### Quadcopter

A quadcopter, is a [multirotor](https://en.wikipedia.org/wiki/Multirotor) [helicopter](https://en.wikipedia.org/wiki/Helicopter) that is lifted and propelled by four [rotors](https://en.wikipedia.org/wiki/Helicopter_rotor). Quadcopters generally use two pairs of identical fixed pitched propellers; two clockwise (CW) and two counter-clockwise (CCW). These use independent variation of the speed of each rotor to achieve control. By changing the speed of each rotor it is possible to specifically generate a desired total [thrust](https://en.wikipedia.org/wiki/Thrust); to locate for the [centre of thrust](https://en.wikipedia.org/wiki/Centre_of_thrust) both laterally and longitudinally; and to create a desired total [torque](https://en.wikipedia.org/wiki/Torque), or turning force. Quadcopters differ from conventional helicopters which use rotors which are able to vary the pitch of their blades dynamically as they move around the rotor hub. In the early days of flight, quadcopters (then referred to as 'quadrotors') were seen as possible solutions to some of the persistent problems in vertical flight; torque-induced control issues (as well as efficiency issues originating from the [tail rotor](https://en.wikipedia.org/wiki/Tail_rotor), which generates no useful lift) can be eliminated by counter-rotation and the relatively short blades are much easier to construct. In the late 2000s, advances in electronics allowed the production of cheap lightweight flight controllers, [accelerometers](https://en.wikipedia.org/wiki/Accelerometer) ([IMU](https://en.wikipedia.org/wiki/Inertial_measurement_unit)), [global positioning system](https://en.wikipedia.org/wiki/Global_positioning_systems) and cameras. This resulted in a rapid proliferation of small, cheap consumer quadcopters along with other multi rotor designs. Quadcopter designs also became popular in [unmanned aerial vehicle](https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle) (UAV or drone) research. With their small size and maneuverability, these quadcopters can be flown indoors as well as outdoors.[[1]](https://en.wikipedia.org/wiki/Quadcopter#cite_note-dasc04-1)[[5]](https://en.wikipedia.org/wiki/Quadcopter#cite_note-b.C3.BCchi11-5)

Increasing blade size increases the momentum. This means that changes in blade speed take longer, which negatively impacts control. At the same time, increasing blade size improves efficiency as it takes less energy to generate thrust by moving a large mass of air at a slow speed than by moving a small mass of air at high speed. Therefore, increasing efficiency comes at the cost of control. Helicopters do not experience this problem as increasing the size of the rotor disk does not significantly impact the ability to control blade pitch.

Flight dynamics

Each rotor produces both a [thrust](https://en.wikipedia.org/wiki/Thrust) and [torque](https://en.wikipedia.org/wiki/Torque) about its center of rotation, as well as a [drag force](https://en.wikipedia.org/wiki/Drag_force) opposite to the vehicle's direction of flight. If all rotors are spinning at the same [angular velocity](https://en.wikipedia.org/wiki/Angular_velocity), with rotors one and three rotating clockwise and rotors two and four counterclockwise, the net aerodynamic torque, and hence the angular acceleration about the [yaw axis](https://en.wikipedia.org/wiki/Aircraft_principal_axes), is exactly zero, which mean there is no need for a tail rotor as on conventional helicopters. Yaw is induced by mismatching the balance in aerodynamic torques (i.e., by offsetting the cumulative thrust commands between the counter-rotating blade pairs).

In order to allow more power and stability at reduced weight, a quadcopter, like any other [multirotor](https://en.wikipedia.org/wiki/Multirotor) can employ a [coaxial rotor](https://en.wikipedia.org/wiki/Coaxial_rotors) configuration. In this case, each arm has two motors running in opposite directions (one facing up and one facing down).[[51]](https://en.wikipedia.org/wiki/Quadcopter#cite_note-51)

### Vortex ring state

All quadcopters are subject to normal rotorcraft aerodynamics, including [vortex ring state](https://en.wikipedia.org/wiki/Vortex_ring_state).[[52]](https://en.wikipedia.org/wiki/Quadcopter#cite_note-52)

### Mechanical structure

The main mechanical components needed for construction are the frame, [propellers](https://en.wikipedia.org/wiki/Propellers) (either fixed-[pitch](https://en.wikipedia.org/wiki/Blade_pitch) or variable-pitch), and the electric motors. For best performance and simplest control algorithms, the motors and propellers should be placed equidistant.[[53]](https://en.wikipedia.org/wiki/Quadcopter#cite_note-53) Recently, [carbon fiber composites](https://en.wikipedia.org/wiki/Carbon_fiber_composites) have become popular due to their light weight and structural stiffness.