Journal of Electrical Engineering, Electronics, Control and Computer Science
JEEECCS, Volume 2, Issue 5, pages 1-4, 2016

Drone for Video Surveillance

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***Abstract* - This article present a system based on a multirotor(drone) for video surveillance controlled by a joystick through a C# interface that communicate with drone using Bluetooth technology. This project required a series of method that were necessaries to reduce vibrations, and to filter the noises.**

Keywords: Arduino Due, regulator PID, multirotor, drone.

I. INTRODUCTION

1.1 Multirotors. General characteristics

Because of science and technology evolution, people have acces in present to a lot of services and technological equipments that can be used by every man to develop his own project.

This opportunity was possible because of the appearance of processors and microcontrollers which dispose of a bigger and bigger processing power, that lead, in consequence to the appearnece of more and more complex software products.

A new domain that gained weight in a very short time is the one of the multirotors. Multirotors are aerial devices, that have more than tho engines , which have satisfied the need of people to watch hard to acces or inaccessible areas at a relatively low price and with a high accuracy.

Multirotors are aerial devices equipped with two or more engines unlike the helicopter which has only one main engine. Multirotors use pitch propellers ,so the control of the device is done by changing the speed of one engine . The radio-controled ones are enjoying popularity and are used as a cheap way to photograph or film things like buildings and landscapes .Going further, we will explore the variety of the multirotors. Mainly, they are named and classified after the number of the engines they have on. The number of t engines and the configuration of each multirotor brings both advantages and disadvantages on it's performance. For example, the bigger the number of the engines is, the bigger the lifting force is so you can carry bigger batteries and therefore extend the autonomy of the ensemble, but the reverse is the fact that the price increases a lot.

1.2 Classification

a. BiCopter – multirotor with 2 engines (fig 1.2.1)

The BiCopter-ul has only two engines that are adjusted by some actuators. It is considered the cheapest multicopter because it uses two engines and two actuators., but it's less stable and hard to adjust. Also it is less tough and has a low lifting power. This model is less popular than the rest of the multirotors.

Fig. 1.2.1 BiCopter

b. TriCopter – multirotor with 3 engines

Tricopter-ul has three Y-shaped engines(Fig. 2.1.2) usually placed in a 120 degrees angle , or T-shape (Fig. 2.1.3). The back engine is activated by an actuator which has the role to adjust the YAW movement (around the Z axis).
Generally it is more stable than a BiCopter but less stable than the rest of the multirotors and less tough because of the small resistance at crashes ,being influenced a lot the resistance of the „tails" ,and it's also hard to build because of the rotation adjustment mechanism around the Y axis (YAW).

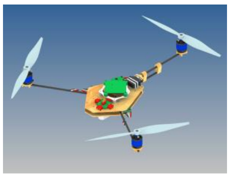

Fig. 1.2.2 TriCopter Y shape

Fig. 1.2.3 TriCopter T shape

c. QuadCopter – 4 engines

A QuadCopter (fig 1.2.4) has 4 engines mounted on 4 arms of a symmetrical frame so it can have a + shape or a X one. For photography, the X one it's most often used because the propellers don't get in the frame It has a high stasbility and a strong resistance to impact.

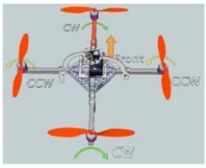

Fig 1.2.4

d. HexaCopter – 6 engines

The HexaCopter has 6 engines on a symmetrical frame with 6 arms disposed at a 60 degrees angle. This type of multirotor is very popular because it has a big lifting capacity and a strong stability even if one of the engines suffers troubles.

Fig. 1.2.5HexaCopter

e. OctoCopter – 8 engines

The OctoCopterul is an improved version of the HexaCopter with a higher lifting capacity and better stability. This can fly and land regularly even with the damage of two engines. The disadvantages of this model are the amount of electric current sucked-in from the source of energy and the high price.

II. THE HARDWARE STRUCTURE OF THE DRONE – VIDEO SURVEILLANCE

The project incorporates knoledge from many domains such as: electronics (BEC circuits– battery elimination circuit),automatic adjustment engineering (PID regulator ,parameters optimization PID), C#,C informatics, all this knowledge being acquired during college.The purpose of the work is to aerial watch the interest areas.

