Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 01, January -2018

Automatic Drone for Military Surveillance System

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Abstract — *Servo motors, Brushless D.C. motor, Bluetooth module and Arduino are used to design the Automated Drone. When given command to microcontroller by Bluetooth module, the microcontroller sends the PWM signal to motors to control the direction and speed of drone. In order to avoid obstacles ultrasonic sensors can be used. The path of drone can be adjusted such that it comes back to its original position.*

Keywords- *PWM (Pulse Width Modulation) Signal, Duty Cycle, BLDC (Brushless D.C.) motor, Servo motor, ESC/BEC (Electronic Speed Controller/Battery Eliminator Circuit), Li-Po(Lithium-ion Polymer) battery, UAV (Unmanned Aerial Vehicle), Drone.*

I. INTRODUCTION

While using an UAV, there might be threat that they might be hacked and can be misused. Also a considerable amount of power is used to control the UAV by wireless remote controller. These problems can be overcome if drones are controlled offline. The control signals can be generated on the controller placed on drone that drives the motors. First of all, a set of commands is loaded in the microcontroller Launchpad (Arduino Launchpad). These commands consist of series PWM signal generated at different pins for certain time intervals of particular duty cycle. This command can be given by Bluetooth module that is connected with the smartphone. These PWM signals are used to drive the motors used in the project. The path can be set such that drone comes to its original place i.e. comes to its master at the end of the path [1].

BLOCK DIAGRAM

The whole process of the working of the project can be divided into following parts so that it can be understood easily. The processes are explained below:

1.1. SELECTION PROCESS

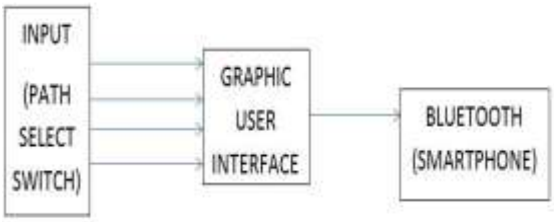

Figure 1. Selection process

The user with a smartphone enabled with Bluetooth has an android application installed on its operating system. The application has GUI (Graphical User Interface) that can be interfaced with the user. The application has 4 selection buttons that corresponds to a particular path of the drone [2].The next step is to transmit this data into the controller.

1.2. TRANSMISSION PROCESS

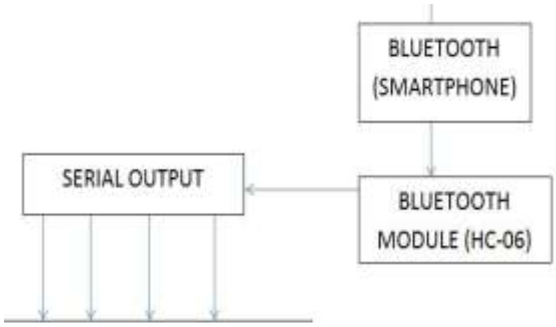

Figure 2. Transmission process

The Bluetooth enabled smartphone will transmit an ASCII code to receiver Bluetooth device. This ASCII code represents the selected button in the application. This ASCII code is then received in Bluetooth module (HC-06). This received code is then decoded in the microcontroller [3].

1.3. MICROCONTROLLER PROCESS

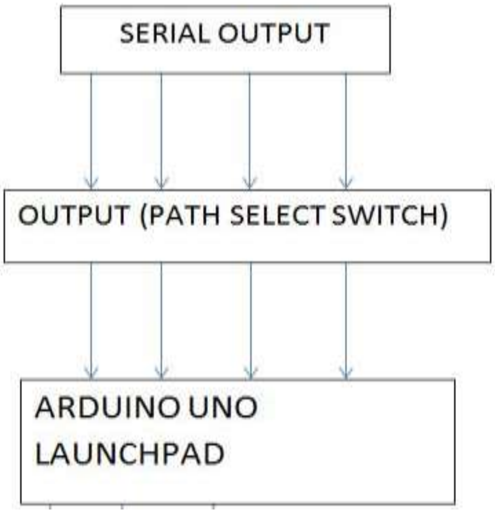

Figure 3. Microcontroller process

The received ASCII code is decoded in the microcontroller and converted into HEX code. This HEX code contains a series of PWM signal. These signals are then generated at the microcontroller pins. The microcontroller will interpret the selected path and will implement [4].

