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A REVIEW ON DRONES AND THEIR USAGE

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Abstract:Unmanned Aerial Vehicle (UAV) is one of the most important invention of recent era. UAVs are popular for their use in places where humans are not allowed. Basically, UAVs are introduced in military to reduce casualty of their solder in warfront by a country. But later many possible applications have been found out by the researchers apart from its use in battlefield. Today the UAVs are popular by the Drone. This paper thrust on the principle of operation of drones and itsmajor areas of application. Along with the discussion on foresaid topics, a system has also been proposed in this paper to monitor the faults of high rise structures and do small maintenance works where the installation of infrastructure could be costly and bears life threat.

Keywords: ***Drones,Quadcopter, surveillance, Unmanned aerial vehicle***

1. INTRODUCTION

In present day, Unmanned Aerial Vehicle (UAV) is very popularly known as DRONE tothe world. DRONE isan abbreviation of Dynamic Remotely Operated Navigation Equipment. This kind of aircrafts are capable to fly without any pilot or passengers onboard. The control of the drone is mainly performed remotely by the help of radio waves. Drones are introduced by Austrians in the year of 1849 as balloons by which they used to drop bombs in enemy territory [1]. These balloons flew off to long distances with the precalculated amount of fuel to be crashed in enemy territory with explosives when the fuel is finished. Later, Mr Charles Kettering along with Mr Elmer Sperrym, Orville Wright and Robert Milikanem, developed an aircraft popularly known as “Kettering Bug” in the year 1915. It was an automatic aircraft, which was equipped with sensors such as a barometer as height sensor.The distance travelled is measured using the number of engine rotation and the position of the drone[2].

Literature review reveals that drones can be classified according to their configurations and

the mission they are deployed for. Watts V.G. Ambrosia and E.A. Hinkley [3] have classified drones on the basis of platforms they are used. These are civil scientific and military platforms. As per their observation, drones are MAVs (Micro or Miniature Air Vehicles), NAVs (Nano Air Vehicles), VTOL(Vertical Take-Off & Landing), LASE (Low Altitude, Short-Endurance), LASE Close, LALE (Low Altitude, Long Endurance), MALE (Medium Altitude, Long Endurance), and HALE (High Altitude, Long Endurance).A. Arjomandi, S. Agostino, M. Mammone, M. Nelson and T. Zhou [4] have classified drones according to the weight, range of fly, endurance, wing loading, maximum altitude and engine type.Drones with more than 2000Kg of weight are under the category of super-heavy weight drones. 200kg – 2000kg under heavy weight category, 50kg-200kg under medium weight, 5kg – 50kg are under light weight and finally weight below 5kg are classified as micro drones.Size of drones vary from manufacturer to manufacturer and also based on their application. Drones are equipped with various sensors for military surveillance and monitoring. Publicly used drones differ from military in size.They are generally smaller and are driven by the help of electric motors. They are mainly used for photographing and filming.

2. CONSTRUCTION AND WORKING PRINCIPLE

Apart from the categorisation mentioned in the previous section, drones are popularly categorized according to the number of arms and number of engines. Based on the parameter said, drones are categorized as bi-copter (two engines), tri-copter (three engines), Quad-copter (four engines), hexa-copter (six engines), octo-copter (eight engines). More the number of engines and number of arms, more is the stability. Every drone has multiple engines and more than two propellers. Engines and propellers produce the required thrust to lift off the vehicle from ground [5-6]. Drones are composed of generally two major systems. One is required for movement of the drone and the other is required for the control of the movement. In this paper, the authors have focussed on quadcopters. The quadcopter is an intense mixture of electronics control system and mechanical components that are mainly concentrating on the principle of Aviation. A typical quadcopterhas four motors whose speed of rotation and the direction of rotation changes according to the user's desire to move the direction as directed by the user.Also, movement of quadcopter includes take-off, landing, left movement and Right movement. The direction of rotation of motors are changed as per the command signal transmitted from transmitter. The microcontroller receives the command as digital signal originated from the joystick through which user sends command. After processing the command, microcontroller transmits the digital command to the Electronic

Speed Controller which in turn controls the Speed of Motor.

Drones uses the rotors for propulsion and control the direction of movement. To lift off the drone from ground, spinning blades over the rotor pushes the air down. When all the forces from the rotors of quadcopter come in pairs to push the air down, the according to “Newtons third law of motion”, the air pushes up on the rotor. This basic principle is the key idea behind the lifting of the drone, which comes down to control the upward and downward movement of quadcopter. The faster the rotors spin, the greater is the lift, and vice-versa.