For the achieving of this goal I used, mainly, the Arduino Due developement board. Due to the functioning frequency of the 84 Mhz internal clockthis developmenet board alloweded us to have a shorter time of adjustment of the process, and , in consequence, a shorter stabilization time.

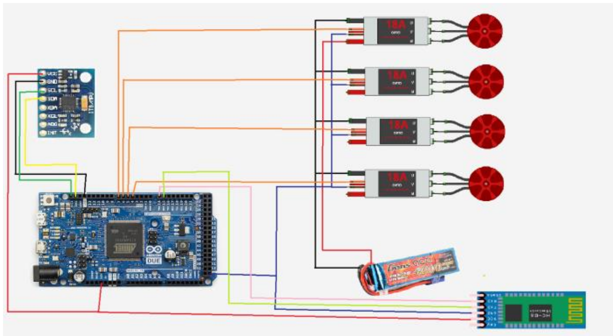

Fig.2. Block diagram

The hardware of the drone is presented in fig.2. This contains the following component modules :

- An Arduino Duo board[1][2],
- A Bluetooth module Hc-05[3],
- A battery 11.1V,4000 mAh,
- 4 engines [4] 920rpm/V without collector brushes ,three-phased, conected in star shape(BLDC).
- 4 electronic controllers of speed [5](ESC) used for the command of the engines.
- 4 propellers APC 9050[6].
- MPU6050[7] a chip with interface I2C,wihich contains an accelerometer, a gyroscope ,and a processor,the last one merging the dates from the accelerometer and the gyroscope for more accurate values .The data supplied and the degrees of tilt of the drone, represent the inputs of some PID regulators which have the role of mentaining the drone stable..For changing the direction and the altitude we will use a serial communication ith a rate of 115200 symbols/s. For the video transmission we will use a camera that will broadcast live through the internet.

Fig. 3

The tilt sensor comunicates with the Arduino board through I2C using SDA1 and SCL1 pins , being powered at 3.3V. In this protocol are being transmitted the 3 parameters necessary for the stabilization of the drone(roll,zaw,pitch).

The ESCs are connected to Arduino Due in pins D4,D5,D6,D7 and have the role to control the speed of the engines according to the PWM of every pin.

The Bluetooth module communicates with the board through pins Rx3 and Tx3 being powered 3.3v.

III. THE SOFTWARE STRUCTURE OF THE DRONE

The software ensemble includes three modular applications, integrated ,which uses different technologies for software.

3.1. The software module for Arduino

For the Arduino board was developed, in the programing environment IDE,a software module which :initializes the serial port (COM), at parameters 115200 symbol/sec, initializes artery I2C; initializes pins D4,D5,D6,D7 of the Arduino Due board as „servo” outputs for the command of ESCs; reads values roll,pitch,yaw and adjusts the speed of the engines with according parameters of the PIDs.

The logical diagram of the software module integrated in Arduino is presented in figure 4. This highlights the informational flow used in programing .

3.2. The software module C#

For PC/Laptop was developed in C# an interface throughout which are read the states of the used game-pad buttons (forward, backword, accelerate, decelerate) and are transmitted through serial comunication (bluetooth) to drone for the control of it’s trajectory an position.

For the C# interface I used 2 group box elements (Drone Control, Conexion) ,2 combo box elements from which will be selected the name of the conexion port, and the transfer rate of it, 2 button type elements which have the role to establish the conexion between the 2 bluetooth devices and to refresh the existing COMs ,1 trackbar type element that has the role to show the acceleration of the drone percentage. The blue arrows will become, one by one, green depending on the movement direction of the drone.

