International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 9, September 2016)

Surveillance Flying Robot

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Abstract— **Unmanned Aerial Vehicles (UAVs) are widely used in for search and rescue operation where human cannot go (2). UAVs are used because of their ability to operate in dangerous locations while keeping their human operators at a safe distance. Flying platform with improved in weight lifting capacity to add a more function in account of UAVs. For this project, we considered many different structures of UAVs. Developed quadcopter can hover while maintain it balancing and the stability is guaranteed. Quadcopter is a typical design for small unmanned aerial vehicles (UAV) because of the simple structure.**

Keywords—**UAV, PID, Quadcopter, Robot.**

I. Introduction

UAV is an autonomous aerial vehicle with the ability to fly independently of an operator all while relaying real-time information to a base. The developed UAV is self-sufficient to hover in air, maintain balance, send video to base station and can be controlled by base station. UAV consists of light weight carbon fiber frame with four motors attached with each arm of quadcopter.

Power to the motor and flight controller is provided by lithium polymer battery and four motors that receive power from battery through electronic motor controllers that allow communication with the microcontroller, current provided to motor is control by PWM signal generated by microcontroller which will in turn control the speed of each individual motor. Roll,pitch,yaw of qudcopter is controlled by controlling the speed of motors by simply changing PWM signal width(1). Accelerometer and gyro sensor is used to control quadcopter stability and the use of these sensors allows us to maintain stability in constantly changing atmospheric conditions by setting PID gain for each axis. Develop system is powered by a high capacity lithium polymer battery capable to provide 15 Min flight time, allowing for sustained flights and adequate power supplied to the system at all times. Developed system, with all of its parts creates a stable and flexible platform for search and rescue operation.

II. Hardware Description

Power has been divided into two separate parts: the motors and the main components for operation and control.

A. Motors

The majority of the required power needed to be drawn is consumed by the motors, directly connect the lithium polymer (LiPo) batteries to the motors. Since the biggest concerns regarding the LiPo batteries are mass and cost, the best route to minimize both of these issues was to select either one very large battery or two smaller ones. The 3-cell 25C, 11.1V, 3300mAH are an excellent source in terms of mass, balance, and charge capacitance. The batteries will be directly connected to the ESC, which are rated at 30A per ESC.

B. Accelerometer Sensors

Image.3.1. Accelerometer module

This is a Tri axis accelerometer board with Freescale's MMA7361L three-axis analog accelerometer with onboard low dropout linear voltage regulator and all required components as per datasheet. The sensor requires a very low amount of power and has a g-select input which switches the accelerometer between ±1.5g and ±6g measurement ranges. Other features include a sleep mode; signal conditioning, a 1-pole low pass filter, temperature compensation, self test, and 0g-detect which detects linear freefall. Zero-g offset and sensitivity are factory set and require no external devices.

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Pin diagram:

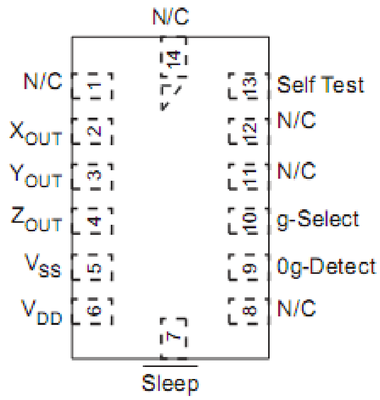

Figure.3.3 pin diagram of accelerometer

C. Gyro sensor IDG500

Image.3.2. Gyro breakout board

It includes an on board 2.8V regulator and all pins broken out to 0.1" pin holes. The IDG-500 is a very small, dual-axis angular rate sensor (gyroscope). It uses InvenSense's proprietary and patented MEMS technology with vertically driven, vibrating masses to make a functionally complete, low-cost, dual-axis angular rate sensor. All required electronics are integrated onto a single chip with the sensor.

Figure.3.4. Axis of gyro

This is a dual-axis rate sensing device. It produces a positive output voltage for rotation about the X- or Y-axis, as shown in the figure above.

Pin diagram:

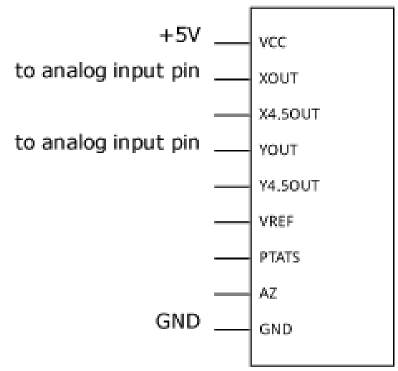

Figure.3.5 pin diagram of gyro

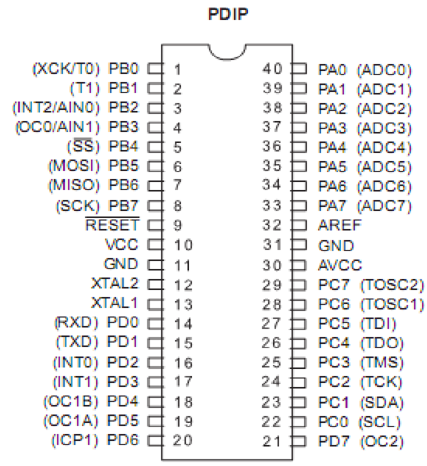

Figure.3.7 pin diagram of ATmega16

D. Motors

We are using brushless DC out runner motors. Its rating is 1500Kv.

