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Analysis honeybee activity monitoring system

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Abstract
The goal of this study is to create a honeybee behaviour monitoring system. Honeybees' everyday actions of entering and exiting their hive are monitored by the suggested system. It offers a novel approach to examine honeybee behaviour and can be used to replace human observation methods. It keeps track of climatic changes in the area and inside the beehive automatically. The data obtained by the device is used for Quantitative analysis, and the results help with research better comprehend the link between the situation and health conditions and honeybees' actions of entering and exiting their hives. The results showed that the performance system is effective will be useful in future research efforts requiring large-scale bee colony monitoring.

Keywords: automatically monitoring system, honeybees

Introduction

Through pollination, honeybees play an important part in the growth of a variety of fruits and fresh vegetables. Honeybees account for almost 66 percent of all pollinators, according to studies [1]. Honeybees also generate honey, royal jelly, and pollen. Honey is a valuable product all around the world. In 2007, total e output was 1.07 million tonnes. Honey demand has been increasing over time, as seen by the consistent annual growth rate of sugar and honey exports. Honey production in 2007 was predicted to be worth up to 125 million dollars. As a result, honey is a product with great economic worth in addition to providing a variety of foods. Climate change, on the other hand, has resulted in rising temperatures and harsh weather around the planet in recent years. Honeybees are particularly sensitive to environmental variables such as temperature, humidity, light, and sun radiation, according to research [6]. Honeybees' growth is influenced by these variables. Furthermore, colony collapse disorder (CCD) is a common occurrence that is still unsolved.
The rapid loss of an adult bee population from a colony is a symptom of CCD [7]. There are no dead adult bees inside the colony or in close proximity to it. From 2006 to 2011, an average of 30% of the colonies in the United States died each winter [8]. As a result, this research suggests a monitoring system that uses ambient sensors to track the actions of honeybees entering and departing their hive. This technology gathers more data on honeybee behaviours as well as changes in environmental conditions.

Honey bee health monitoring using energy harvesting devices

This paper presents a new technique on behalf of monitor sweetheart bees in real time across their entire foraging range. The communication of bee position data is powered by energy harvested from mechanical vibrations of bees, with no physical injury or flight restriction 5.8 GHz receiver is also built into a multisource power harvest entity that uses wind, sun, and RF power scavenging to track the bees' place. The power circuits, transmitter, and receiver designs and considerations are covered. A new approach for honey bee monitoring around the hive using energy harvesting has been proposed. A wearable gadget gathers energy from a bee's mechanical movements, eliminating the need for large batteries while also offering a renewable source of electricity. The most important aspects of energy harvester design have been explored. The integrated 5.8 GHz receiver is powered by a multisource energy harvester, which delivers long-term energy. Once implemented, the device will require no maintenance and will eventually give beekeepers furthermore scientists by way of an user-friendly, instantaneous information flow of bee position, with the ability to successfully monitor colony health.

Materials and Methods, Second

The goal of this work was to create a monitoring system that could track foraging behaviours in real time. The suggested system's architecture is depicted in Figure 1. The temperature and humidity data in the surrounding surroundings as well as inside the beehive were also automatically recorded by the device. The frequency of Over a period of time, insects enter and quit the hive. Specific period of time was used to represent foraging activity.

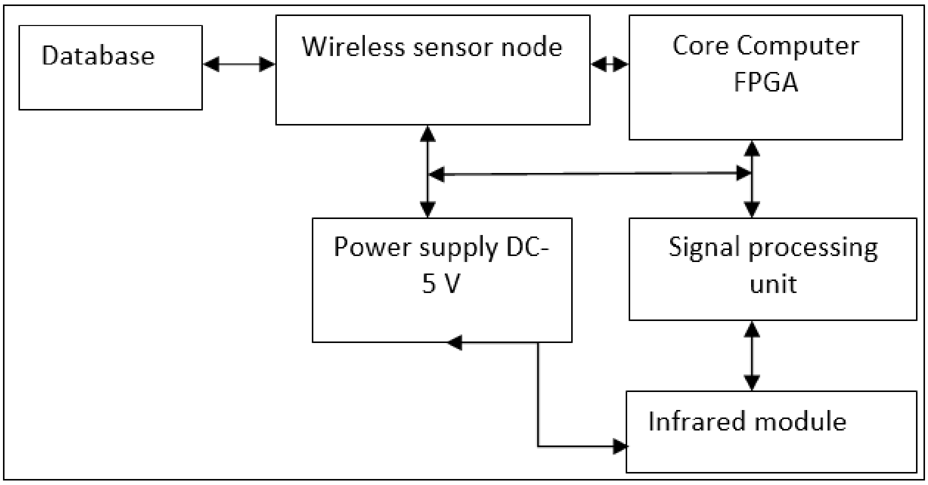

Fig 1: The suggested system's architecture

At a specific time point, sensors monitored temperature and humidity. Data was evaluated after gathering data, the frequency of bees activities was calculated. The meteorological information and forage patterns over a lengthy period of time. In the surveillance system, a bee enters a route.

