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A Study on the System for measuring the Activity of Honeybees inside and outside the Beehive

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Abstract

Recently, due to rapid climate change, the population of honey bees has decreased, posing a great threat to the existence of the Earth's ecosystem. In particular, the colony collapse phenomenon in which bees disappeared nationwide in early 2022 had devastating consequences for beekeepers. In order to solve the problems of beekeeping due to climate change, it is urgent to develop a system that can monitor the situation inside the hive through various IoT sensors. This paper develops a system that can measure the activity of bees inside the hive and uses it to measure the number of times of entry and exit of the hive. The data measured by the developed system can be monitored in real time on a smartphone through the cloud server. The system developed in this paper can monitor the ecology of bees according to climate change and measure internal and external bee activities. Using this method, it is possible to check in advance for the colony collapse phenomenon in which bees disappeared in early 2022. This is very meaningful in that it presents an alternative that can identify the cause of the problem through early detection.

Keywords: *IoT, Measuring the Activity of Honeybees, Measurement of Honeybees Movement, Cloud System*

1. INTRODUCTION

Recently, due to rapid climate change, the honey bee population is rapidly declining. In particular, a collective disappearance phenomenon in which 7.8 billion bees disappear nationwide in early 2022, the so-called 'colony collapse', has occurred, posing a great threat to beekeepers and the existence of the Earth's ecosystem. It is true that there are insufficient aspects to attribute this phenomenon to abnormal temperature due to climate change and poor overwintering management of beehives in winter. In order to solve this problem, it can be said that it is essential to monitor the inside and outside of bees and beehives through IoT technology. Recently, through the advancement of IoT technology, various smart farm technologies that apply

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IoT technology to agriculture are being developed [1]. In particular, in the field of beekeeping, it is impossible to observe the inside of the hive with the naked eye, so IoT technology using sensors is being actively introduced. In order to identify the number of bees, a bee entry and exit counting system is implemented [2-4]. Attempts to monitor bees through imaging [5]. A study to predict the beehive situation by measuring the temperature inside the hive through a temperature sensor [6]. Attempts to monitor conditions around hives through sound measurements of bees and wasps [7-8]. For beekeeping management and detection of swarming, beehives equipped with temperature/humidity, sound, and weight sensors are developed, and data recorded through this are attempted to apply AI technologies such as LSTM algorithms [9]. In addition, the damage to honey bees by wasps is also serious, especially the damage to honey bees by long-lived wasps has a huge impact on the honey bee ecosystem [10]. In order to minimize the damage of these long-lived wasps, a prototype of a long-lived wasp early warning system was designed [11]. The development of a system that detects wasp sounds to open and close the hive [8] can be combined with a bee movement measurement system [4] using a photo detector to expand into a system that can measure the internal and external movement of bees. This means that it is possible to present a clue to determine the cause of the phenomenon of 'colony collapse'.

2. EXPERIMENTS

Figure 1 shows the configuration of the system for measuring the amount of movement of bees inside the hive. The step 1 is to develop a measurement board that can measure the movement of bees inside the hive [4]. The step 2 is to send the movement data of bees measured on the developed board to the cloud server. Step 3 shows the step of monitoring the data stored in the cloud server through the mobile web.

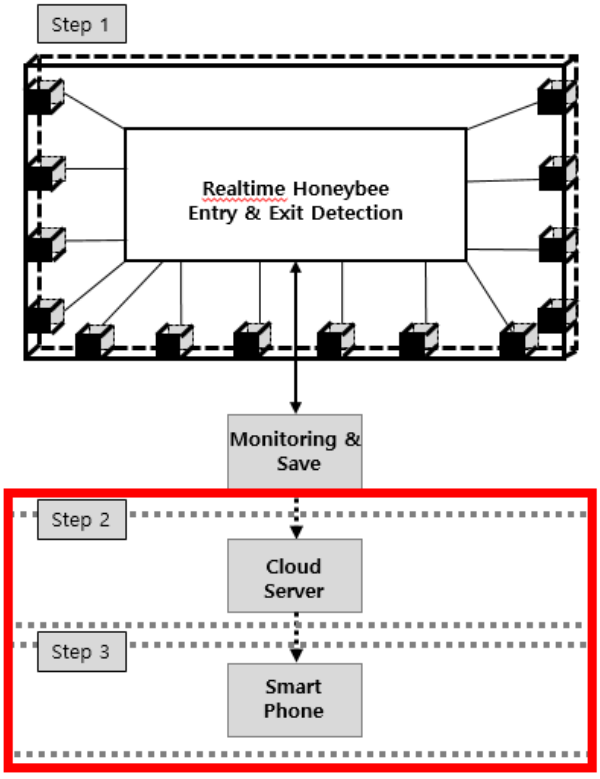

Figure 1. Step-by-step system configuration diagram for measuring the amount of movement inside bees

