Secret Sounds of Bees: Analysis of Honey Bee Vibroacoustics Using Hidden Markov Models

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Honey bees are an essential part of global food production and revenue. However, pollinators around the world are declining at a rate faster than ever recorded due to pesticides, diseases and pests, and habitat loss. Unfortunately, honey bee colony loss is difficult to prevent because early warning systems for colony health are lacking. I developed an early warning honey bee health detecting system that uses a machine learning model and vibroacoustic signals to provide information about the health of a colony before it is lost. Vibroacoustics are sounds and vibrations that are emitted by bees in response to stimuli and improve our understanding about honey bee behavior and health. In this study, I developed a Hidden Markov Model within MATLAB using a Hidden Markov Model Toolkit for MATLAB (MATLABHTK). Nine health states were included in the model, and 5-minute vibroacoustic signals were recorded at least weekly from 25 hives on my family's farm in Iowa from August-November, 2021. The signals were analyzed using this Hidden Markov Model to predict their colony health. The model was 100% accurate in identifying the signals from the training repository and 92% accurate when the entire collection of 258 audio files from 25 hives was assessed. This model is the first reported model that provides beekeepers with a non-invasive analysis of their colonies' health that identifies vital situations like exposure to volatile chemicals, robbing of a dwindling hive, active honey flows, etc. This model can be used to reduce colony loss rates when combined with mitigation strategies from beekeepers.

Awards Won:
Third Award of $1,000
Acoustical Society of America: (Not to be read aloud) Travel Funds $2k divided by total number of award recipients
Acoustical Society of America: First Award of $1,500. In addition, their School will be awarded $200, and their Mentor will be awarded $500.