Because the monitoring system was to be utilised in an outdoor location, Bakelite was employed to create a bee entry pathway that could withstand the effects of Taiwan's hot and humid climate. Infrared transceiver modules were installed on the channel's top and bottom sides, powered by DC power of 5 volts. On both the top and bottom sides of the canal, there were 20 holes. The holes were drilled to match the LED diameter on the infrared transceiver module. For the infrared light, there was an Imm hole within the hole.

1. Power source

To convert 110-volt AC power to 5-volt DC, a converter was used. Power for the monitoring system, which was powered by 11 O-volt AC power supplied by a utility provider. Because the power came from the mains, the chances of a power outage were considerably minimised under normal circumstances.

2. Module for detecting bees (D)

The infrared transceiver was inserted in the unique channel's top and lower ends. Infrared light was continuously emitted by the infrared transmitter. In the optical receiver, the internal resistance would be extraordinarily high if the ultraviolet light was not absorbed by the IR receiver. Under constant voltage, If the electromagnetic transmitter, on the other hand, regularly generated infrared waves,, If the electromagnetic transmitter, on the other hand, regularly generated infrared waves, the infrared receiver's resistance value would be low. As a result, various resistance values represented the amount of infrared light received by the infrared receiver.

The honeybees obstructed the transmitter's infrared light, causing the resistance value to rise from low to high. This wave, whose waveform represented an analogue signal, was captured by an oscilloscope. The arithmetic processing cores of a field-programmable gate array (FPGA) were used to process signals in this study. The error would arise if analogue signals were given to the FPGA, because the FPGA could only process digital signals. To remedy this difficulty, the analogue signals sent from the infrared receiver must be rectified so that the FPGA can reliably record the digital signals generated by foragers passing across the channel.

Module for signal processing

This research created a signal processing circuit board. The information processing route board be primarily accountable for decoding the infrared receiver's signal. The analogue signals sent next to the infrared receiver must be converted to any signals so that the FPGA's mathematics dealing out unit be capable of detect a honey bee enters and/or exits the hive during the outlet. A indication generate through the infrared receiver was rehabilitated to a four-sided figure switching signal processed by the computer chip for real - time applications .Even if signals are disturbed by the environment, the likelihood of digital signals being distorted is smaller than that of analogue ones. Furthermore, a digital signal's output was either "1" or "0," making it simple for the processor organization to calculate the number of bits and considerably reducing the likelihood of distortion. Two integrated circuits were employed in the signal processing module: the LM324 [8] and the HEF4538 [9]. The LM324 contained four operational amplifiers. The infrared transceiver's signals were transformed to digital signals using the comparing function.

If only the LM324 was utilised to process the signal, a honeybee remaining in the infrared transceiver path would result in the signal constantly being at 0 volt. A HEF4538 wafer was added to the signal processing

module to improve signal processing. When the infrared was blocked, this wafer was negatively edge-triggered. The pins lOA / lOB measured signals from 1 to O at the same time. A square wave would be triggered by the HEF4538.The goal was to keep honeybees from staying at the channel for too long, leading to erroneous judgements. Furthermore, the width of the square wave might be adjusted by connecting a capacitor and a resistor to the pins etc and RCtc.
By multiplying the capacitor by the resistor, the width was calculated. Controlling the amount of interruption signal could improve the precision with which the processor cores determine and compute.

Platform for counting bees (F)
Because FPGA had more logic gates and RAM blocks, the bee collectively with stand used it to do complicated digital computations. It also had a lot of pins on it. One of the most essential benefits of adopting FPGA be with the purpose of a number of signals at once. As a result, an FPGA board was chosen for the development of the bee plus stage within research. The FPGA's job during the monitoring method in the direction of take delivery of data beginning the 40 infrared module and figure out which information represented honeybees arriving and departing the hive.
The information was then delivered to a wireless sensor node by FPGA, which calculated all of the entering and leaving activities. Figure 8 depicts a block diagram of the counting procedure.

Sensor node that is wireless
The Arduino Yun, which is based on the ATmega32U4 chip and the Atheros AR9331 CPU, was employed as the sensor node in this investigation, as shown in Fig 9.Atheros supports the Open Wrt-based Linux distribution. A built-in USB-A port, a micro-SD slot, 20 digital input/output pins, a 16MHz crystal oscillator, a micro USB connector, and three reset buttons were all included on the sensor node's board. It has Ethernet and WiFi capabilities. The ATmega32U4 chip gave different options for reading and sending data to output ports in real time, which was one of the key advantages of employing the sensor node.
It was simple to save data on the SD card and send it to the database over WiFi. A temperature humidity sensor SHTll, manufactured by Sensirio, was also used in the monitoring system. The sensor's advantages included its tiny size, low cost, and good accuracy. Temperature and relative humidity error ranges for SHT I I were OSC and 3.5 RH percent, respectively. Two temperature humidity sensors were employed in this study. The first was placed outside the beehive, while the second was placed within.