Figure 2(a) shows the measurement board developed in step 1 of Figure 1 in 2021 [4]. Figure 2(b) shows the result of optimizing the measurement board developed in step 1 of Figure 1 to be applied to the actual beekeeping beehive. Figure 2(b) shows the number of entry and exit sensors on the board developed in the first stage was increased, and the board was minimized so that it could be applied to the actual beehive.

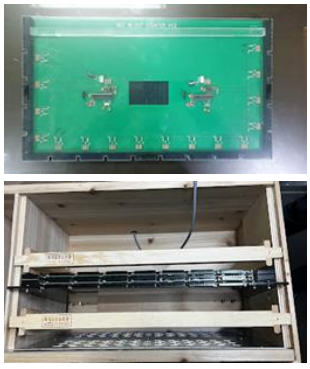

Figure 2(a). prototype in 2021

Figure 2(b). Optimization Board in 2022

Figure 2. Development of a board for measuring the amount of movement inside bees

Figure 3 shows the result of measuring the bee internal activity measurement board in Figure 2(b) from June to the end of August 2022 by mounting it on the actual beehive. 'Internal entry 1' means the number of times bees pass through the consumption installed inside the hive and into the empty space, and 'internal entry 2' means the number of times the bee enters the parenting area in the empty space. The amount of bee movement was stored at 10-second intervals and transmitted to the cloud. As a result of monitoring by accumulating the amount of internal movement of honey bees, it was found that the amount of internal movement also increased as the number of honey bees increased over time. These results indicate that bees are active inside the hive, which means that the ecology of bees inside the hive can be inferred. In other words, if the number of bees decreases, the amount of internal movement also decreases.

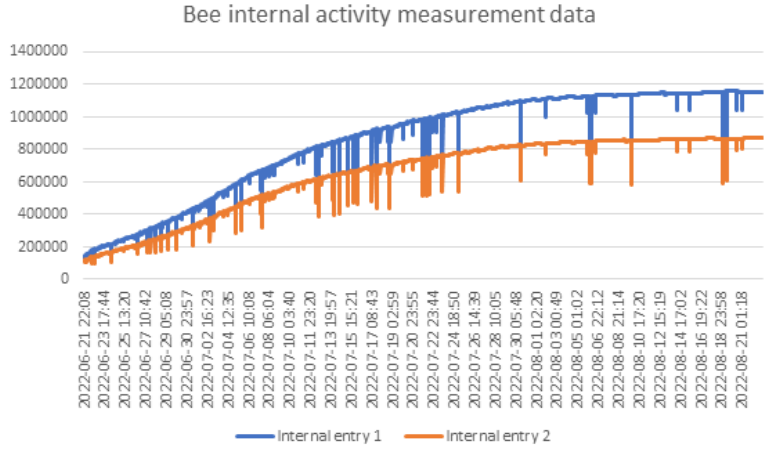

Figure 3. Bee internal activity measurement data

Figure 4 shows a system that combines a bee internal movement measurement board and a door to enter and exit the hive. It is designed to open and close the hive door automatically or manually by installing a motor on

the hive door. For example, you can automatically open and close the beehive at a specific time according to the setting value, or manually open and close the beehive on the mobile web. This system can measure the number of times bees enter and exit the hive through photo detectors when the beehive door is open.

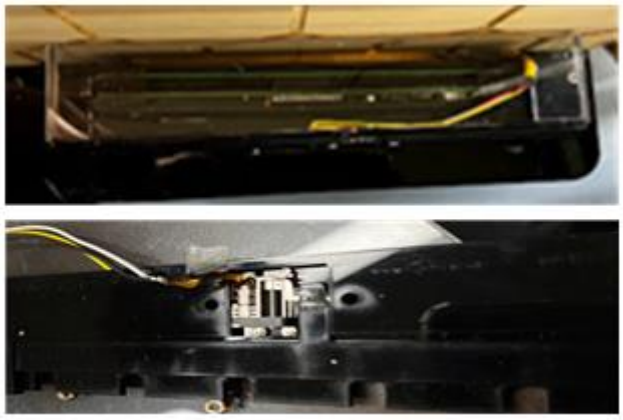

Figure 4. A device for measuring the number of times a bee enters and exits the beehive

