# BeeMind AI: Development of an AI-Based System to Assess Honeybee Health, Behavior, and Nutrient Effects on Learning and Memory

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This research proposed and built the first integrated AI-based honeybee health assessment system called BeeMind AI. It includes eight different sensors, allowing it to track in-hive and external conditions. BeeMind AI has many diverse applications due to its ability to analyze honeybee movement and behavioral patterns to determine honeybee health, and it was used to evaluate the effects of four nutrients on honeybee health in two experiments, one in a tri-chambered maze, and another in a free-flying paradigm. The free-flying experiment was conducted to study the effect of nutrients on return rates of honeybees at distances of 300 m, 500 m, and 800 m. The free-flying experiment indicates that honeybees are very capable foragers, with return rates of the control group even at 800 m being close to 75%. It was observed for the first time that C60 nanoparticles have significant positive effects on learning, memory, and flying capabilities, improving return rates by around 9% at 300 m, 16% at 500 m, and 20% at 800 m, while neonicotinoid pesticides have negative effects on return rates, reducing them significantly by up to 30% and confirming the results from the dual-chambered maze experiments. Additionally, a new social behavior of healthy honeybees clustering together was observed, and this behavior was mathematically modeled using a proposed term called the Honeybee Clustering Dimension (HCD) number with the capability to indicate nutrient effects on honeybees. The developed BeeMind AI has a significant impact on honeybee-related research, especially in the evaluation of honeybee learning and memory.

**Awards Won:**

Third Award of $1,000

NC State College of Engineering: Scholarship to attend NC State Engineering Summer Camp

National Taiwan Science Education Center: One adult chaperone to attend

Patent and Trademark Office Society: Second Award of $500