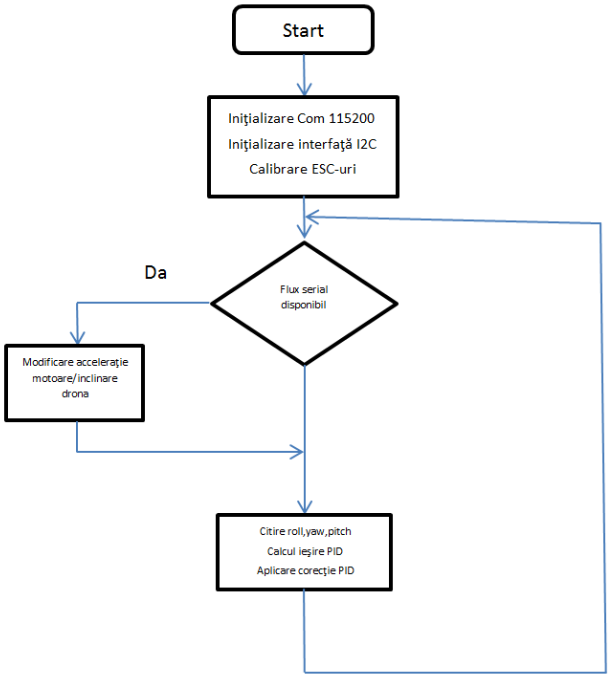

Fig. 4. The logical diagram of the Arduino application

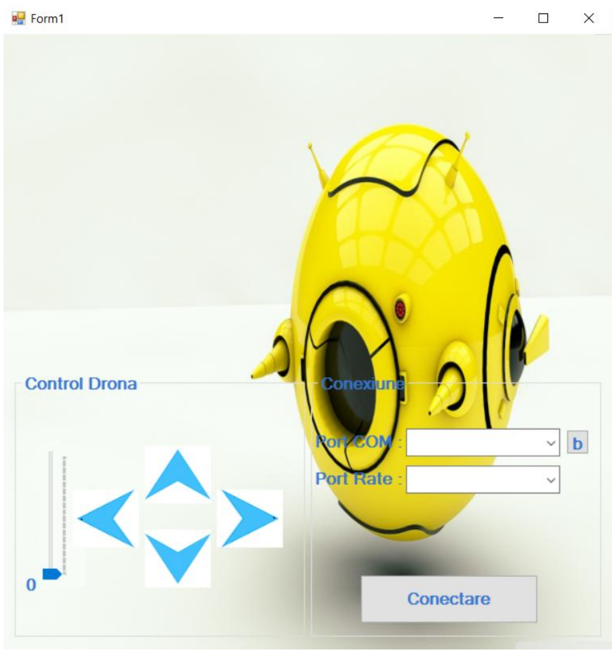

Fig. 5

3.3 The projection and adjustment of the load regulator PID

For the balancing of the drone was created , in the software module no. 1 a program that helped at the designing of a PID regulator and was accorded with the modifying of it’s accord parameters.
The regulator is the main block in the automatization device. The automatic regulator has the role to retrieve the error signal (obtained after the comparison between the input size y and the measure size y, in the

comparison element) and to elaborate, at output, a command signal for the execution element.
The regulator block is made of many interconected-functional components which allow both the achievement of the control law (analitically expressed by the dependence between the output size and the input size), but also some auxiliary functions : indication, signalization of the overcome of the normal value for certain sizes, saturation, going from automatic to manually etc.

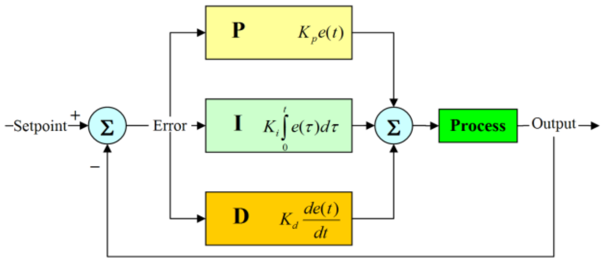

Fig. 6.

IV. RESULTS AND CONCLUSIONS

Realising this project represented a real challenge and supposed the optimization of the sistem by identifying some optimal variables for a much efficient functioning .
For the composing of the hardware ,the challenges were choosing :

- the engines, the ESCs , the propellers and the coefficients of the 3 PID regulators because they had to be depreciated ;
- the vibrations by balance of the propellers, by setting a MPU6050 on an absoring vibrations material.

The directions of the developement of this project are :
-the command of the drone through radio waves of 2.4 Ghz frequence, for the extension of the control distance up to 2 km, in open field .
-the growth of the drone autonomy by integrating a GPS module. This will indicate the exact position of the drone and will be used for the achievement of images from hard to acces areas.

ACKNOWLEDGEMENTS

My thanks are given to my coordonator of the project conf.dr.ing.Paul Patic, s.l.ing. Marin Mainea, prof. dr. ing. Minca Eugenia, conf. dr. ing. Dragomir Florin, conf. dr. Ing. Duţă Luminiţa for the support given for providing ideas and theoretic considerations.

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