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SESSION H. Room: Bach 2 13.20-14.40 hrs

How bumblebees land on rapidly-moving flowers

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Landing precisely is vital for flying animals. However, disturbances in outdoor environments always complicate the process. For bumblebees, dynamic gusts cause both unpredictable flower movements and displacements of foraging bumblebees, which necessitate a rapid compensation of perturbations with their sensory-motor control system. Here, we study how rapid flower movements affect the landing behavior of bumblebees *Bombus terrestris*. Using stereoscopic high-speed videography, we track bumblebees landing on an oscillating flower mimic and model their landing kinematics with control theory. The result shows that bumblebees land on moving flower with rapid motor actions controlled using visual perception of the moving target. The proposed visual-motor control model shows that optical perception signals facilitate bumblebees tracking the moving flower and gaze control while landing. The model also suggests a surprisingly low sensory-motor delay (median 57.1 ms). Moreover, by examining in-flight time histories of roll angle and sideway-acceleration, the helicopter model for aerodynamics force production proposed based on fruit flies is proved as valid for bumblebee flights. These results lead to a more thorough understanding of insect flight control system and could facilitate bio-inspired tracking and landing algorithms for flying robots.