EAVE: Emotional Aerial Vehicle Evaluator

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Quadrotors experienced a huge gain in popularity over the past twenty years. Thanks to their mechanical simplicity, they have found their way from the hobby sector via research into everyday life. Most applications take advantage of their elevated view, whether for locating victims in disaster scenarios, for inspection of buildings or for filming movies. Private consumers mainly utilize quadrotors as self-flying cameras that accompany them during various leisure activities.

Today, semi or even fully autonomous quadrotors are available and follow humans while avoiding obstacles and receiving commands via smartphones or gestures. This also enables them to be helpful companions in home environments, where in future scenarios they could accompany people through daily life as smartphones do today. Whatever the exact purpose, the number of robot assistants, be it ground-based or of aerial nature, will most likely increase in the future and demand research on possible communication channels for human-quadrotor interaction.

Even with today's state of technology and miniaturization, it is still very important to keep the size of the quadrotors to a minimum. Larger platforms, thus larger rotors, the noise generated from them and the resulting downwash are more likely to be perceived as disturbing by humans. This introduces an inhibition threshold which is not desirable in companionships. For this reason, the quadrotors used in this work are lightweight and cannot and should not carry sensors or other electronics beyond ensuring their ability to fly.

What remains when all means for further improving interaction, such as anthropomorphic features, are not an option is the robot's motion [HJ14]—in case of quadrotors: their trajectories. To enable humans to still follow their desire to interpret intent into the behavior of their communication partner, we aim to convey character traits via the trajectory of the purely mechanical remaining quadrotor. The desire to animate quadrotors clearly exists [De18; Ka17; KKK16] but published research remains on a purely conceptual level [De18] or lacks detailed implementation and parameterization [Ca16].

In this paper we present the application *EAVE* (Emotional Aerial Vehicle Evaluator) that allows to design, control and evaluate quadrotor trajectories in simulation and reality. Trajectories are defined by multiple control points, each consisting of position, velocity, acceleration and heading angle. They can further be parameterized to increase the expressiveness of the quadrotor's motion in order to convey intent and thus improve interaction by applying various principles of animation. Based on the control points, polynomial trajectories are generated, which are finally followed by the quadrotor that is controlled by a Model Predictive Controller (MPC). *EAVE* allows for safe test flights of arbitrary quadrotor models in a simulated environment but also controls real quadrotors in our testbed [Li17] to which *EAVE* belongs.

References

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