Review on application of heavy lift drone for agriculture

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ABSTRACT: The fact that agriculture drone is a heavy lift type of multirotor drone. The design ergonomic multirotor airframe enables it to carry heavy payloads is main factor in agriculture application. This paper provides some technical detail of heavy lift drone architecture and reviews application of the drone for crop spraying. High rigidity airframe eliminate vibration resulting high stability flight. In addition, hub centric design distributes equal load to each propulsion increase flight performance. Future application of drone demanding reliable equipment, good performance and efficient. So by improving design can secure drone demand, employment, more revenue and income.

Keywords: *Multirotors; Heavy lift; Payload*

1. INTRODUCTION

The development of heavy lift drone for agriculture really pushing the drone's technology closer to the end user make it more beneficial. The drone system adapts better in the ecosystem increase the efficiency and productivity. Also reducing farmers workloads with automation of operation [1]. Application of drone technology in agriculture is also commenced in developed country [2]. However, it is important to address design challenge for agriculture drone such as heavy payload which refer to fertilizer and pesticides weight for every flight. Also required a longer flight time for practicality. A simple operating system and reliable control system is another key indicator for implementing drone technology to agriculture.

2. HEAVY LIFT DRONE ARCHITECTURE

There are several types of multirotor drone configuration developed for heavy lift application such quadcopter, hexacopters, and octocopter. This frame configuration is popular design for large size multirotors. Figure 1 shows agriculture drone from szttfuav website (https://www.szttfuav.com).

Figure 1: Sprayer Agriculture Drone

Previous study also shows another platform as well such as helicopter and fixed wing. Table 1 shows various type of UAV developed for agriculture. Different platforms are associated to different lifting ability. More rotor is better for heavier load, however it come at more cost due to number of electronic parts and motors [3].

Table 1: Type of UAV for agriculture

Types	Reference
Multirotor	[4]
Fixed Wing	[5]
Helicopter	[6]

There is also study made for precision agriculture with multirotors configuration[7]. But this review is to focus on design architecture to support heavy lifting. So, for this purpose, multirotor are design to distribute load equally to all rotors. This design is hub centric type which locate center of load at the center point of multirotors frame. Figure 2 shows example of quadcopter with hub centric design from Ardupilot website (https://ardupilot.org). Thus, all arm and motor bear the same amount of load. In addition, hub centric design also generates the same amount of thrust for each rotor. This condition making the motor run at same power output and rotation. It is important to prolong the lifetime of motors and electronic speed controller.

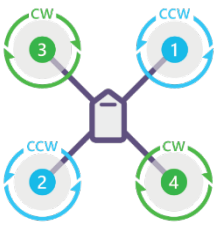

Figure 2: Hub centric type configuration of quadcopter

The material of frame is combination of carbon fiber and aluminum joint. Properties of carbon fiber which is strong and light weight is very much suitable for multirotor drone. Precise sizing of carbon fiber arm is important to eliminate flexibility in the rotor arm. Furthermore, high rigidity frame resulting an efficient and stable flight. Aluminum foldable joint normally added to the frame for ease of transporting without compromising the overall frame rigidity.

3. AGRICULTURE APPLICATION

Multirotor drone advantages are stability, linear maneuverability, and lifting power. It is most suitable platform for agriculture for its functionality and size. There is wide range option of liquid sprayer payload and granular spreader. Figure 3 illustrates heavy lift agriculture drone with sprayer payload performing crop spraying source from Equinoxdrones website (www.equinoxsdrones.com). It can be used for either spraying fertilizer or pesticide.

Fig 3: Crop spraying heavy lift multirotor drone

Current development adopts the use of simple interface ground station providing user with simple control without battling with complex command behind the control system. This is heavily impacted the growth of drone application. Figure 4 shows example of ground station user interface for planning from Ardupilot website (https://ardupilot.org). Ground station automatically route the possible flight path from selected flight area. Further enhanced of flight path can be made easily to avoid obstacle and surrounding object with help of navigation system and range sensors.

Figure 4: Example of ground station flight planning

4. CONCLUSION

This paper provides a review of heavy lift drone application in agriculture sector. Specifically, the capability of carrying heavy payload such as fertilizer and pesticide. Some technical detail of drone airframe design and material selection. This review is toward optimization of heavy lift drone in agriculture and future application. To achieve that, some design challenges and accurate specification must be addressed.

ACKNOWLEDGEMENT

The authors would like to thank the Ministry of Higher Education for providing financial support under Fundamental Research Grant Scheme (FRGS) No. FRGS/1/2016/TK03/UMP/02/21 (University reference RDU160139) and Universiti Malaysia Pahang for laboratory facilities as well as additional financial support under Internal Research grant PGRS2003143.

REFERENCES

[1] U. R. Mogili and B. B. V. L. Deepak, “Review on Application of Drone Systems in Precision Agriculture,” *Procedia Comput. Sci.*, vol. 133, pp. 502–509, 2018, doi: 10.1016/j.procs.2018.07.063.

[2] S. Kulkarni and A. Natu, “Adoption and Utilization of Drones for Advanced Precision Farming: A Review,” May 2016, doi: 10.17762/ijritcc.v4i5.2237.

[3] B. Y. Suprapto, M. A. Heryanto, H. Suprijono, J. Muliadi, and B. Kusumoputro, “Design and development of heavy-lift hexacopter for heavy payload,” in *2017 International Seminar on Application for Technology of Information and Communication (iSemantic)*, Oct. 2017, pp. 242–247, doi: 10.1109/ISEMANTIC.2017.8251877.

[4] S. G. Rajput, M. S. Thakur, C. V Wagh, and M. D. Mahale, “A Review on Agricultural Drone Used in Smart Farming,” pp. 313–316, 2021.

[5] C.-V. Eduardo, R.-T. Hugo, A.-S. Otilio-Arturo, T.-P. Alfredo, and C.-M. Mireya, “Use of unmanned aerial vehicles (UAV) as an innovation in agriculture,” *African J. Agric. Res.*, vol. 16, no. 12, pp. 1665–1673, 2020, doi: 10.5897/ajar2020.15101.

[6] G. Cai, B. M. Chen, and T. H. Lee, *Unmanned rotorcraft systems*. Springer Science \& Business Media, 2011.

[7] P. Daponte *et al.*, “A review on the use of drones for precision agriculture,” *IOP Conf. Ser. Earth Environ. Sci.*, vol. 275, no. 1, 2019, doi: 10.1088/1755-1315/275/1/012022.