1.4. OUTPUT PROCESS

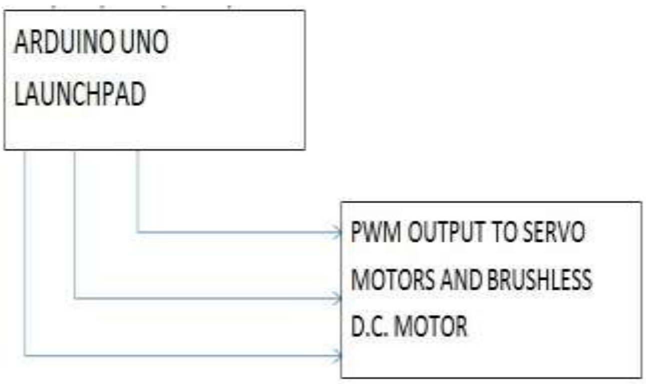

Figure 4. Output process

The microcontroller will perform the operation of generating a series of PWM signals at the respective pins of the servo motors and the BLDC motor. This in turn will drive the drone in the specific path. It is to be noted that the path is actually a series of PWM signals. This PWM signals are generated at the GPIO pins of the microcontroller at specific time intervals.

To understand this consider that the servo motors are there to control the direction of the drone and BLDC motor is there to provide the momentum to the drone. So there is need of three PWM signals generated simultaneously at a time. Thus we can interpret that to make the drone follow the path that is preloaded in the microcontroller memory we have to make a series of PWM signals of different duty cycle and specific "on time" to operate those motors.

The user has the smartphone with Bluetooth with him that has graphic user interface (GUI) supported application. The application has actually four GUI buttons that will represent the particular path of the drone. This is the data that will be transferred. The smart phone will connect the user to the drone via Bluetooth. This will provide him access to the Bluetooth module installed on the model drone. This Bluetooth module will send a serial data to the Arduino Launchpad. The Arduino will decode this serial data and sense that which button is pressed. Now after the button being sensed, the arduino will execute the set of commands that will drive the motors which in turn will drive the drone [5] [6].

II. COMPONENTS DESCRIPTION

Following components have been used in making of the project: Arduino Launchpad, Bluetooth module, BLDC motor, ESC/BEC, servo motor and Li-Po battery.

2.1. ARDUINO UNO LAUNCHPAD

Figure 5. Arduino Launchpad

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world.Arduino basically uses the Harvard architecture where the program code and program data have separate memory. It consists of two memories- Program memory and the data memory. The code is stored in the flash program memory, whereas the data is stored in the data memory. The Atmega328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the boot loader), 2 KB of SRAM and 1 KB of EEPROM and operates with a clock speed of 16MHz [7].