Image.3.4. bldc motor

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This sturdy 1500kv BLDC gives maximum thrust of 1200gms and weights only 78gms. It has pretty good electrical efficiency because of its precision built and high quality parts. It is best suited for larger size quadcopter. Its rotor shaft is made up of hardened steel and supported by sealed dual bearings. It comes with propeller mount with 6mm diameter. You can fit most of the propellers. Motor has sturdy construction and has sealed dual ball bearings for smooth operation. This motor can be run by 2 to 4 cell lithium polymer batteries.

Specifications:

- Outrunner Brushless DC Motor
- Dual sealed ball bearings
- Weight: 78gms including motor mount and propeller adaptor
- KV: 1500 RPM/V
- Thrust: 1200gms max. with matched propellers
- Voltage: 7V to 16.8V
- Current: 18Amp continuous, 20Amp max.

E. BLDC ESC

Image.3.5. bldc ESC

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.

F. Xbee

Image.3.6. Xbee

Specifications:

- Serial data interface:3.3V CMOS UART
- Configuration method: API or AT commands, local or over-the-air
- Frequency band: 2.4 GHz
- Interference immunity: DSSS (Direct Sequence Spread Spectrum) channels
- Serial data rate:1200 - 250000 bps
- (6) 10-bit ADC inputs,
- (8) Digital I/O

G. Wireless camera

Mobile Camera is used to shoot video using WIFI.

III. SOFTWARE DESCRIPTION

The software will be responsible for controlling all aspect of the Quad-Copter. These include the action perception loop, polling of the sensors, and controlling movement. The code is written in the C programming language, using the AVR Studio IDE.

1. Action-Perception Loop

The action-perception loop is the main loop in the software. This loop will run continuously, acting on sensor perceived sensor data. The software needs to keep track of the time it takes to run the action-perception loop for sensor data calculations. A minimum of 50 Hz must be maintained in order to keep flight.

2. Polling of Sensors

The sensors are polled using the internal ADC of the MCU. The ADC has a resolution of 10 bits. The sensors are continuously polled at a rate of 250 KHz. This is done because the MCU can perform more accurate conversions at this speed.

3. Control Movement

The software for movement control consists of a sensor fusion algorithm, and a PID loop. The sensor fusion algorithm is responsible for taking the accelerometer and gyroscope sensor readings, and combining them into a better estimated angle. This algorithm takes the force projection vector of the accelerometer and relates it to the gyroscope instantaneous velocity. It does this by projecting the X or Y component of the force vector onto the Z plane. The gyroscope measures the speed of the angle between the projection and the Z axis. Through this the algorithm can produce a better estimate of the force vector, which can then be used to calculate the angle position of the Quad-Copter. This estimated angle is then run through a PID loop(8). The PID will produce the adjustment of the motor needed to correct the position of the Quad-Copter.

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CODE DESCRIPTION:

Figures with motor directions and speed to obtain different motions of quadcopter are shown as below.

Fig1. Upward motion

Fig2. Downward motion

Fig3. Rotate Clockwise

Fig4. Rotate Anti-Clockwise

Fig5. Move towards low speed motors

Fig6. Move towards low speed motors

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Fig7. Pitch Forward

Fig8. Pitch Backward

Algorithm

Step 1:

- Setup
    a) Initialize timer
    b) Set top
    c) Initialize serial
    d) Enable interrupt
- Initialize ADC

Step 2: loop forever

- Stabilize the system
    1. Measure the current values of accelerometer and gyro.
    2. Calculate the combined value by taking average of current accelerometer and gyro values.
    3. Generate an error by subtracting the current reference value with the combined values.
    4. Control the speed of motors using PID algorithm.
- If interrupt occurs enter the interrupt service routine

Step 3: Interrupt Service Routine

- Data received

1. ***If data received is yaw negative***

   Decrement speed of motor 1 and motor 4

   Increment speed of motor 2 and 3

2. ***If data received is yaw positive***

   Increment speed of motor 1 and motor 4

   Decrement speed of motor 2 and 3

3. ***If received data is pitch forward***

   Decrement speed of motor 1 and motor 2

   Increment speed of motor 3 and 4

4. ***If received data is pitch backward***

   Increment speed of motor 1 and motor 2

   Decrement speed of motor 3 and 4

5. ***If received data is negative roll***

   Increment speed of motor 1 and motor 3

   Decrement speed of motor 2 and 4

6. ***If received data is positive roll***

   Increment speed of motor 2 and motor 4

   Decrement speed of motor 1 and 3

IV. FUTURE SCOPE

- We can attach a robotic arm with high torque motors to convert it to pick and place robot.
- A swarm of this robots can be used which will communicate with each other and carry out the given task.

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V. CONCLUSION

Developed quad-Copter used simplified algorithm with PID setting and this can carry 1 kg weight with 15 minute flight time. For PID gain setting platform developed, Platform made gain setting much easy. This developed platform used Mobile camera to shoot video for search and rescue operation.

Acknowledgment

It is a great pleasure and moment of immense satisfaction for us to express sense of gratitude to our all faculty of KVN Naik College, Nashik, and Maharashtra, who encouraged, inspired and guided us for accomplishing this task.

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