Experimentation techniques
In July 2014, three beehives with the suggested technology were installed the monitoring systems. Inside the beehive, seven near eight frames also a temperature and humidity sensor was installed. Honeybees be also fed each three time, furthermore the dependency and beehives be inspected every three days to guarantee a healthy atmosphere. In beehives, unique care be rewarded to the emperor bee near ascertain if she was still alive. More significantly, if an extra garden centre thing be discovered at home every one mount, it quickly separated near make certain with the aim of each beehive had just one queen bee.

Experimental results
Three beehives through monitoring systems be position up in an open-air area, as previously reported. The monitoring devices recorded hotness and qualified moisture within with exterior the beehives, as well as the number of honeybees entering and exiting the hive. The sample period was one minute.
Environmental conditions were comparable in all three beehives. They were all in the shade, for example, and the wind and sun came from the same direction. The weather data (ambient temperature, relative humidity, and rainfall) and the average number of foragers entering and exiting the beehives per minute are shown in Fig. 11 (a) and (b).The Central Weather Bureau of Taiwan provided the rainfall data, and the ambient temperature and relative humidity were computed by averaging the temperature and relative humidity outside the three beehives. Honeybee activity has been shown to be affected by ambient temperature in previous investigations.
One study found that increasing the air temperature from 30 to 40°C induced a decrease in metabolic rate, an increase in locomotor activity, and fanning. The variations in running away movement were related to changes in ecological hotness across the experiential hotness range, The limited to changes in solar radiation to a particular threshold (0.66 langleys).The night activity dropped if the sun radiation exceeded this value [10]. The experimental results reveal that honeybee activities of entering and departing beehives are affected by ambient temperature fluctuations in this study. Foragers enter and leave the beehives more frequently on days when the ambient temperature is high.
Foragers, on the other hand, become less active on days when the ambient temperature is low, and their actions of entering and leaving the beehives decrease. As a result of the research findings, it can be concluded that flying activity is connected to ambient temperature. Furthermore, honeybees' flight behaviours are influenced by rainfall, according to this study. Honeybee activity was shown to be reduced or interrupted during the rain in previous research [12–13]. Kasper! (2008) found that activity did not totally cease during the rain, but rather dropped by 30% in all nests before returning to pre-rain levels [13]. Precipitation reduces honeybee activity, according to all of these investigations. Our research came up with similar conclusions.

Honeybees' flight activity is greatly reduced on wet days.In this study, the monitoring data from August 12 to August 14, 2014 was used to conduct further analysis. The standard numeral of foragers incoming as well as departing the beehives for each minute per day, as well as the ambient and beehive high temperature and comparative humidity .The sample period lasted one minute. The findings of the analysis demonstrate that the ambient temperature rises in the sunrise, the ambient moisture drops, along with honeybees begin to leave their hives.

However, there is minimal evidence to establish a link between ambient relative humidity and forager actions such as entering and exiting beehives. The frequency of foragers entering and departing their beehives does not rise in proportion to the increase in ambient relative humidity. This suggests that honeybee behaviour is not only influenced by relative humidity levels in the environment. The beehive warmth patterns are all changed from the ambient temperature, as seen in Fig. 12.Because of the beehive's insulating effect, the temperature inside the hive can be independent of the ambient temperature. Heat can be generated by honeybees [14] and delivered to the brood through direct contact [15].

As a result, honeybees do not transmit heat through air movement or an external heat source. Apart from that, the ideal temperature for all hive regions is the same: a high temperature promotes optimal brood development and honey ripening [16]. Humidity adjustment, on the other hand, nectar or water collecting outside the beehive and evaporation, each step adding variety to the management system [17]. As a result, honeybees control the humidity in their hives, but only to a certain extent. The regulated relative humidity level in this investigation was determined to be close to 80%.

Final Thoughts

The goal of this research is to create a system for tracking honeybee behaviour. The monitoring arrangement is an innovative and reliable coordination with infrared transmit in addition to receiving module that give a original approach to watch honeybee behaviour and substitute human observation methods. At the same time, the monitoring system measures environmental elements such seeing that ambient and beehive heat, as well as qualified humidity. Data on honeybee behaviour along with ecological parameters be able to be together using the monitor coordination. Beekeepers and researchers can observe the health of a beehive by monitoring honeybee foraging activities, furthermore the monitor numbers also serves as a documentation for value manage of honey-related goods. The manners of honeybees are partial by a number of factors.

Conclusion

This honeybee behaviour monitoring system uses infrared LEDs to determine the frequency of foragers towards the inside and leaving their hives, as well as SHTll sensors to become aware of ambient and beehive warmth and virtual wetness. More sensors are likely to be added to the monitoring system in the future to measure additional variables such at the same time as enlightenment, ambience, furthermore the load of a beehive.As a result of the monitoring, beekeepers and researchers will be able to keep track of several physical parameters of honeybee colonies in real time.

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