Modelling male fly courtship pursuit behaviour under a control theory approach

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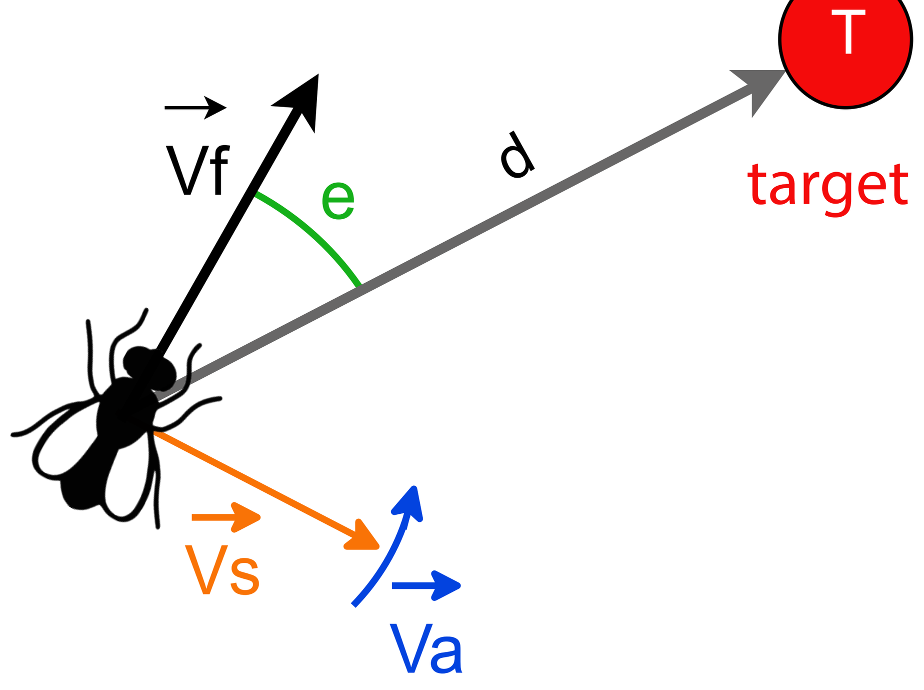
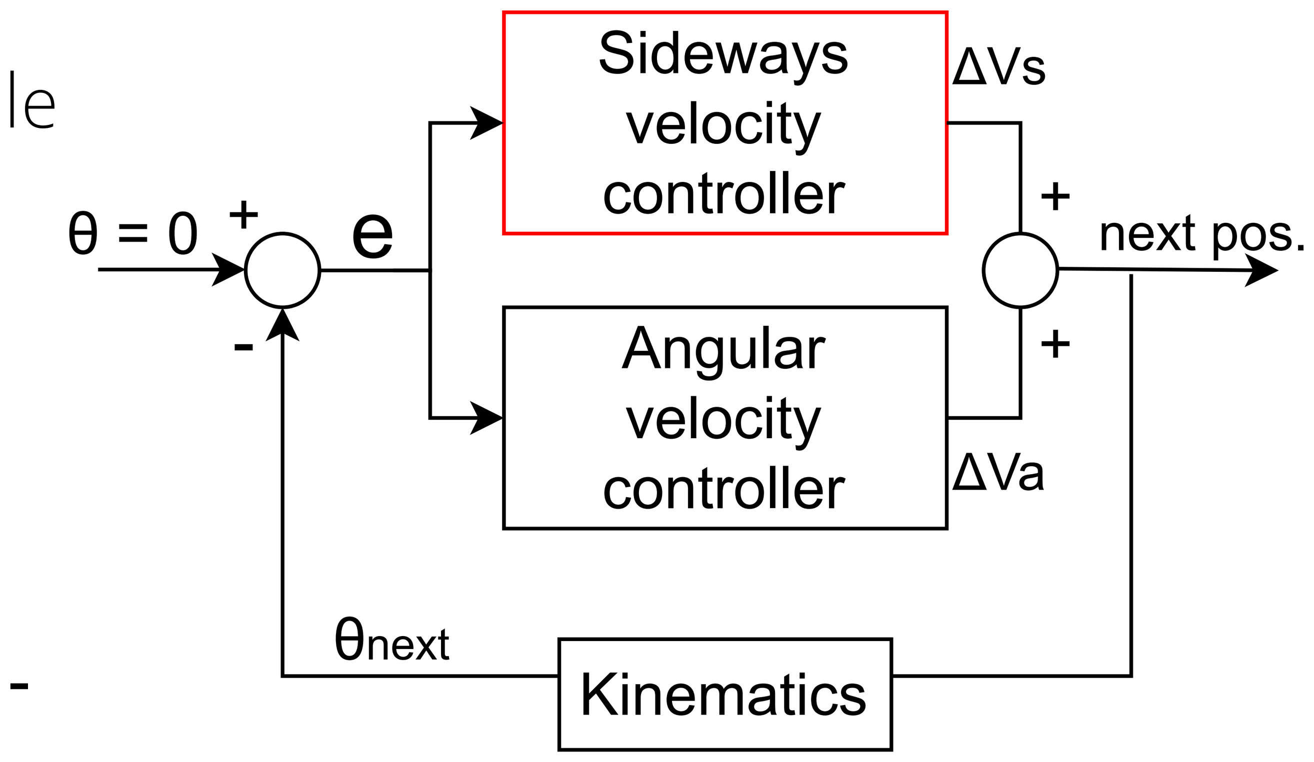
1) In courtship behavior, the male chases the female ("target") by minimizing the error angle (**e**) utilizing its outputs: forward (Vf), sideways (Vs) and angular (Va) velocity.
In simulations only **angular** velocity has been used to control the error angle, however data from flies shows they use **sideways** velocity.
We simulated and agent using two **parallel, independent controllers** for angular and sideways velocity to minimize **e**



