**DRONE UNIT COST**

Response Model

Drone frame cost\*

Propeller cost\*

Motor cost\*

Battery cost\*

Drone unit cost

Navigation system cost\*

Communication system cost\*

Electronic Speed controller cost\*

Microcontroller cost\*

Flight controller cost\*

Vision system cost\*

\*Denotes random variable

DRONE WEIGHT

Drone frame weight

Response Model

Propeller weight

Motor weight

Battery weight

Drone weight

Navigation system weight

Communication system weight

Electronic Speed controller weight

Microcontroller weight

Flight controller weight

Vision system weight

**RATED LIFTING CAPACITY**

Response Model

Thrust coefficient

Torque coefficient

Rated lifting capacity

No-load speed

Stall torque

Drone weight

**MAXIMUM SPEED**

Response Model

Thrust coefficient

Torque coefficient

Drone frame dimensions

Maximum speed

No-load speed

Stall torque

Drone weight

Drag coefficient

**MAXIMUM FLIGHT TIME**

Response Model

Thrust coefficient

Torque coefficient

Drone frame dimensions

Maximum flight time

No-load speed

Stall torque

Drone weight

Drag coefficient

No-load current

Drone cost = (Drone frame cost + 4\*propeller cost + 4\*motor cost + battery cost + navigation system cost + communication system cost + vision system cost + electronic speed controller cost + microcontroller cost + flight controller cost)

Drone weight = (Drone frame weight + propeller weight + motor weight + battery weight + navigation system weight + communication system weight + vision system weight + electronic speed controller weight + microcontroller weight + flight controller weight)\*1.1

The 1.1 multiplying factor is used to account for other components such as propeller guard, wires, connectors, etc. that were not included in the system definition.

From [1], and

Where At = Thrust coefficient = 8 \* 10-7 N/RPM2

Aq = Torque coefficient = 2 \* 10-9 N.m/RPM2

T = Thrust of a single propeller (in N)

Q = Torque of a single propeller (in N.m)

= Propeller rotational speed (in RPM)

RPM stands for revolutions per minute

Where D = Drag on the drone (in N)

Cd = Drag coefficient = 0.04 0.0035[2]

= air density = 1.2 kg/m3 at sea level

A = frontal area of the drone i.e. projected area of the drone on a screen orthogonal to the drone direction

V = relative velocity of the drone with respect to the air velocity (in m/s)

Where Atop is the top area of the drone

Afront is the front area of the drone

From [3] ,

Where Qm = motor torque (N-m)

Q0 = motor stall torque or torque when there the motor is stationary

= motor no-load speed or speed when there is no external load on the motor

= motor speed (RPM)

Propeller torque = motor torque

When the motor operates at its rated voltage,

From [4] , the recommended thrust-to-weight ratio is 2:1.

The free body diagram of the drone in horizontal flight can be represented as follows

T

D

Drone weight



Where is the tilt of the drone or the inclination from the vertical

T is the thrust produced by the drone

D is the drag of the drone

At constant speed, net force is zero.

Thus, Drone weight = T cos and D = T sin

Maximum speed is rated for the drone with no package moving continuously in a straight line with the vertical component of its velocity zero. At maximum speed, the drone is producing maximum thrust and is operating at the motor rated voltage.

Drone weight = Tmax cos and

The maximum flight time is rated at 3 m/s for the drone and it is the upper limit on the time the drone can continuously fly in the air.

Where Tmaxft is the drone thrust at maximum flight time conditions

Qmaxft is the propeller torque at maximum flight time conditions

imaxft is the current drawn by the motor at maximum flight time conditions

Qc is the torque constant i.e. change in motor torque/change in current

inl is the no load current i.e. current when there is no external load

BattCap is the battery capacity (in Ah)