# A bee in the corridor : Side-slip control autopilot

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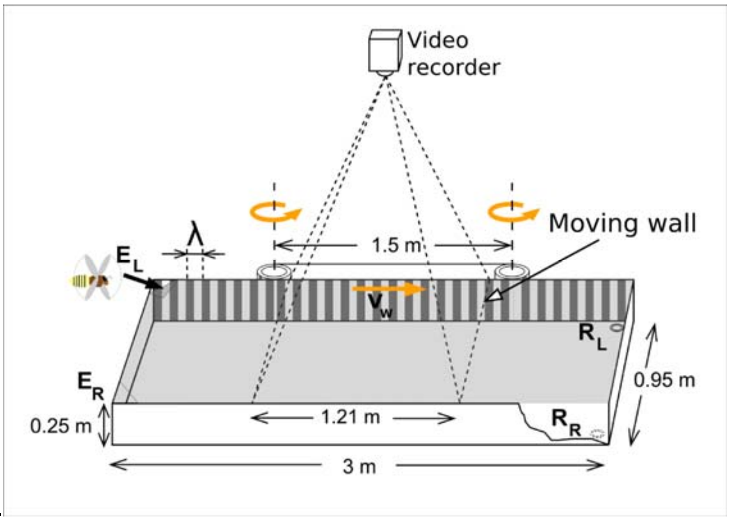
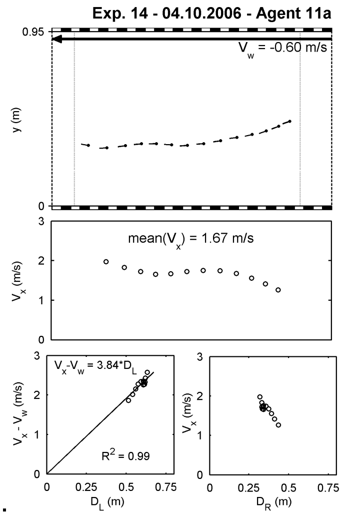
To scrutinize the logics behind the honeybee's lateral anti-collision system, we filmed bees (*Apis Mellifera*) flying freely through a *wide* (0.95m) flight tunnel and analysed the trajectory of individual bees frame-by-frame. The central part of one wall of the tunnel was moved steadily to alter the optic flow (OF) unilaterally (figure 1a). Using a narrower tunnel (0.12m wide), Srinivasan et al. [1,2] had shown that bees tend to centre in a tunnel, and when one wall was moved, bees modified their lateral position according to the authors' *OF balance hypothesis*. In contrast with these results, we observed that bees flying through a wide tunnel do not center systematically and exhibit instead a *wall-following behaviour* [3,4]. When we moved one wall at a constant speed $V_W$ , we observed that the forward speed of the bee with respect to the moving wall ($V_x$- $V_W$ ) and the distance $D$ to this wall were proportionnal to each other (figure 1b).




a.




b.

**Figure 1.**
**a.** Large flight tunnel (width 0.95m, length 3m). The central part of the left wall can be moved steadily at a constant speed $V_W$ by a motor. Free-flying bees enter the corridor individually at positions $E_L$ or $E_R$. They fly through the tunnel and are rewarded with sugar solution at positions $R_L$ or $R_R$.
**b.** Typical bee trajectory and speed profile. The bottom left plot shows that the relative speed between the bee and the moving wall ($V_x$- $V_W$) and the distance D to this wall are proportionnal to each other. Thus the bee maintains the left OF constant. The bottom right plot shows that is not the case for the right OF.

This means that the OF (angular velocity *$(V_x - V_w)/D$*) perceived from the moving wall was held constant. Our hypothesis is that bees are able to *regulate* (i.e., maintain constant and equal to a reference) their lateral OF unilaterally, even in non-stationnary environments.
These results are well accounted for by a control scheme called *side-slip control autopilot* that we developed in a study dealing with the autonomous behavior of an hovercraft [5]. As shown in simulations, this control system makes a (fully actuated) hovercraft automatically adjust its distance to one wall by regulating the optic flow on one side [5].

## References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[3] Ruffier, F., Serres, J., Masson, G. and Franceschini, N. (2007) A bee in the corridor : regulating the optic flow on one side. *Abstract, Göttingen Meeting of the German Neuroscience Society*.

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