2) To control the fly corrects its current angle and updates its position. On the next step, based on the target's movement, a new angle is fed back yielding a new value of **e**.

Each controller (angular and sideways) has inside three components: a **proportional**, which scales the current error, an **integral**, which accumulates past errors, and a **derivative**, which indicates how the error will grow



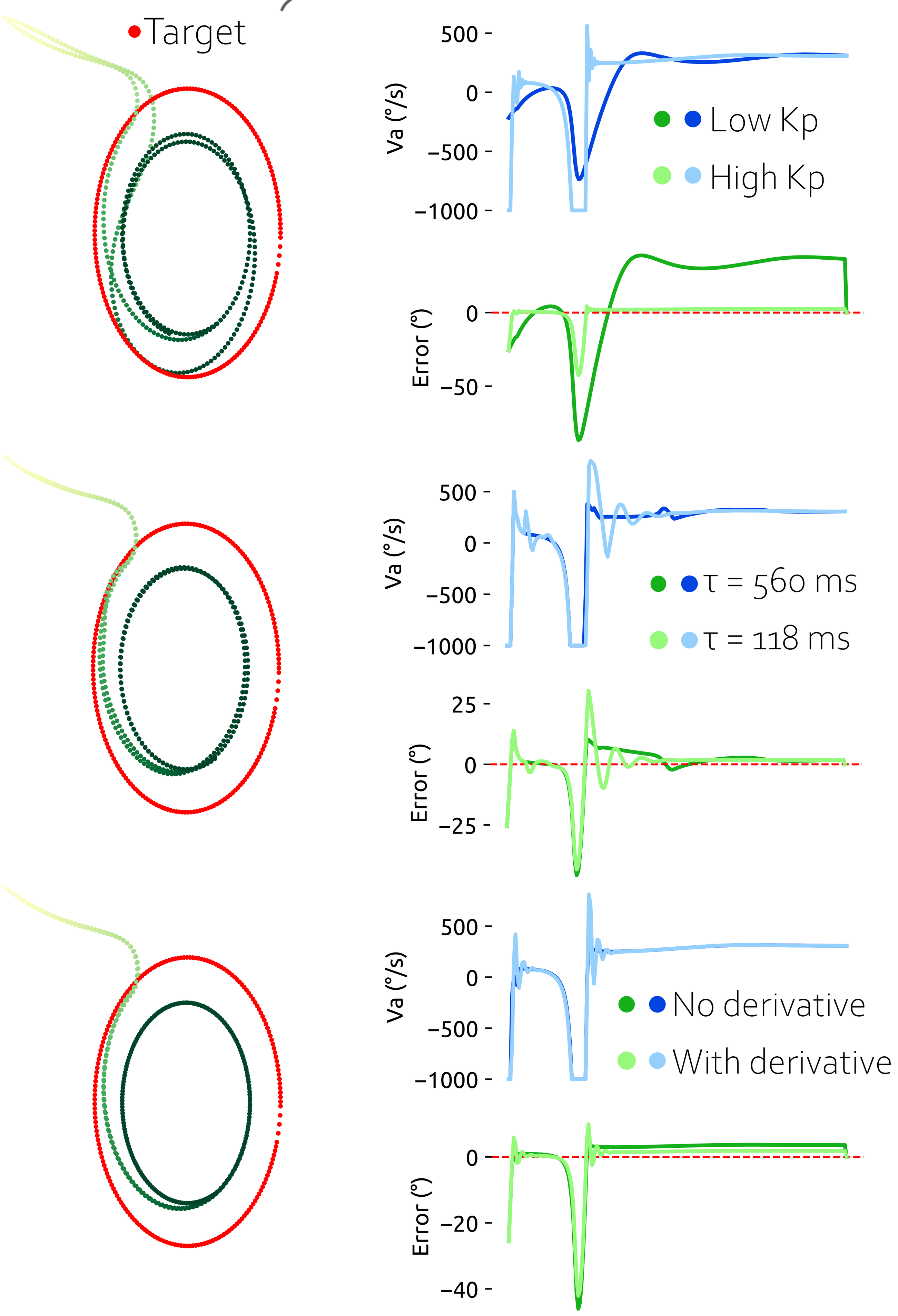
3) Initial observations: circular paths

Using only an **angular** controller first, we add components one by one. The target and pursuer trajectories are shown

