



## Agriculture Drone for Spraying Fertilizer and Pesticides

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**Abstract:** The application of pesticides and fertilizers in agricultural areas is of prime importance for crop yields. The use of aircrafts is becoming increasingly common in carrying out this task mainly because of its speed and effectiveness in the spraying operation. However, some factors may reduce the yield, or even cause damage (e.g. crop areas not covered in the spraying process, overlapping spraying of crop areas, applying pesticides on the outer edge of the crop). Climatic condition, such as the intensity and direction of the wind while spraying add further complexity to the control problem. In this paper, we describe an architecture based on unmanned aerial vehicles (UAVs) which can be employed to implement a control loop for agricultural applications where UAVs are responsible for spraying chemicals on crops. The process of applying the chemicals is controlled by means of the feedback obtained from the wireless sensor network (WSN) deployed on the crop field. The aim of this solution is to support short delays in the control loop so that the spraying UAV can process the information from the sensors. We evaluate an algorithm to adjust the UAV route under changes in wind intensity and direction. Moreover, we evaluate the impact of the number of communication messages between the UAV and minimize the waste of pesticides.

**Keywords:** UAV, ESC,

### I. INTRODUCTION

Unmanned aerial vehicles have become cheaper because many control functions can be implemented in software rather than having to depend on expensive hardware [1][2]. This even allows multiple UAVs to be used for a single application. In this case, the UAVs must have communication facilities so that they can communicate with each other. This can easily be achieved by equipping an UAV with a wireless mesh node. In this scenario, the UAV swarm can be considered to be a highly mobile wireless mesh network [7].

In this paper we propose an architecture based on unmanned aerial vehicles (UAVs) that can be employed to implement a control loop for agricultural applications where UAVs are responsible for spraying chemicals on crops. The process of applying the chemicals is controlled by means of the feedback from the wireless sensors network deployed at ground level on the crop field. The aim of this solution is to support short delays in the control loop so that the UAV spraying can process the information from the sensors. Furthermore, we evaluate an algorithm to adjust the UAV route under changes in the wind (intensity and direction) and the impact related to the number of messages exchanged between the UAV and the WSN [10]. The information retrieved by the WSN allows the UAV to confine its spraying of chemicals to strictly designated areas. Since there are sudden and frequent changes in environmental conditions the control loop must be able to react as quickly as possible.

### II. SYSTEM DESCRIPTION

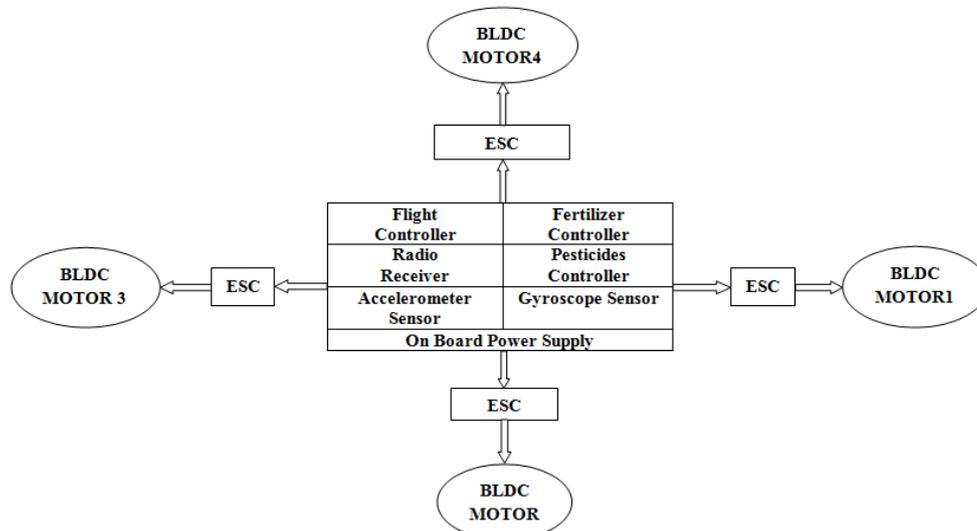


Fig 1. Block Diagram

### 1. BLDC:

The brushless motors are multi-phased, normally 3 phases, so direct supply of DC power will not turn the motors on. BLDC electric motor also known as electronically commutated motors.

