Sanitization using Hexacopter Autonomous Drone

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Abstract. Multicopter are slowly finding its way into various industrial sector applications including security, oil & gas, public health, etc. Unmanned Aerial Vehicles provides faster and reliable solutions for many real time challenges. Spraying sanitizers using drone is one such solution which is effectively implemented during COVID-19 pandemic situation. Hexacopter is designed to carry up to 2 litres of sanitizer in its reservoir and the sanitizer spray system is designed to dispense the liquid as droplets at a constant flow rate. Hexacopter is made of carbon fibre and equipped with Pixhawk autonomous module as flight controller. The UAV can be operated in both manual and autonomous modes to increase the ease of operation for indoors as well as in outdoors sanitization process.

Keywords: Hexacopter; Sanitization; Spray; Autonomous

1 Introduction
Corona virus outbreak has a major impact on health, economy and daily life for the people around the world. Worldwide governments are taking various measures to overcome the effects caused by corona virus outbreak. Delay in the availability of vaccine and cyclic raise in the number of victims pose a challenge to the huge population to return to their routine. People who returned to their work are also being exposed to the infection. The current solution proposed by public health care officials is to frequently sanitize one’s own self and their surroundings. In this aspect, disinfecting large hall, malls, shops, playground, parks, streets, etc is a challenging task. This requires number of people to be employed and lot many man hours to do it as a daily chorus. Drones can be effectively used to perform the sanitization process in a large area. Hexacopter drones (Figure 1) are capable for performing vertical take and landing which makes them most favourable choice of indoor as well as outdoor operation. In the outdoor environment, autonomous module installed in the drone can make the task easy for the pilot as it follows a predetermined path [1]. For the indoor operation, obstacle avoidance module can be most preferable for the safe flight. There are number of drones successful designed and tested for pesticide spraying in agriculture fields. The knowledge gathered from the same can be used to design a disinfection drone[2–4].

Pesticide spray drones are already employed in many agricultural field and successfully evaluated on its capability. The pesticide spray agri drones are used in open fields and provide greater flexibility in its operations [5–9]. It is easy to perform the pesticide spray process in an open field due to better GPS connectivity and less obstacles on its surrounding [10]. The drone available in the market for the agri-spray purpose can be redesigned to perform the sanitization process for a large area [11]. This will reduce the time required to sanitize a zone and requires less amount of sanitizer [12–14]. The commercially
available drones are quite expensive, hence a cost effective autonomous drone is designed for the sanitization purpose.

![Hexacopter UAV used for sanitation](image)

**Figure 1.** Hexacopter UAV used for sanitation

## 2 Design and fabrication

The design and fabrication of sanitizer drone is divided into two sections. Section 2.1 explains the design and fabrication of multicoptor and section 2.2 explains the design and fabrication of the spray step-up. The drone was designed to carry 2 litre of sanitizer with endurance of 25 minutes and radio range up to 1.2 km. Each component was selected based on the mission profile and mission requirements. 3D printed components were also used in fabrication of the spray step-up.

### 2.1. Hexacopter Fabrication

Hexacoter which is capable of performing vertical take-off and landing is chosen for the sanitization purpose. The multicoptors is a classification of Unmanned Aerial Vehicle (UAV), which are capable of take-off and land vertically, unlike fixed wing UAV which requires a runway to take-off and land. The vertical take-off and landing characteristic of the multicoptor is crucial for the spray application. Multicopter UAV’s have number of brushless DC (BLDC) motor which together produces the required take-off thrust. The designed hexacopter has 6 brushless DC motor coupled with 6 light weight 10* 4.5 plastic propellers and 30 amp electronic speed controller which can able to generate a total thrust up to 90 N. A light weight carbon fibre frame is used to house the various components including the BLDC motors and the spray set-up. Provision to mount the sanitizer reservoir and other allied components were provided at the bottom of the carbon-fibre airframe. The entire multicopter is powered using single 11.1V 8000 mAh Lithium polymer battery. The Lithium polymer batteries has high power to weight ratio and high power density when compared with other batteries which make it ideal battery to power the entire drone. The power to operate the spay step-up is also drawn from the lithium polymer battery. Power from the battery is distributed to various components in the multicoptor using a dedicated power distributor and voltage regulator is used for components which operates in low voltage such as the flight controller.

| Component       | Specification |
|-----------------|---------------|
| BLDC Motor      | 920 kv        |
| Propeller       | 10*4.5        |
| Frame Material  | Carbon Fibre  |
| Battery         | 8000 mah      |
| Flight controller| Pixhawk 2.8   |

The hexacopter is controlled manually using 6-channel transmitter and receiver which operates in 2.4 GHz ISM band. Real time flight data such as altitude, airspeed, Vertical speed, heading, etc. are transmitted to the ground control station (GCS) through on-board telemetry module connected to the flight controller. The flight controller is a bag of electronics which is used for automated flights. The flight controller has 3- axis MEMS based accelerometer and gyroscope for stabilization and dual
A redundant Global Positioning System (GPS) receiver to identify the current location. The flight controller uses ARM cortex processor, has high computing power with less energy consumption. Flight controller uses I2C, UART, CAN communication protocols to communicate with the other peripherals. The speed of the pump in the spray set-up is controlled using the flight controller.