Increasing the value of the **proportional** component determines how fast it converges, but also leads to a less smooth control

Adding the **integral** component reduces the steady state offset, but induces oscillations by overcompensating. Decreasing the window of accumulation (560 to 118ms) modulates the oscillations

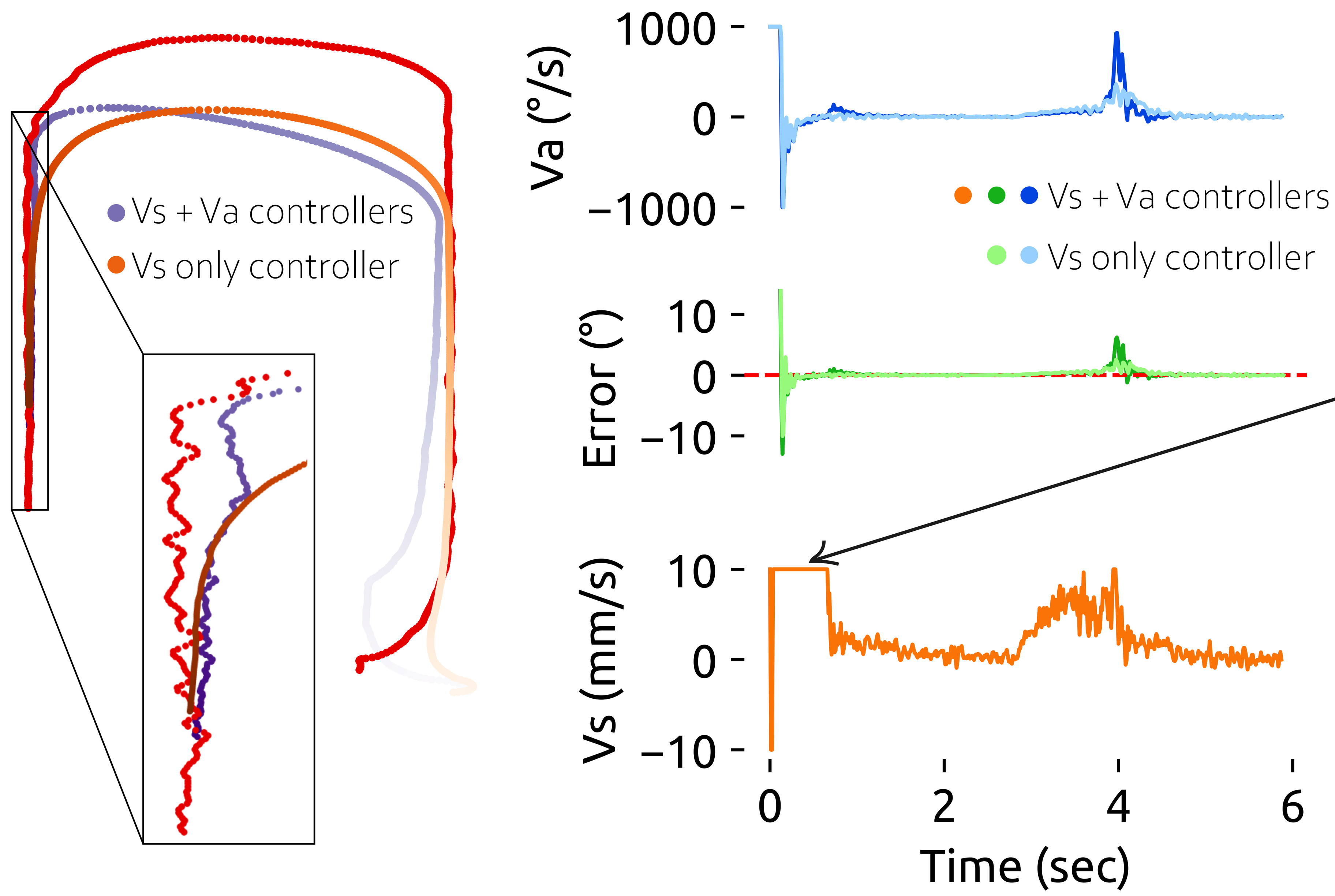
Adding the **derivative** component speeds the controller at the cost of fast changes in velocity



4) Initial observations: parallel paths with noise

The **angular** controller yields trajectories in which the pursuit is performed from behind.

When using **both** controllers, the pursuer appears to intersect the target at its collision course, rather than following from behind



Future work / Caveats

Tune parameters of components to real fly's behaviour

Controller on forward velocity based on distance

Including integral reset to avoid error accumulating when controller is at saturation which precludes changes in direction

Video of real fly's behavior versus simulations