**2017 UF Opportunity Seed Fund Concept Paper**

**Short Title** Wireless Sensor System for Beehive Health Monitoring

**PI** COE → ECE → Joaquin Casanova, jcasa@ufl.edu

**Co-PI** IFAS → Entomology → James Ellis, jdellis@ufl.edu

**Compliance Check.**

Yes No Is there more than one investigator?

Yes No Is the research new and not supplementing an existing project?

Yes No Is the funding request within +/- 25% of $85,000?

**Problem Statement.** Pollinators perform an important ecological service. Honeybees are special in their gathering of large amounts of pollen for food, in the process transferring pollen between flowers. Colony Collapse Disorder reflects part of a decades long decline in the population of managed honeybees. CCD is characterized by a sudden colony die-off where worker bees fly off and abandon the hive. The changes result in physically detectable changes to the bees appearance and foraging behavior, as well as the hive as a whole. The aim of US government-sponsored research is to reduce honeybee overwintering losses to no more than 15%. Part of this overall goal is to establish a baseline for the current state of honeybee health. There exists no monitoring system for the health status of managed hives in the US. Our project’s aim is to design, build, and test a noninvasive, wireless, multimodal beehive monitor that could be used nationwide.

**Technical Approach.**  In particular, our system would implement visual, audio, and electromagnetic sensors to monitor bee health and behavior, as well as hive food content, without having to disturb the hive. With 3G or Bluetooth connection, these stations could upload data to a centralized database, enabling real-time monitoring of trends in beehive health: “Internet of things” applied to beehives. This could form the basis for a network similar to the weather station network of WeatherUnderground. In this way researchers could understand variation of colony losses over space, time, weather, and management practices. Computer vision will permit counting bee traffic at the hive entrance, as well as morphological changes that could imply disease. Audio monitoring would enable monitoring of hive health, as certain frequencies had been associated with incipient swarming, and the presence or absence of a queen. Electromagnetic sensors could noninvasively monitor the quantity and distribution of honey, by making use of time domain reflectometry. In this work, several relevant variables could be artificially controlled to evaluate the system’s efficacy, including presence of a queen, level of Varroa mite, and level of small hive beetle. Sensor measurements can be tested statistically for significance with regards to these variables indicative of hive health.

**Qualifications of Proposal Team.**

* Joaquin J. Casanova
  + Expertise: Agricultural sensors, computer vision, machine learning
  + Role: lead for system design and development
* James D. Ellis
  + Expertise: honey bee pathology, ecology, toxicology and behavior
  + Role: lead for beehive controlled experiments

The proposers are collaborating for the first time on this project.

**Potential for Future Funding or Commercialization**.

* NIFA – topic A1112
* SBIR -
* NSF -

**References**.

Pollinator Health Task Force. "Pollinator Research Action Plan." (2015). Alexandria, Virginia.

[https://www.whitehouse.gov/sites/default/files/microsites/ostp/Pollinator%20Research%20Action%20Plan%202015.pdf](https://www.whitehouse.gov/sites/default/files/microsites/ostp/Pollinator Research Action Plan 2015.pdf)

Eren, Halit, Lynne Whiffler, and Robert Manning. "Electronic sensing and identification of queen bees in honeybee colonies." *Instrumentation and Measurement Technology Conference, 1997. IMTC/97. Proceedings. Sensing, Processing, Networking., IEEE*. Vol. 2. IEEE, 1997.

<https://www.researchgate.net/profile/Halit_Eren/publication/3699725_Electronic_sensing_and_identification_of_queen_bees_in_honeybee_colonies/links/55ea80c708ae3e1218450d2f.pdf>

Campbell, Jason, Lily Mummert, and Rahul Sukthankar. "Video monitoring of honey bee colonies at the hive entrance." *Visual observation & analysis of animal & insect behavior, ICPR* 8 (2008): 1-4.

<http://www.hivetool.org/hardware/counters/vaib9_mummert.pdf>