BeeSMART: Bee Sustainability Monitoring and Automated Response Technology

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Honeybee colonies continue to be the main victim of a series of problems caused by parasites, environmental stress, and the beekeeping methods used. A large part of the losses was due to the Varroa mite, a parasite that infests bees and spreads diseases. The 2024-2025 U.S. Beekeeping Survey pointed to a loss of 55.6% of the total number of colonies under management, which means that there is a huge need for tools that can provide beekeepers with the early detection of problems and thus allow them to respond more effectively. BeeSMART (Bee Sustainability Monitoring, Analytics, and Response Technology) represents a multi-phase platform that makes use of lot sensing, edge computing, and cloud analytics to maintain the health of the hive. The tool is designed to be attached directly to the hive, where it collects real-time audio, video, and environmental data. Raspberry Pi-based local Al models are capable of identifying at an early stage any colony stress from among the following sources: mites on the comb, swarming behavior, queen events, temperature changes, and more drum. Upon detection of such signs, the fan system of the hive can be turned on, and methylated sugar can be spread on the beehive to facilitate the natural hygienic activities of the bees, all without human intervention. Besides that, data are also sent through a central server and cloud service, enabling beekeepers to access reports and alerts through their mobile devices. The current paper documents the conceptualization, realization, and first assessment of the BeeSMART platform.

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