2.2. Spray set-up
The spray set-up is used to deliver the sanitizer on a target area. The set-up consists of sanitizer reservoir, pump, flow tube(s) and nozzle(s). The custom designed 2 litre sanitizer reservoir is manufactured using High Density Polyethylene (HDPE) through injection moulding process. A high speed pump is designed to pump the sanitizer from the reservoir to the nozzle(s). The pump and its components were designed on solid works software (Figure 2 and Figure 3) and printed using 3D printer (Figure 4).

![Figure 2. Impeller designed in solid works](image1)

![Figure 3. Motor pump designed in solid works](image2)

The flow tubes are connected with pump in one end and to the nozzle on the other end. Mass flow rate in the nozzle and the sanitizer pump pressure is controlled in order avoid flow tube bulging and subsequent leakage due to pressure build in the flow tube. The spray set-up has two nozzles one mounted on the left arm and other on the right arm of the hexacopter and the nozzles are mounted at an equal distance from the sanitizer reservoir which is mounted at the centre of gravity of the hexacopter.

![Figure 4. 3D printed components](image3)
Method of Sanitation Using Hexacopter

A pre-flight inspection on the hexacopter is to be performed on the model to ensure the working of all components and installed subsystem. Crucial components such as propellers, batteries, sanitizer reservoirs and flight controller are fastened tightly to the frame. Sanitizer is filled in the 2 litre container and prepared for spraying. The sanitizer need to be filled in the reservoir before uploading the flight envelope into the flight controller. The hexacopter drone using the Pixhawk flight controller is calibrated during the pre-flight inspection. The calibration process ensure the steady flight while change in weight experienced by the drone during the discharge of sanitizer.

The location need to be disinfected is fed into the drone as a flight envelop using the ground control unit. The flight envelope can be created using Real-Time Kinematic (RTK) device or by giving Global Positioning System (GPS) co-ordinates to the multicopter using software like mission planner or Universal Ground Control (UGC), these software has a graphical user interface which allows the user to choose GPS co-ordinates manually. Since the mission planner software is more compatible with Pixhawk, it is chosen as the ground control unit for this application. The mission planner software uploads the flight envelope data using telemetry to the flight controller in the hexacopter where the information is processed and a virtual flight path is created. This virtual flight path can be viewed in mission planner software. The auto-pilot flight does not require any human intervention during the entire flight. All the flight telemetry data are transmitted to GCS, using on board telemetry module operating at 433 MHz which is received by the ground based receiver. The 8008 nozzle is coarse type nozzle which can able to spread the sanitizer on the target region precisely even with a crosswind (Figure 6). The dual nozzle configuration provides large coverage. The sanitizer pump speed which influence the pressure inside the nozzle is controlled by the flight controller, constant pressure inside the nozzle will ensure the even sanitizer deposition on the target area.

Figure 5. 8008 nozzle connected to pump

The 8008 flat fan nozzles are classified as very course nozzles with low drift potential factor and has a very large diameter droplet [15]. The 8008 nozzle has maximum spray angle of 80 degrees, can have a maximum mass flow rate 2.8 litre/minute and operating pressure of 2.5 bar (Figure 5). The entire dry set-up weight around 1.2 Kg and can be mounted on the bottom of the multicopter.

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The reservoir pressure, sanitizer level, tube pressure and mass flow rate of the nozzle can be monitored using the on-board telemetry module which is used for flight telemetry data transmission. Once the marked areas are covered the multicopter will automatically land where it took-off. If the sanitizer in the reservoir ran off before covering the given area, the multicopter is programmed to land and sanitizer can be refilled in the reservoir and begins the spraying process for the remaining region from the point of return. The hexacopter drone can effectively sanitize an area of 200 m² for a single refill.

4 Conclusion
The following conclusion can be stated from the design and operating of sanitizer drone.

1. Hexacopter drone can effectively carry 2 liters of sanitizer and fly for 25 minutes with 8000 mAh battery
2. Large area can be disinfected with smaller work force and in a short duration
3. Improved safety for the personnel working in the disinfection process

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