door by transmitting a signal to the motor unit when it detects a Vespa Hornet sound. The system developed in this study is installed in SolarBeeHive and is being tested. When the demonstration period is over and it is distributed to farms, it will be possible to dramatically reduce the damage to beekeeping farms caused by Vespa Hornets.

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