Figure 5 shows the result of measurement from June to the end of August 2022 by installing the device for measuring the number of times the bees enter and exit the hive in Figure 4 to the actual beehive. 'Outside entry 1' means the number of times bees went out through the door, and 'Outside entry 2' means the number of times bees returned to the hive through the door. The number of entry/exit of bees into and out of the hive was stored at 10-second intervals and transmitted to the cloud, similar to the measurement of the bee internal activity. As a result of monitoring by accumulating the number of times of entry and exit of the bee hive, it was found that the number of bees increased as time passed, and the number of entry and exit of bees also increased. It was found that the number of bees coming in was 1.5 times more than the number of going out, and it was found that there were more bees entering and leaving around the hive than bees that actually flew away and returned.

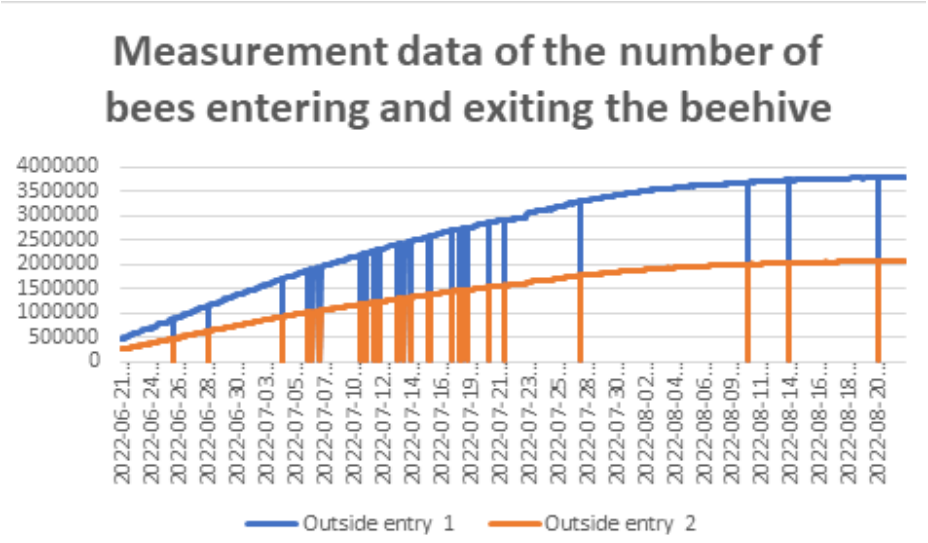

Figure 5. Measurement data of the number of bees entering and exiting the beehive

Figure 6 shows the internal movement measurement board installed in the actual beehive, 'Sola Bee Hive', and the number of internal and external accesses mounted on the beehive door, monitored by a smartphone. It was developed to transmit data from the actual beehive to the cloud server and check this data on a smartphone. As shown in Figure 6, the beehive can be equipped with various IoT sensors to measure the temperature/humidity inside the hive, CO2, beehive weight, food weight, water supply, and sugar solution. In addition, the results of measuring the amount of internal movement and the number of times of internal and external access, which were additionally installed in this study, can also be monitored.

