Automated detection of swarm catch box occupation with the Internet of Things

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Introduction

Catch boxes are deployed to attract swarms and typically are empty or only contain one comb. Once bees move in, wild comb is built, so rapid detection of swarm encroachment is necessary.

Australia is the only continent without Varroa. Biosecurity surveillance catch boxes are placed around its shipping ports. Monitoring of these for invasive bee incursion is crucial and remote scrutiny is therefore highly beneficial.

Ultrasonic sensors emit pulses of sound and measure the time taken for the signal to bounce from a reflecting surface. They are cheap and widely used as car parking sensors. Using an ultrasonic sensor in a catch box allows detection of a cluster of bees.

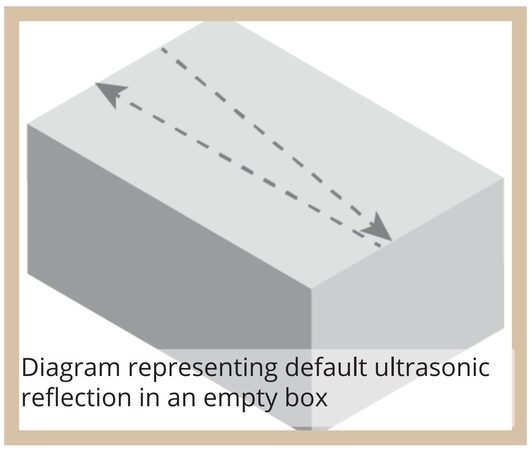
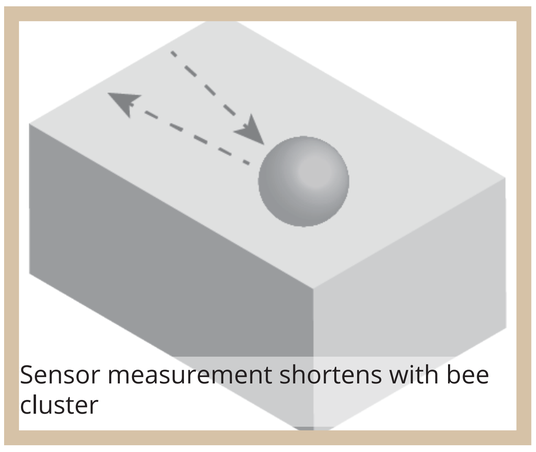
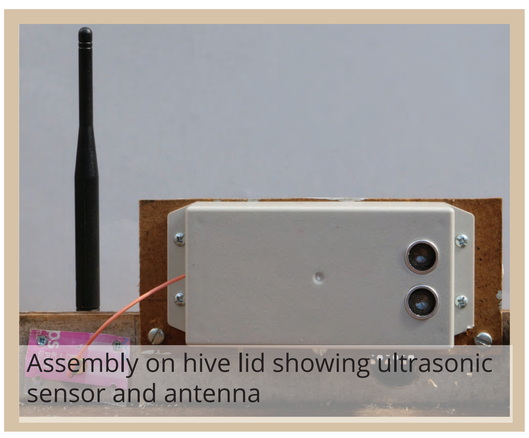


Diagram representing default ultrasonic reflection in an empty box



Sensor measurement shortens with bee cluster



Assembly on hive lid showing ultrasonic sensor and antenna

Agriculture Victoria biosecurity catch box

Approach and design

Arduino microcontrollers offer low-cost sensor monitoring. Connection to the Internet and low power sleep provide long term battery operation (potentially several years).

LoRa radio transceivers can communicate with the Internet via public gateways connected to The Things Network (TTN). An intelligent response such as the sending of an email or text message in response to a positive signal is readily enabled.

A Rocketscream Mini Ultra Pro microcontroller[1] with integral LoRa radio transceiver was equipped with an ultrasonic sensor[2] to monitor the internal space of the catch box. An occupying swarm will trigger a change in the distance measured to the reflecting far wall of the hive.

Software Connections

The device sends uplinks once per hour and data signals consisting of single byte messages are received by the TTN gateway.

Messages are decoded by the bespoke TTN application. A change in distance measured triggers a report.

An integrated IFTTT (IfThisThenThat) service applet forwards the positive result via text message or email to a chosen operator.

1 Rocketscream Electronics, Malaysia (www.rocketscream.com)
2 RCLW-1601 Adafruit, USA (www.adafruit.com)

Results and Discussion

Testing

As proof of concept a hive was removed from its stand and replaced with an empty hive with installed sensor. The bees were shaken from the combs in front of ths, allowing them to return via the entrance. As they clustered inside the lid, they triggered the sensor.

The distance reported decreased from 40 to 23 cm. The combs were then returned to the colony.

Shaking bees in front of sensor hive.

Biosecurity Installation

An existing catch box from the Agriculture Victoria biosecurity program in Port Melbourne was fitted with a working prototype. The device successfully connected to a public gateway located on a city building at 3.2 km distance and commenced reporting.

Monitoring and battery life assessment is ongoing. Some connection issues were experienced due to the hive location being surrounded by trees, necessitating installation of a more powerful antenna.

Robustness of the sensor under field condtions requires establishing. Extraneous insect or arachnid activity (eg spider webs) within the catch boxes may compromise measurements and necessitate periodic maintenance.

Outcome

The device functions well and will detect bee incursion. Components are readily available and can be assembled for less than $100. Expansion of the project to deploy in additional biosecurity locations is planned.

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