Dronesare designed to perform three major functions in the vertical plane: Hover, Climb and Descend. To hover, the net thrust of the four rotors pushing the drone up must be equal to gravitational force pulling it down. Therefore, the speed of four rotors are increased to ensure a non-zero thrust in upward direction which is greater than its weight.Along with the upward thrust, three more forces act simultaneously on the drone. These are weight of drone, thrust, and air drag. That is why, thrust is required to be greater to lift the drone up.In a similar manner, descending requires exactly opposite i.e., decrease in the rotor thrust by reducing thespeed of rotor so the net force is downward.

Rotation or turning to could be in clockwise or anticlockwise direction. In the Figure 1, a diagram has been given to describe the rotation. The diagonal rotor pairs rotate in opposite direction e.g. rotor 1 and 3 rotates clockwise and rotor 2 and 4 rotates in counter clockwise direction. Rotation of diagonal rotor pairs in same speed but in opposite direction to each other causes the angular momentum to be equal and opposite. It keeps the drone hover in fixed position without rotation.

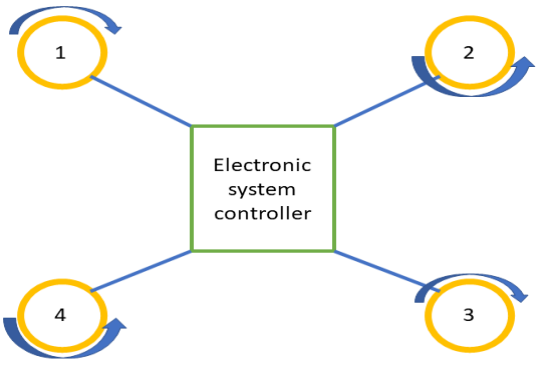

Figure 1: Diagram explaining Turning or rotating;

To produce rotational torque in any particular direction two consecutive rotor pair will be needed to decrease the rotational speed while the other two require to increase the speed e.g.

for a left-hand rotation or flip, rotor 1, rotor 4 to decrease rotational speed and rotor 2 and rotor 3 need to increase the rotor speed as shown by figure 1. For a clockwise rotation, the rotors to be chosen must be different. Rotor 2 and 4 need to increase the speed and rotor 1 and 3 required to decrease the speed. The rotation in opposite direction requires the respective rotor speed to increase or decrease accordingly.

Since thrust is the main component to all the movements of quadcopter, to achieve the forward movement of quadcopter, resultant thrust must be in the forward direction. As shown by Figure 2, when the speed of rotation of rotor 3 and rotor 4 are increased and speed of rotor 1 and rotor 2 are decreased simultaneously, the thrust produced in the front becomes less than the thrust produced by the back rotors. As a result, quadcopter bows down in front but the speed of rotation is so adjusted that it never rolls. The resultant thrust obtained from front and back pair of rotors helps movement in the front direction. Since the back rotors uses opposite direction of rotation with same speed and so also the front rotors, the weight of the copter is balanced by the upward thrust force produced by the rotors to keep the copter hanging in air.

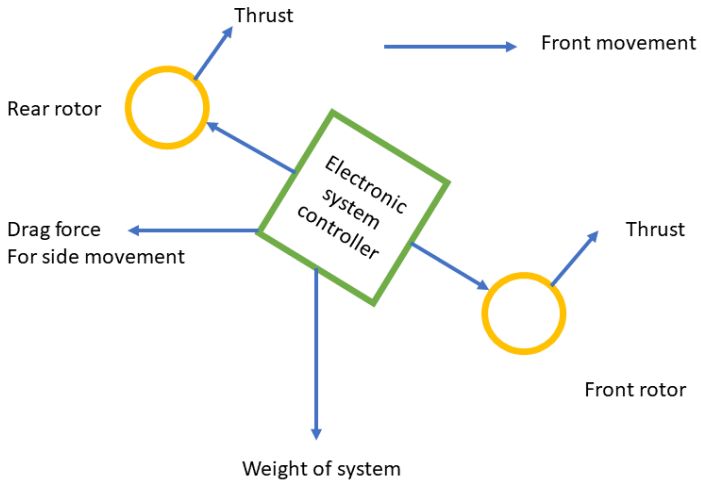

Figure 2: Diagram explaining Forward and Sideway Movement,

In the Figure 3, block diagram of quadcopter has been shown that implements electronic control system with four driver modules to run the actuators. These actuators are directly controlled by the driver circuit. Driver circuits receives control signal from the electronic control system (ECS) which is generally a highly efficient microcontroller. Generally, this microcontroller is a 32-bit microcontroller namely ARM cortex M4 runs RTOS real time operating system. The bus interface implemented either UART, SPI, I2Cor CAN protocol. There are multiple sensors such as gyroscope, one 3 axis and one 6 axis accelerometer and high precision barometer systems. The wireless

