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Using Q-Learning to Auto-Tune PID Controller Gains for Online Quadcopter Altitude Stabilization

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Abstract : Unmanned Arial Vehicles (UAVs), and more specifically, quadcopters need to be stable during their flights. Altitude stability is usually achieved by using a PID controller that is built into the flight controller software. Furthermore, the PID controller has gains that need to be tuned to reach optimal altitude stabilization during the quadcopter’s flight. For that, control system engineers need to tune those gains by using extensive modeling of the environment, which might change from one environment and condition to another. As quadcopters penetrate more sectors, from the military to the consumer sectors, they have been put into complex and challenging environments more than ever before. Hence, intelligent self-stabilizing quadcopters are needed to maneuver through those complex environments and situations. Here we show that by using online reinforcement learning with minimal background knowledge, the altitude stability of the quadcopter can be achieved using a model-free approach. We found that by using background knowledge instead of letting the online reinforcement learning algorithm wander for a while to tune the PID gains, altitude stabilization can be achieved faster. In addition, using this approach will accelerate development by avoiding extensive simulations before applying the PID gains to the real-world quadcopter. Our results demonstrate the possibility of using the trial and error approach of reinforcement learning combined with background knowledge to achieve faster quadcopter altitude stabilization in different environments and conditions.

Keywords : reinforcement learning, Q-leanring, online learning, PID tuning, unmanned aerial vehicle, quadcopter
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