### 2. ESC:

The ESC generating three high frequency signals with different but controllable phases continually to keep the motor turning. The ESC is also able to source a lot of current as the motors can draw a lot of power.

### 3. DC:

30PRM 12 v DC geared motors for robotics application. Very Easy to use and available in standard size. A power supply is an electronic device that supplies electric energy to an electrical load.

### 4. Accelerometer Sensor:

The accelerometer measures acceleration and also force, so the downwards gravity will also be sensed. As the accelerometer has three axis sensors, we can work out the orientation of the device.

### 5. Gyroscope Sensor:

A gyroscope measure angular velocity, in other words the rotational speed around the three axis.

A gyroscope is a device that uses Earth's gravity to help determine orientation. Its design consists of a freely-rotating disk called a rotor, mounted onto a spinning axis in the center of a larger and more stable.

### 6. LIPO Battery:

LiPo battery can be found in a single cell (3.7V) to in a pack of over 10 cells connected in series (37V). A popular choice of battery for a QuadCopter is the 3SP1 batteries which means three cells connected in series as one parallel, which should give us 11.1V.

## III. HARDWARE DESCRIPTION

### 1. ATmega328

- High Performance, Low Power AVR® 8-Bit Microcontroller.
- Advanced RISC Architecture.
- 131 Powerful Instructions – Most Single Clock Cycle Execution
- Six PWM Channels.
- 6-channel 10-bit ADC in PDIP Package.
- Programmable Serial USART
- Master/Slave SPI Serial Interface

### 2. BLDC(3000mAh,25C)

Brushless DC electric motor also known as electronically commutated motors are synchronous motors that are powered by a DC electric source via integrated inverter/switching power supply, which produces an AC electric signal to drive the motor. A BLDC motors for quadcopter is constructed with a permanent magnet rotor and wire wound stator poles

### 3. ESC

ESC is used to control BLDC motor. It takes signal from microcontroller and breaks into 3 parts and sends it to the BLDC motor. We would require 4 ESCs as we are using 4 BLDC motor. The ESC is an inexpensive motor controller board that has a battery input and a three phase output for the motor. Each ESC is controlled independently by a PPM signal (similar to PWM). The frequency of the signals vary, but for a Quadcopter it is recommended the controller should support high enough frequency signal, so the motor speeds can be adjusted quick enough for optimal stability.

### 4. Accelerometer Sensor

Digital-output triple-axis accelerometer with a programmable full scale range of  $\pm 2g$ ,  $\pm 4g$ ,  $\pm 8g$  and  $\pm 16g$

- Integrated 16-bit ADCs enable simultaneous sampling of accelerometers while requiring no external multiplexer
- Accelerometer normal operating current: 500 $\mu$ A
- Low power accelerometer mode current: 10 $\mu$ A at 1.25Hz, 20 $\mu$ A at 5Hz, 60 $\mu$ A at 20Hz, 110 $\mu$ A at 40Hz
- Orientation detection and signalling
- Tap detection
- User-programmable interrupts
- High-G interrupt
- User self-test

### 5. Gyroscope Sensor

Digital-output X-, Y-, and Z-Axis angular rate sensors (gyroscopes) with a user-programmable fullscale Range of  $\pm 250$ ,  $\pm 500$ ,  $\pm 1000$ , and  $\pm 2000^\circ/\text{sec}$

- External sync signal connected to the FSYNC pin supports image, video and GPS synchronization
- Integrated 16-bit ADCs enable simultaneous sampling of gyros
- Enhanced bias and sensitivity temperature stability reduces the need for user calibration Improved low-frequency noise performance
- Digitally-programmable low-pass filter
- Gyroscope operating current: 3.6mA
- Standby current: 5 $\mu$ A

- Factory calibrated sensitivity scale factor
- User self-test

#### **6. Radio receiver**

This receives 2.4GHz signals coming from the transmitter side. It has got 6 independent channels to receive the signal from the transmitter and then send the signal to the microcontroller for further processing. Its current consumption is less than 40 mA and works on 5 volt power supply.