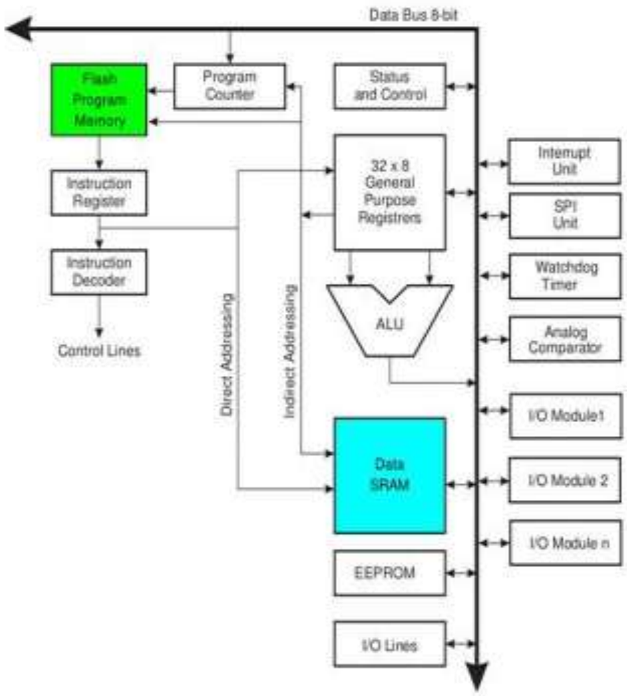

Figure 6. Arduino Architecture

2.2. BLUETOOTH MODULE

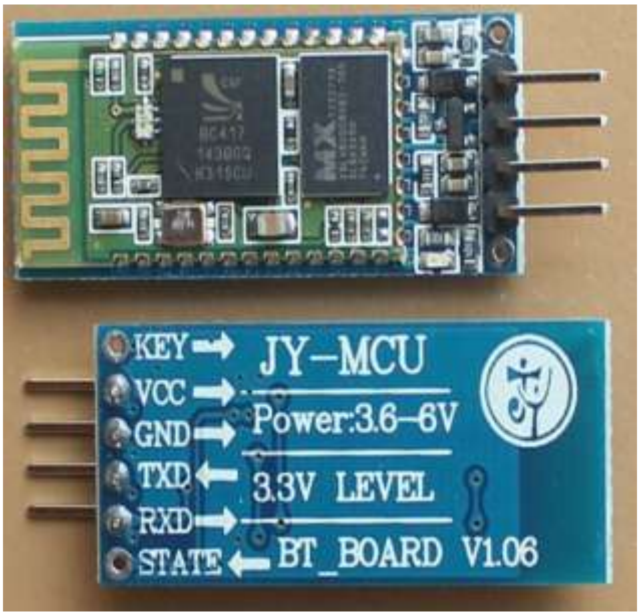

Figure 7. Bluetooth module

This Bluetooth module can easily achieve serial wireless data transmission. Its operating frequency is among the most popular 2.4GHz ISM frequency band (i.e. Industrial, scientific and medical). It adopts Bluetooth 2.0+EDR standard. In Bluetooth 2.0, signal transmit time of different devices stands at a 0.5 seconds interval so that the workload of Bluetooth chip can be reduced substantially and more sleeping time can be saved for Bluetooth. This module is set with serial interface, which is easy to use and simplifies the overall design/development cycle [8].

2.3. BRUSHLESS DC MOTOR

Figure 8. BLDC motor

Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors), or synchronous DC motors, are synchronous motors powered by DC electricity via an inverter or switching power supply which produces an AC electric current to drive each phase of the motor via a closed loop controller. The controller provides pulses of current to the motor windings that control the speed and torque of the motor. The structural element of a brushless motor system is typically similar to a permanent magnet synchronous motor, but can also be a switched reluctance motor, or an induction (asynchronous) motor. The advantages of a brushless motor over brushed motors are high power to weight ratio, high speed, and electronic control. Brushless motors find applications in such places as computer peripherals (disk drives, printers), hand-held power tools, and vehicles ranging from model aircraft to automobiles [9].

Figure 9. Internal structure of BLDC motor

A brushless DC motor is a permanent magnet synchronous electric motor which is driven by direct current (DC) electricity and it accomplishes electronically controlled commutation system (commutation is the process of producing rotational torque in the motor by changing phase currents through it at appropriate times) instead of a mechanically commutation system. BLDC motors are also referred as trapezoidal permanent magnet motors. Unlike conventional brushed type DC motor, wherein the brushes make the mechanical contact with commutator on the rotor so as to form an electric path between a DC electric source and rotor armature windings, BLDC motor employs electrical commutation with permanent magnet rotor and a stator with a sequence of coils. In this motor, permanent magnet (or field poles) rotates and current carrying conductors are fixed.

The armature coils are switched electronically by transistors or silicon controlled rectifiers at the correct rotor position in such a way that armature field is in space quadrature with the rotor field poles. Hence the force acting on the rotor causes it to rotate. Hall sensors or rotary encoders are most commonly used to sense the position of the rotor and are positioned around the stator. The rotor position feedback from the sensor helps to determine when to switch the armature current. This electronic commutation arrangement eliminates the commutator arrangement and brushes in a DC motor and hence more reliable and less noisy operation is achieved. Due to the absence of brushes BLDC motors are capable to run at high speeds. The efficiency of BLDC motors is typically 85 to 90 percent, whereas as brushed type DC motors are 75 to 80 percent efficient.

