Technology Offer

Sensor Support for a Beehive Panel

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Abstract

This advanced beehive panel system revolutionizes hive management with precise, real-time control of the 3-dimensional temperature distribution inside the honey bee colony. The technology developed makes it possible to maintain and restore the optimal thermal homeostasis in the hive after and during the action of external stressors, strongly supporting the optimal relative density of the bee population. The sensing system is minimally invasive, promotes colony health and productivity, while preserving natural bee behaviors such as the wiggle dance. Seamlessly integrating temperature, humidity, and parasite detection, the system empowers beekeepers with data-driven tools for proactive, efficient hive care.

Background

Honey bee colonies are susceptible to multiple stress factors, including extreme temperatures, humidity imbalances, nutritional deficiencies due to the decrease of flowering plants, diseases, and pests such as the *Varroa destructor* mite. These stressors can lead to decreased honey yields, colony depopulation, impaired swarming abilities, or even colony collapse. Available heated beekeeping devices have attempted to manage temperature but often fail to provide benefits due to their uniform heat distribution and low acceptance by bees. Additionally, these conventional devices cannot adequately address the *Varroa mite* infestation.

Technology

The sensor support (Figure 1) is designed to support honey bee health within a beehive by aligning with their natural communication and environmental. It operates within a 15 Hz to 300 Hz eigenfrequency range, preserving vibrational signals like the waggle dance across both sides of the frame – unlike conventional rigid frames that dampen these signals. In addition, the included grooves (Figure 1, left) enhance communication by allowing pheromone and gas exchange while enabling fine-tuning of the eigenfrequency. As heating elements and sensors are integrated in every sub-unit, the design provides precise, localized temperature control, replicating natural thermal gradients for optimal hive conditions. An example of the resulting heating scheme is shown in Figure 2. Furthermore, a wax-coated honeycomb surface minimizes disruption, ensuring bee acceptance while maintaining minimally invasive design (Figure 1, right).

Figure 1 left: A beehive panel consisting of 13 x 7 sub-areas having a size of 30 mm x 30 mm. Each sub-area is equipped with one temperature sensor and four individually controllable heating diodes. **Right:** A Honeycomb build-up on top of such a beehive panel together with a brood of worker bees.

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The system could also incorporate flexible electronic elements, which could be fully inkjet-printed, allowing for lightweight, adaptable, and scalable manufacturing. Additionally, the energy supply for the system could come from a solar panel with an accumulator, ensuring sustainable and self-sufficient operation, reducing external energy dependencies while maintaining optimal beehive conditions.

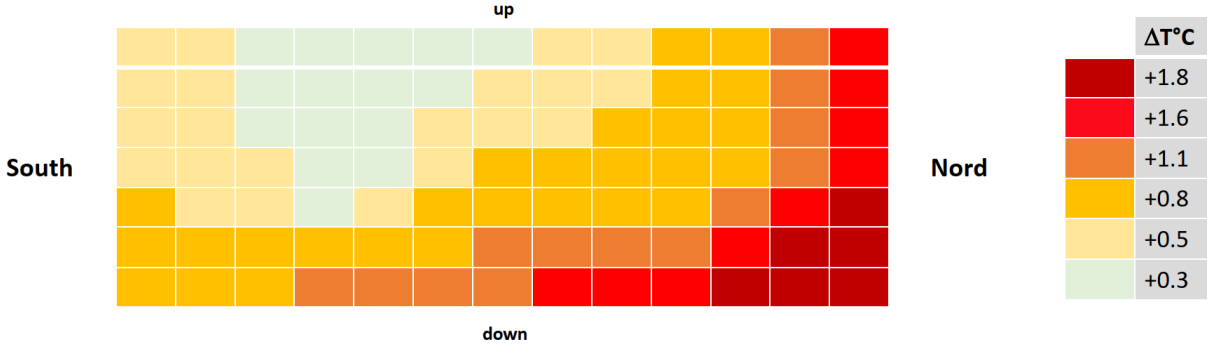

Figure 2: Heating scheme of a beehive panel. The system allows precise control of absolute temperature, customizable temperature intervals, and spatial distribution. This flexibility is achieved through a coactive operating system that enables individual access to each heating and sensing unit.

Advantages

- **Minimally invasive monitoring:** Maintains bee communication without obstructing pheromone and vibrational signals.
- **Enhanced acceptance by bees:** Wax layer covering the sensor support reduces invasiveness by avoiding direct contact with larvae and pupae.
- **High-precision data collection:** Sensor placement within the honeycomb structure captures real-time, accurate temperature data.
- **Optimized thermal control:** Individually controlled heating elements allow precise temperature distribution.
- **Integrated hive health management:** Tracks multiple parameters, aiding in parasitic control and disease prevention.

Potential applications

- **Real-Time Hive Temperature Monitoring:** Provides continuous and precise monitoring of beehive temperature, enabling beekeepers to maintain optimal conditions for colony health and development.
- **Bee Health Maintenance:** Assists in maintaining bee health by supporting efforts to control parasites, such as the Varroa mite, through localized temperature adjustments that can reduce infestation impact.

Patent Information

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