AI could help drones ride air currents like birds

September 20 2018, by Nicholas Martin

Credit: Engin Akyurt from Pexels

Birds have long inspired humans to create their own ways to fly. We know that soaring bird species that migrate long distances [use thermal updrafts](https://phys.org) to stay in the air without using up energy flapping their wings.

And glider pilots similarly use thermals currents and other areas of rising air in order to remain airborne for longer.

Yet, while we've mastered gliding through these updrafts using various instruments, the exact mechanisms that allow birds to soar are still unknown. But a team of researchers from California and Italy have made some telling steps towards answering this question using artificial intelligence (AI). And it could lead to new developments in navigation systems for aircraft, with particular implications for creating drones that can stay airborne for very long periods of time.

The aim of the study, published in *Nature*, was to train a small two-metre wingspan autonomous glider to fly in thermals, just like a real bird would. The glider was programmed with a kind of AI known as machine learning that enabled it to work out how to use the air currents to stay in the air for longer.

Machine learning is an alternative approach to programming a computer to do a complex task. Rather than feeding a computer (or autonomous glider in this case) a set of instructions telling it how to do something, you tell the computer how you would like it to respond and reward it when it does the right thing.

Over time it will learn what things are rewarded and will tend to do these behaviours instead. This technique is how computer programs such as Google's AlphaGo can learn to play the board game Go and then beat professional players, a feat simply not possible with conventional programming techniques.

This type of machine learning is called reinforcement learning and it relies on a large amount of input data being fed to the computer in order for it to learn what actions will provide it with rewards. For the researchers programming the autonomous glider, the input data consisted of specialised instruments capable of reading the change in upwards (vertical) wind strength. The instruments were able to determine these changes along the length of the glider (longitudinally) and from one wing tip to the other (laterally). The sensors were able to make these measurements ten times every second.

This data was then used to make flight adjustments to what is known as the bank angle of the of the glider. A well-balanced aeroplane with its wings level has zero bank angle and will fly in a straight line. Tilting the wings and increasing the bank angle will make the plane turn. In the study, the glider was rewarded if the change in upward wind speed along its flight path increased. In other words, if the glider was flying into an updraft.

Updrafts are key to increasing the amount of time a glider can stay airborne. Unlike a powered aeroplane, a glider not able to find any updrafts will gradually fall toward the ground. Whether or not the glider is falling or rising depends directly upon how much air is moving upwards around it. In an updraft, the increase in vertical air movement can be enough to stop the glider falling and, if the vertical wind is strong enough, allow it to climb.

Over the course of a number of flights (about 16 hours of flying in total), the study glider learnt to fly by training itself that under a certain combination of inputs (bank angle, longitudinal and lateral change vertical wind speed) to decide what the next change in bank angle should be. The result was that by the end of all that flying the plane had taught itself how to fly into updrafts, allowing it to stay in the air for longer.

As a bonus, the researchers used a numerical model to show this approach would benefit larger gliders even more, since their longer wingspan will provide a more accurate measurement of the change in upwards wind speed from one wing tip to another.

Making aircraft smarter

The results raise the question of what possible futuristic autonomous gliders we could see gliding around and what would they be used for. Engineers at MIT recently took inspiration from the aerodynamics of the wave-riding albatross to design an autonomous glider.

Airbus has developed a solar-powered glider that can remain airborne for very long periods of time as an alternative to surveillance or communications satellites, for example that could broadcast internet signals to remote locations on the ground. Microsoft is reportedly working on autonomous planes with state-of-the-art artificial intelligent navigation systems.

But perhaps the techniques developed in this study could one day lead to a new generation of "smart" navigation and autopilot systems for conventional aircraft. These could use data gathered over thousands of hours of flying time to make decision about the most efficient way to get around. This would rely on accurate sensors and further development that would allow a plane to identify and then hop from one thermal updraft to another. At the moment, the method only allows gliding inside a single thermal.

The methods and programming techniques developed in by the researchers will undoubtedly bring us a step closer to the goal of an autonomous flying vehicle with flight times of days, weeks or months carrying out these tasks. But it is the use of reinforcement learning that once again shows how flexible these algorithms are at adapting to a wide range of complex tasks, from controlling a glider to beating a human at Go.

Provided by The Conversation