2.4. ESC/BEC

Figure 10. ESC/BEC

An electronic speed control or ESC is an electronic circuit with the purpose to vary an electric motor's speed, its direction and possibly also to act as a dynamic brake. ESCs are often used on electrically powered radio controlled models, with the variety most often used for brushless motors essentially providing an electronically generated three-phase electric power low voltage source of energy for the motor. An ESC can be a stand-alone unit which plugs into the receiver's throttle control channel or incorporated into the receiver itself, as is the case in most toy-grade R/C vehicles. Some R/C manufacturers that install proprietary hobby-grade electronics in their entry-level vehicles, vessels or aircraft use on-board electronics that combine the two on a single circuit board [11].

2.5. SERVO MOTOR

Figure 11. Servo Motor

A servomotor is a rotary actuator that allows for precise control of angular or position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively complicated controller, often a dedicated module designed specifically for use with servomotors.

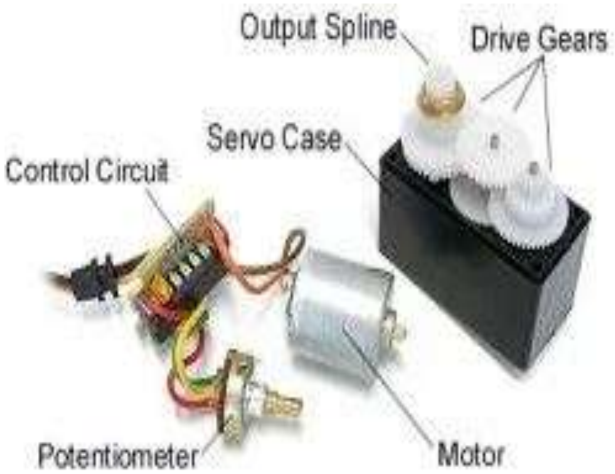

Figure 12. Internal structure of Servo motor

2.6. LIPO BATTERY

Figure 13. Li-Po battery

A Li-Po, is a rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid one. High conductivity semisolid (gel) polymers form this electrolyte. These batteries provide a higher specific energy than other lithium-battery types and are being used in applications, where weight is a critical feature - like tablet computers, cellular telephone handsets or radio-controlled aircraft.

A Li-Po cell has a nominal voltage of 3.7V. For the 7.4V battery above, that means that there are two cells in series (which means the voltage gets added together). This is sometimes why you will hear people talk about a "2S" battery pack - it means that there are 2 cells in Series. So a two-cell (2S) pack is 7.4V, a three-cell (3S) pack is 11.1V, and so on. The voltage of a battery pack is essentially going to determine how fast the vehicle is going to go [12].

III. INTERFACING OF COMPONENTS

For a system to work the above described components need to be interfaced with each other. Following is the explanation of how a component runs while the project is in its running state.

3.1. BLUETOOTH MODULE WITH ARDUINO

The Bluetooth module is set to the slave mode by programming it. The Bluetooth module receives the serial data from the transmitted mobile handset and simply makes a link between the arduino and mobile. The arduino then reads the data and further does the process described above [8].

3.2. SERVO MOTOR WITH ARDUINO

Servos are controlled by sending a PWM signal through the control wire from arduino. The servo motor is powered by a 5 volt source from the Launchpad. The arduino generates the PWM signal and sends to the servo motor. There is a minimum pulse, a maximum pulse, and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180° movement. The motor's neutral position is defined as the position where the servo has the same amount of potential rotation in the both the clockwise or counter-clockwise direction. The PWM sent to the motor determines position of the shaft, and based on the duration of the pulse sent via the control wire; the rotor will turn to the desired position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns. For example, a 1.5ms pulse will make the motor turn to the 90° position. Shorter than 1.5ms moves it in the counter clockwise direction toward the 0° position, and any longer than 1.5ms will turn the servo in a clockwise direction toward the 180° position. The respective rotation of the servo will bend the flaps of the drone so that it travels in the direction required [10].