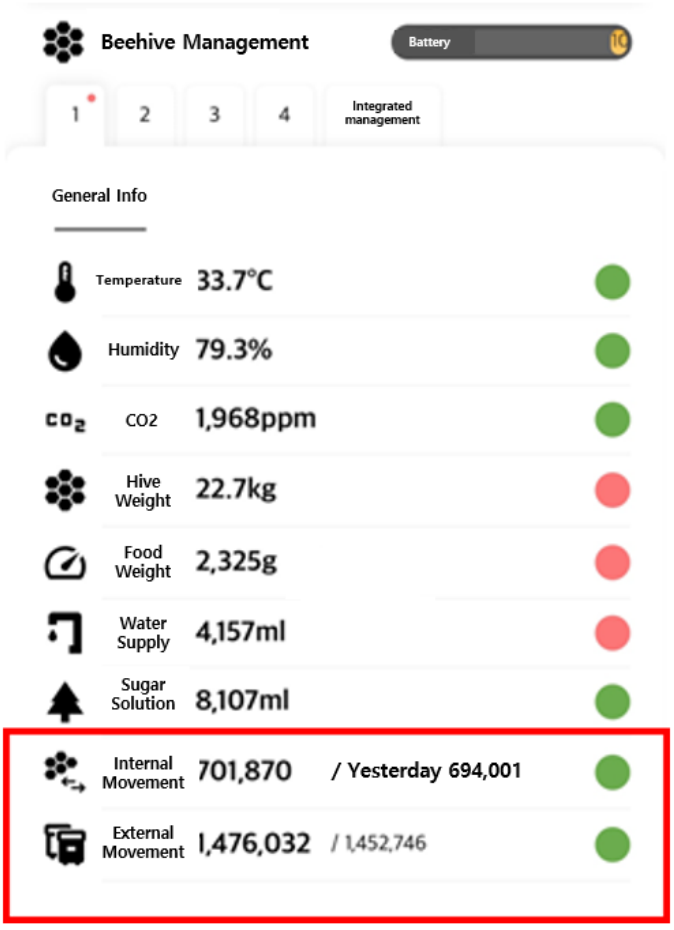

Figure 6. Beehive Management Mobile Web Monitoring Screen

Figure 7 shows the correlation between the amount of movement of bees inside the hive and the number of times they enter and exit the hive. According to Figure 7, it was found that the amount of internal activity and the amount of external activity of bees are activated in direct proportion to each other. It was found that the amount of internal activity was approximately half of the amount of external activity and was similar to the ratio of the amount of external output and internal output. This is about 1/2 of the total number of bees (qualified group) that have a lot of outdoor activities, and it can be inferred that the remaining bees go in and out and move inside the beehive. In addition, these results indicate that it is sufficient to monitor the internal movement of honey bees when checking the colony collapse phenomenon in advance.

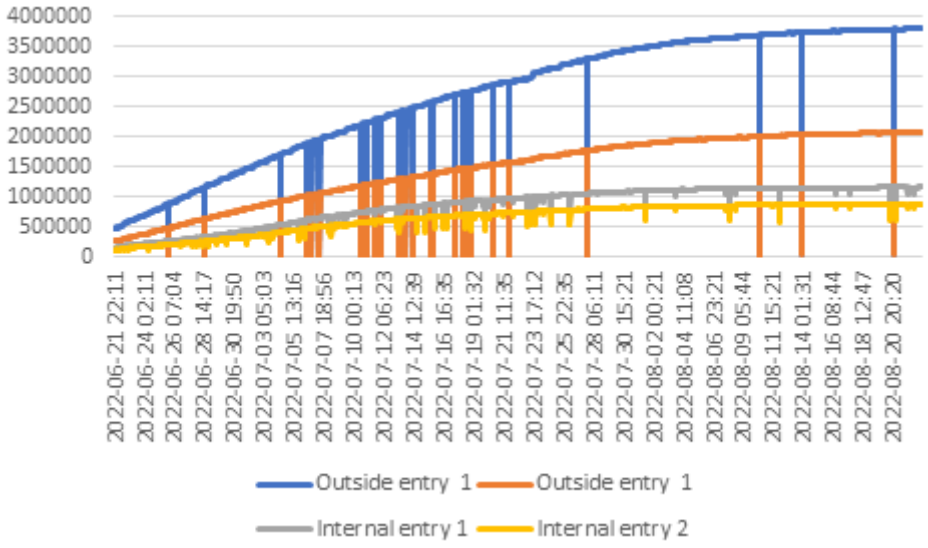

Figure 7. Analysis of the correlation between the amount of internal activity and the amount of external activity of bees

3. CONCLUSION

We are about the development of a system that can measure the amount of activity inside and outside the hive of bees. By supplementing and optimizing the existing bee internal movement measurement system, the system can be installed in the rumor of the hive. As a result, it was possible to measure the number of times honeybees entered and exited the hive. This means that the number of bees can be predicted by measuring the amount of activity of bees in the hive by measuring the number of entry and exit times of bees. In addition, by measuring the amount of movement of bees inside the hive, beekeeping farms can observe the internal activity of bees without internal examination of the hive. In other words, it is possible to know that bees are in the hive by measuring the amount of internal movement of bees, and by measuring the number of entry and exit of bees through the measurement of internal and external movement, it is possible to infer the increase or decrease in the population of bees. The above research results are significant in that it is possible to check in advance for the disappearance of honey bees (colony collapse) that occurred in early 2022, and to suggest an alternative to identify the cause of the problem through early detection.

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