communication channel is 455MHz. 7.4V 2200mAH lithium-polymer battery is used here to supply required voltage and current to the actuator and controller. There are 4 rotor or actuators present in the quadcopter. These motors are brushless motors with 80% of efficiency that can draw current of 4-20A at high efficiency output. For transmission of data, 6 channel and 2.4 GHz system has been used. The modulation type used is GFSK (Gaussian Frequency Shift Keying).

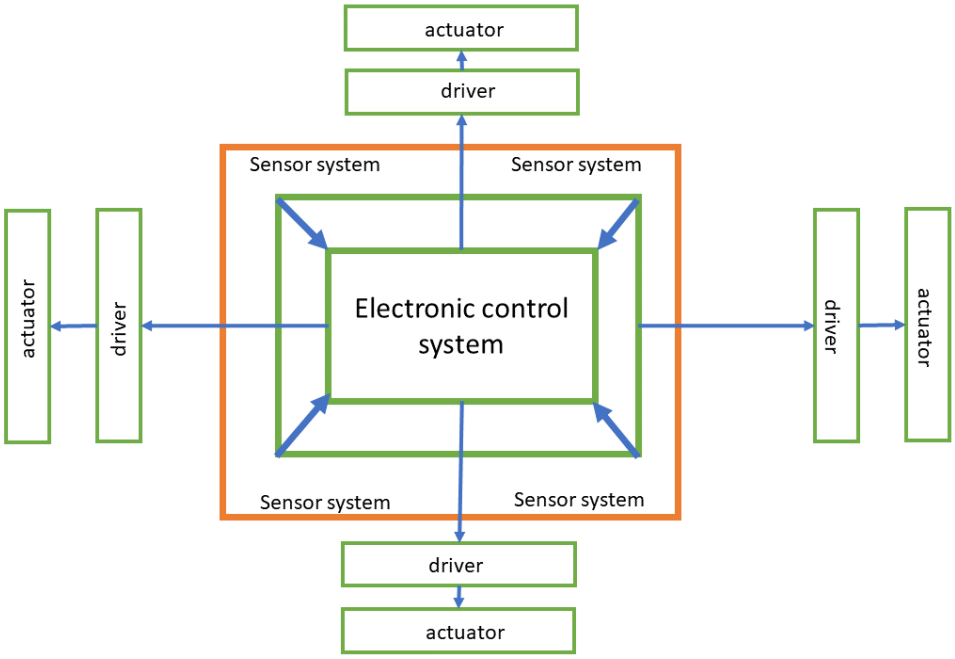

Figure3 : Block Diagram of drone

3. USES AND POSSIBILITIES OF DRONE

The drone can be used in many purposes. The drone built in this way can be used to monitor situation in specific areas without being noticed by people. These devices are perfect to patrol large areas. These devices along with technologies of capturing picturescan perform aerial photography to study archaeological discoveries. Models with night vision and thermal vision can be used for wild life monitoring or border intrusion. Drones of smaller dimension can be used as toys. Apart from that drones can be used in fire brigade for thermal imaging to identify the direction of forest fire or other disasters. Tracking and monitoring of pollution. Police drones specifically used for communication disaster management, patrolling in designated areas. In the border, drones can be used to track moving objects. In the army it is used for fight against terrorism and providing aerial support. In chemical industries drones finds its application in monitoring and diagnosis of hazardous gas and undesirable substances along with radiation detection.

4. CONCLUSION

The drone that has been proposed in this paper is a quadcopter havingfour arms and six degrees of freedom that makes it suitable for monitoring and surveillance specific areas. This prototype is presently in development stage with a vision and goal to incorporate it for fault detection and monitoring of high-rise buildings. Specially where the level of work is minimum but life risk is higher. Upon successful development of the prototype this device can be commissioned for the public welfare development and housing urban development society to become applicable for the very cause that minimize the cost and life threat to human labours.

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