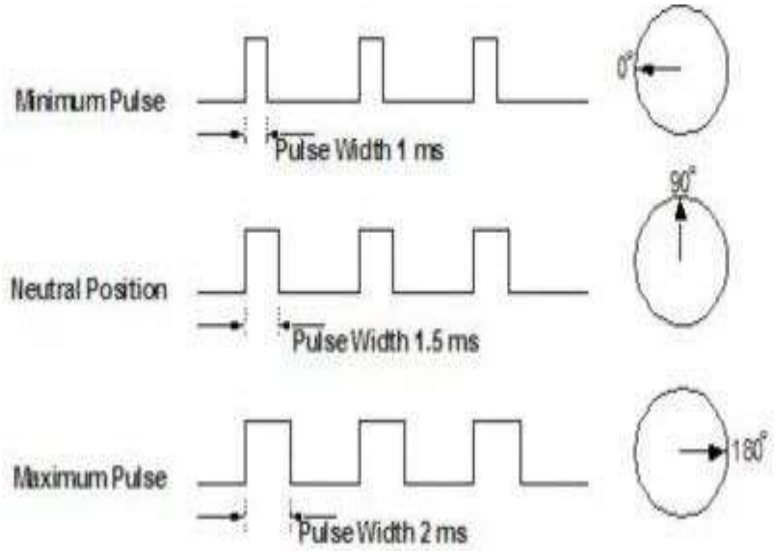

Figure 13. Effect on servo motor of PWM

3.3. ESC/BEC WITH ARDUINO AND BATTERY

ESC is an electronic motor controller which controls the speed, direction and possibly braking of a motor. This term is typically used in the radio control (RC) world, but may also appear when discussing Brushless DC motor controllers. In the Electric Car Conversion world, the term ESC is rarely used.

BEC stands for Battery Eliminator Circuit. In Radio Control (RC) contexts, the BEC is extra circuitry on the ESC to provide power to the controls (such as steering, servos, receivers) to the controlled vehicle (e.g. airplane, car, helicopter and boat) so that this control circuitry does not need to carry its own battery pack. That is, it piggy backs of the battery pack used to drive the motors of the vehicle or in other words, the motor and servos share the same battery pack. In motorcycle / ATV contexts (which use Internal Combustion Engines), BECs are sometimes used so that a battery is not required. Instead, it relies on the alternator to generate the required electricity and the BEC is used to regulate the electrical power which will be used for electrical items on the motorcycle /ATV such as lights, horn etc. If there is no battery, there is no electric starter on these machines [11].

In this project the ESC provides the power the brushless motor and the BEC provides power to the arduino, Bluetooth module and servos to work. The battery here provides a voltage of 11.1 volts on an average. Regulated 5 volts are extracted from this source by BEC for components other than the brushless motor to work.

3.4. BRUSHLESS DC MOTOR WITH ESC

These ESCs need a command to work. Most of the ESCs need a 50Hz frequency i.e. a 20 ms cycle and the speed depends upon the duty cycle you provide. 1ms will reduce its speed to minimum or even stop it (it depend upon the ESC model) while a 2ms pulse will run the motor on its full speed. The values between them give a variation in speed.

Here, MOSFET Transistor is used as a switch instead of a mechanical device and the amount at which it is switched is about 2000 times a second. So, the power to the motor is diverse by changing the amount of ON time, against off time in a specified cycle. Here is the simple ESC circuit with waveform diagram may help with the description.

When the MOSFET is switched ON, the current rises up as the magnetic field in the windings of the motor increases. When the MOSFET is switched OFF, magnetic energy stored in the windings has to be absorbed by the ESC. By cabling a diode across the motor, we return the energy back into the motor as current, which rises down as the magnetic field failures [12].

Voltage directly influences the RPM of the electric motor (brushless motors are rated by kV, which means 'RPM per Volt'). So if there is a brushless motor with a rating of 3,500kV, that motor will spin 3,500 RPM for every volt applied to it. On a 2S Li-Po battery, that motor will spin around 25,900 RPM. On a 3S, it will spin at 38,850 RPM. So the more voltage applied, higher the RPM achieved [13].

