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2010s
Commercialization of industrial-use unmanned helicopters called as drones (Yamaha Motor, etc.)

~ Application Products ~

Drones, as unmanned helicopters are expected to be applied in various industrial fields, including agriculture, aerial photography, surveying, inspection, research, security, and logistics, due to their superior convenience caused by hovering flight and vertical takeoff/landing characteristics. In the 1990s, advances in semiconductor and MEMS technology led to the development of compact, low-cost MEMS gyro sensors, acceleration sensors, high-resolution semiconductor image sensors, and CPUs with high computing power. Full scale operation of GPS satellites started in 1995. The development of drones with programmable-navigation operation by utilizing these satellites has become active [1), 2)]. There are two types of drones: single-rotor type and multi-rotor type called as multicopter.

In 1987, Yamaha Motor commercialized the R-50 (model L09), the world's first industrial-use unmanned single-rotor helicopter powered by a 98 cc (12 HP) gasoline engine with a 20 kg payload. In 2001, the company launched the RMAX G0, two-stroke 246cc engine unmanned helicopter that achieved the world's first autonomous navigation flight based on a program while out of sight [3)]. According to a 2002 American Institute of Aeronautics and Astronautics (AIAA) survey, 65% of the world's drones were made in Japan and used primarily for pesticide spraying. In 2013, Yamaha Motor launched the "FAZAR" with a 4-stroke 390 cc engine and increased payload to 35 kg [4)]. The FAZAR R G2 released in 2016 equipped a satellite communication function and was succeeded in remote operation from 1,700 km away [5)]. Unmanned helicopters have been used for not only in the agricultural fields but also in a variety of other application such as transporting cargo to remote islands and mountainous areas, and observing and measuring dangerous hazardous areas in addition to their active role in the agricultural sector.

Keyence, a major gyro sensor manufacturer in Osaka, released the Gyrosaucer E-170 in 1989 as the radio-controlled helicopter for hobby use, which is said to be the world's first commercially available multicopter. In 2010, Parrot SA in France launched the AR Drone, a four-rotor helicopter. It was an epoch-making device with a built-in small camera, a free operation-software downloaded in an iPhone or iPad, and a Wi-Fi connection. The drone was able to operate from the viewpoint of a person on board the drone while viewing images from the on-board camera (FPV: first-person view). The appearance of the AR Drone made the name of "drone" known to the world with big surprise.

The PHANTOM drone, launched by DJI (Da-Jiang Innovations Science and Technology Co. Ltd.) in 2014, was well received for its combination with a gimbal that was able to mount an action camera, and was used for aerial photography, etc. It was called a “Camera Drone”, and drone use spread quickly

around the world. Although multicopters have been mostly used for hobby purposes, they also have been actively developed for industrial applications in such agricultural field as pesticide spraying, growth observation and in such civil engineering and construction as structural inspection and surveying like the YMR-08 (model L80) industrial drone launched by Yamaha Motor in 2019 [6].

Drones install several to several dozen electric motors for rotors and servo systems to handle camera, etc. and equip power transistors and motor controller ICs in order to drive these motors. The position information from GNSS (Global Navigation Satellite System) such as GPS satellites and RTK (Real Time Kinematic)-GNSS are used to estimate the drone's self-position. For self-positioning in non-GPS environments, image processing visual SLAM (Simultaneous Localization and Mapping) navigation is used, which is based on images obtained by multiple cameras viewing forward, backward, downward, and in both lateral directions.

The control system of drone attitude consists of an Inertial Measurement Unit (IMU) or Attitude Heading Reference System (AHRS), which combines a 3-axis gyro sensor, 3-axis acceleration sensor, geomagnetometer, and barometric pressure sensor. Obstacle detection is also important for collision avoidance, and moreover object identification by processing camera images, infrared sensors and ultrasonic sensors are used for distance measurement. Therefore, drones are equipped with so many different types of sensors that they are called "flying sensors". Drones also install GPS receiver, wireless communication functions such as communication with base stations, and CPUs for motor control and image processing, so that these drones are called "flying processors".

Figure 1　Industrial-use unmanned helicopter FAZAR R (model L31)
(3,665mm(L)×1,078mm(H)×770mm(W), Main rotor diameter: 3,115mm)
(Motor :　Water-cooled, 4-stroke OHV 2-valve, horizontally opposed two-cylinder gasoline engine, 390cc)
Courtesy of Yamaha Motor Co. Ltd.

Figure 2　Industrial-use multirotor YMR-08 (Model L80)
(1,923mm(L)×2,181mm(W)×669mm(H), Number of rotors: 8, Rotor diameter: 26inch(66mm))
(Rated battery capacity: 852 Wh)
(Motor torque: (maximum) 2.4 Nm/4,000 rpm, (continuous output) 1.2 Nm/2,800 rpm)
Courtesy of Yamaha Motor Co. Ltd.

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