#### **7. LIPO Battery**

Lithium batteries are the preferred power sources for most electric modelers today. They offer high discharge rates and a high energy storage/weight ratio. However, using them properly and charging them correctly is no trivial task.

#### **8. DC Voltage Supply**

- A **power supply** is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another and, as a result, power supplies are sometimes referred to as electric power .
- 30 RPM Side Shaft 37mm Diameter Compact DC Gear Motor is suitable for small robots automation systems. It has sturdy construction with gear box built to handle stall torque produced by the motor. Drive shaft is supported from both sides with metal bushes. Motor runs smoothly from 4V to 12V and gives 30 RPM at 12V. Motor has 6mm diameter, 22mm length drive shaft with D shape for excellent coupling.
- 30RPM 12V DC motors with Gearbox
- 6mm shaft diameter with internal hole
- 125gm weight.

### **IV. SOFTWARE DESCRIPTION**

#### **1. ARDUINO**

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

#### **2. EAGLE( Easily Applicable Graphical Layout Editor)**

16-bit application for Microsoft DOS, with support for OS/2 and Windows added later on. Starting with version 4.0, EAGLE was converted to 32-bit. EAGLE version 4.0 also dropped support for DOS and OS/2, but was among the first professional electronic CAD tools available for Linux. A 32-bit DPMI version of EAGLE 4.0 running under DOS was available on special request in order to help support existing customers, but was not released commercially. Starting with version 4.13, EAGLE became available for Mac OS X, with versions before 5.0.0 still requiring X11. Version 5.0.0 officially dropped support for Windows 9x and Windows NT 3.x/4.x. EAGLE 6.0.0 no longer supports Mac OS X on the Power PC platform (only on Intel Macs), and the minimum requirements have been changed to Mac OS X 10.6, Linux 2.6 and Windows XP. On 24 September 2009 Premier Farnell announced the acquisition of CadSoft Computer GmbH, developer of EAGLE.<sup>[1]</sup>EAGLE contains a schematic editor, for designing circuit diagrams. Parts can be placed on many sheets and connected together through ports. Free maintenance and support. Low cost, easy to use Printed Circuit Board design solution.

#### **3. Multi wii**

Multi Wii is an open source software project aiming to provide the brain of a RC controlled multi rotor flying platform. It is compatible with several hardware boards and sensors. It is portable, no installation required. MultiWii is a popular flight control software for multi-rotor craft. It performs well on most typical copters with minimal tuning and has a number of advanced features such as GPS position hold and return to home. MultiWii gets its name from early hardware versions which were built from parts scavenged from Nintendo Wii controllers, such as gyroscopes and accelerometers, which were connected to the popular Arduino micro-controller boards.



## V. CONCLUSION

In this paper we have described an architecture based on unmanned aerial vehicles (UAVs) that can be employed to implement a control loop for agricultural applications where UAVs are responsible for spraying chemicals on crops. The process of applying the chemicals is controlled by means of the feedback from the wireless sensors network deployed at ground level on the crop field. Furthermore, we have evaluated an algorithm to adjust the UAV route under changes in the wind (intensity and direction) and the impact related to the number of messages exchanged between the UAV and the WSN.

However, precision agriculture is about to know a further progress and UAVs will play a crucial role.

Important savings (20% - 90%) in terms of water, chemical treatments and labor are expected.

Flight regulations are an issue but UAVs, for most agriculture applications, have low weight and fly at low altitudes over uninhabited and private areas.

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