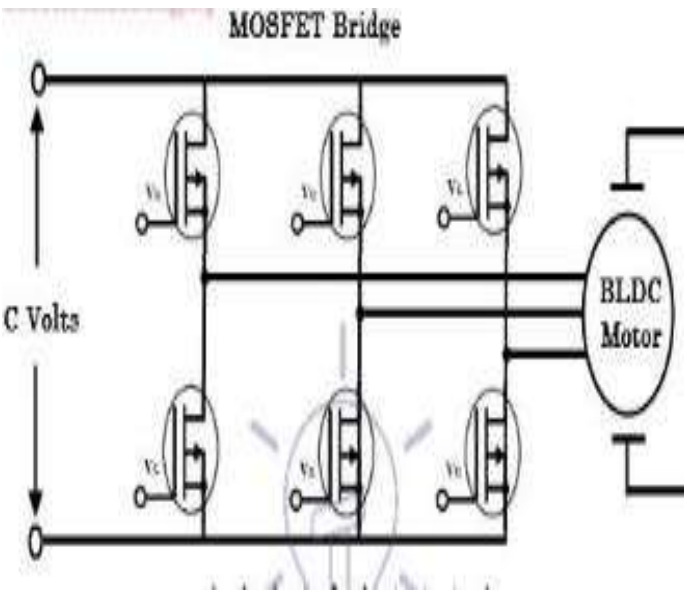

Figure 14. Connection of ESC with BLDC

IV. CONCLUSION

The project can be mainly used for military applications for surveillance purpose. The problem of hacking of drones is solved. Places like borders can be prone to such hackings; hence if there is no signal to transmit, they cannot be duplicated to control the drone. There is always a fear of unknown factor intentionally or unintentionally trying to be an obstacle in the way. Same problem can occur here also. A flying drone may come across any obstacle in the sky like birds or electric wires. We thought of a possible solution for this and came to conclusion of using ultrasonic sensors. This ultrasonic sensor can be interfaced with the microcontroller. When the obstacle comes in the way of drone the sensors will detect it and send a signal to the microcontroller and the rest is in the hand of controller. The microcontroller can be programed such that it controls the motors such that drone avoids the obstacle and safely passes it and continues on it journey on its original path.

REFERENCES

[1] Shreyas S Hegde, Sandeep Nayak, Kishan R, Narayan Chavan, "A Systematic Approach for Designing, Analyzing and Building a Model RC Plane", Department of Mechanical Engineering NITK Surathkal, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181, Vol. 3 Issue 12, December-2014

[2] Omkar Bhosle, Rohit Varpe, Mahesh Pula, "Radio Controlled Airplane", Department of Electronics & Telecommunication Engineering, M.H. Saboo Siddik College of Engineering Mumbai University, India IJSRD - International Journal for Scientific Research & Development Vol. 3, Issue 02, 2015

[3] J. J. Lugo and A. Zell, Frame- work for Autonomous On-board Navigation with the AR.Drone, Journal of Intelligent & Robotic Systems, vol. 73, Issue 1-4, pp. 401-412, 2014.

[4] E. Pall, K. Mathe, L. Tamas and L. Buşoniu, Railway Track Following with the AR.Drone Using Vanishing Point Detection, IEEE International Conference on Automation, Quality and Testing, Robotics (AQTR), 2014.

[5] R. D'Andrea, ''Guest editorial can drones deliver?'' IEEE Trans. Autom. Sci. Eng., vol. 11, no. 3, Jul. 2014.

[6] L. Gupta R. Jain G. Vaszkun "Survey of important issues in UAV communication networks" IEEE Commun. Surv. Tutorials vol. 18 no. 2 2016.

[7] https://en.wikipedia.org/wiki/Arduino
[8] https://wiki.eprolabs.com/index.php?title=Bluetooth_Module_HC-05
[9] http://electronics.howstuffworks.com/brushless-motor.htm
[10] https://www.jameco.com/jameco/workshop/howitworks/how-servo-motors-work.html
[11] https://www.elprocus.com/electronic-speed-control-esc-working-applications/
[12] https://www.elprocus.com/electronic-speed-control-esc-working-applications/
[13] https://rogershobbycenter.com/lipoguide/

