

#7657 AUTONOMOUS HEXACOPTER SPRAYING DRONES FOR PLANTS PROTECTION

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ABSTRACT

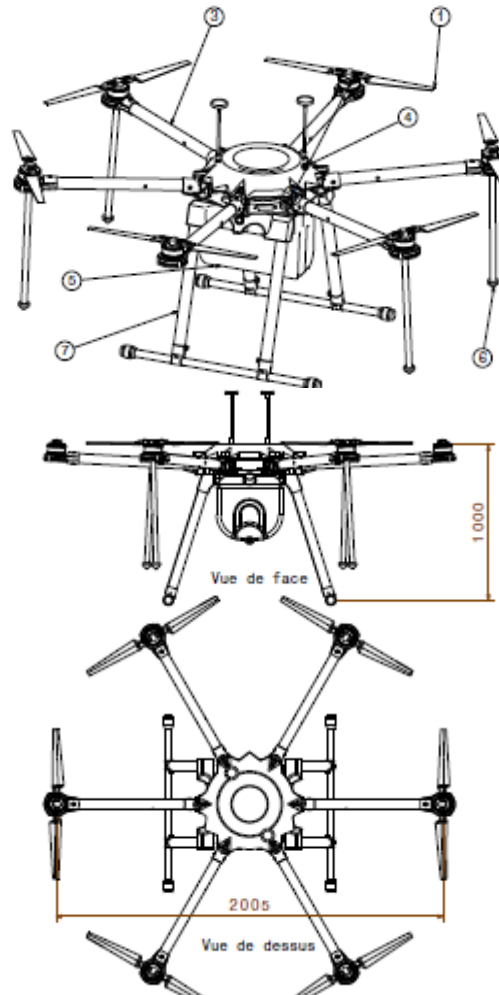
Farming technologies have considerably evolved over the last decades considering new agricultural problems and constraints. This paper discusses a Moroccan project based on autonomous spraying drones developed during the last three years in collaboration between Moroccan Industry Services & Engineering company, the INRA institute and the ONCA office. The main purposes of this project is to assist Moroccan farmers improve their performance and enhance their efficiency using chemicals to withstand different diseases, increase crop yields (crops and orchards) and monitor their growth. Also, using our drones helped farmers during the last two years protect themselves and the environment from chemicals and reduce the use of water. Many operations and tests have been carried out in cooperation with the two departments (INRA and ONCA) to highlight the efficiency of our system and to develop new processes together considering this new technology. This paper gives an overview of different experiences conducted, the main results obtained and the technical descriptions of our hexacopter.

INTRODUCTION

Precision agriculture and digital tools are becoming the pillar parameters for an agriculture that withstand to all constraints and climate changes. The use of agricultural inputs including fertilizers, plant protection chemicals and water, is increasing considerably and it is becoming important to optimize their use in order to protect humans and environment. Currently the chemical treatments are done through sprayers dragged by tractors or on small vehicles or by plane in case of large areas. These conventional methods can be very time-consuming and energy-non-efficient, polluting and non-water-efficient. They can also cause damage especially at advanced stages of cultivation. The spraying drone greatly reduces time and cost of treatment, water consumption based on low volume technology ensuring a stable and high yield, crops need balanced, consistent fertilization and continuous maintenance. It also allows immediate access to the parcels for the treatment of large crops after the rains fall and after irrigation, especially for clay soils with difficult access. The use of spraying drones could be the ideal solution for hard-to-reach crops (rice, sugar cane, corn, rapeseed, sunflower). This paper deals with technical characteristics of our hexacopter (Moroccan Agriculture Spraying Drone MASD-M6) from design to flight tests and highlights the most important operational phases during the last two years.

Design and Manufacturing

First Phase: the main purpose was to design and manufacture hexacopter drone achieving all performance parameters mainly the stability and thrust subsystem. Three prototypes were realized before reaching the final version.



During these stages we focused on structure mechanical strength and configuration and the flight stability. We used a Linear Quadratic Regulator controller to establish an efficient control law which satisfies a given specification and maintains sufficient stability and accuracy even under the strong effects of intrinsic parameters uncertainties.

In the next step we will adapt the fractional controller to enhance the stability performances and reduce the energy consumption.

In order to reduce the weight and increase the capacity of the drone in term of chemical payload, we decided to choose the carbon fiber material for the 90% of the structure and all other parts are made from Aerospace Aluminum.

Second Phase: After flight and crash tests, we started working on the spraying system and nozzles configurations. Two main categories were adopted: pressure and electrostatic nozzles.

- Pressure nozzles for crops
- Electrostatic nozzles for orchard

Two pumps are mounted in order to ensure the pressure and flow rates during the spraying operations.

The main performances of MASD-M6 drone are:

- Payload capacity: 25 liters
- Spraying area/hour: 8-10 ha

Spraying Operation and Chemical Treatments

Since the final version of the hexcopter drone was tested and approved we started spraying operations in collaboration with our clients.

The spraying program was supported by our two main partners INRA and ONCA. In this way, during 2019 year we have treated:

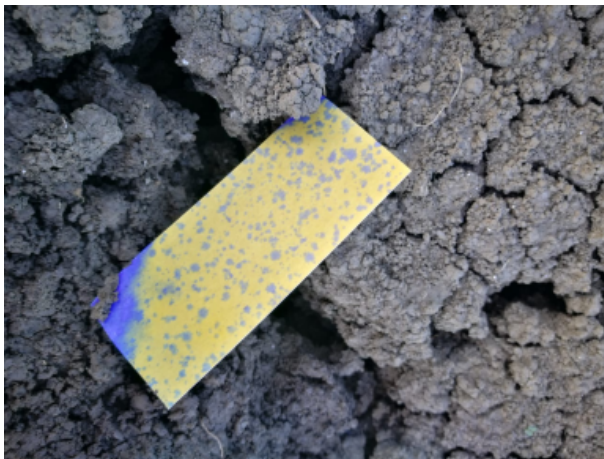
- more than 3,000 hectares of rice,
- more than 1000 hectares of sunflower
- more than 1000 hectares of olive trees
- more than 500 hectares of citrus
- more than 200 hectares of sugar canes
- more than 200 hectares of corn
- more than 200 demonstrations and tests.

As such, in order to raise awareness among all stakeholders about the benefits and added values of these drones, we organized several awareness and scientific field days in partnership with all our partners. We cite as an example:

- In partnership with INRA a National Scientific Conference: Smart Agriculture.
- In partnership with the province of SIDI KACEM: Field day with official use of drones for wheat treatment with the presence of major agricultural departments (ONCA, DRA, ORMVA, Associations, etc.).

During these operation two main objectives were defined:

- the efficiency of the treatments
- the droplets distribution and density



CONCLUSIONS

MASD-M6 drone is an autonomous hexacopter spraying drone for agriculture chemical treatments. This project aims to develop R&D and scientific research rather than helping Moroccan farmers to enhance their efficiencies and improve spraying methods while protecting environment and humans from chemicals.

In this project, an aerial spraying system with a capacity of 25-liter tank was designed and manufactured. Field experiments were carried out in order to apply pesticide in agriculture. The results are excellent and meets the farming constraints and chemical spraying optimal objectives.

However, in order to improve the main performance parameters of the drone many research programs were developed to continue increasing the stability against the wind effect and spraying efficiencies in different conditions.

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