SURVEILLANCE AND ESTIMATION OF THE CROP USING QUADCOPTER

Britto Martin Paul N, Rajendra Prasad K, Srikanth M

Abstract— Quadcopter plays a vital role in surveillance, monitoring and estimation of a crop or a particular area where human access is limited by the terrain contour of the area which is to be monitored. The response of the Quadcopter to the control input is very much essential in case of emergency situations. The flight control board on which it is designed plays a vital role in the response time of the Quadcopter [2] drone. Capabilities of the drone increases with the incorporation of power-packed processors running at higher mega hertz so that all the channels of the transmitter can be decoded by a single timer instead of multiple channels for decoding. In this paper, we present a new Unmanned Aerial Vehicle Drone, called as Quadcopter, based on ARM processor board. For the purpose of on board processing and for current location of the Quad, MPU 6050[6] sensor is incorporated. This Quadcopter[2] will consume less power so that the Flight time of the Drone will increase greatly. The fusion of accelerometer and gyroscope data will deliver accurate position of the Drone. Proportional, Integral and Derivative (PID)[3] control algorithm is implemented for stabilization of the Quadcopter. The drone can be operated even at the night time for emergency operations. Our experimental result shows Quadcopter[2] is highly stable during its flight time and responses are very fast for the user input.

Index Terms— Quadcopter, MPU6050 Sensor, PID.

1 INTRODUCTION

Quadcopters are Un-manned aerial vehicles (UAV). These are important nowadays for many applications and experimental activities. These UAV's are business leading systems, designed by us for many applications like 3-D modeling[1], volumetric analysis, mining, precision agriculture, surveying etc. Actually these drones are classified into 2 types, they are fixed wing and rotary wing, again this rotary wing is classified into 2 types, and they are single rotor and multi-rotor. The merits and the demerits of different drone types are described in the table below. The quad-copter control comes from the variations in the torque from the motors and thrust. The main advantage of this quad-rotor is vertical[1] takeoff and landing.

S. No	Types	Merits	Demerits
1	Fixed wing[1]	Long life time, large coverage area	Expensive, large space is required for take-off.
2	Single wing	Vertical take-off, heavy payload capacity[1].	More dangerous, harder to fly.
3	Multiple wing[1]	Easy to use, good control on camera	Short flight time.

Table1. Merits and demerits between types of UAV's

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2 LITERATURE SURVEY:

2.1 Review Stage

Quadcopters are very popular for monitoring, package delivery, search-and-rescue missions, target tracking, and various other applications. Alex Waller [12] PARCov (Planner for Autonomous Risk-sensitive Coverage) This paper propose the system for surveillance purpose of risk sensitive areas using a team of unmanned aerial vehicles (UAVs), which keeps the track of the areas that are already surveyed and time of the previous survey. PARCov is used for detection of risk by using quad copter in risk sensitive area which are under its coverage. It is able to cover more area and provide continuous surveillance. A nonlinear optimization formulation is also used in this paper to determine the optimal altitude for quadcopter flying with maximized data sensor quality and minimizing risk.

Miguel Torres-Torriti [13] paper HRI is introduced i.e. Human Robot Interaction, because of lack of human labour there is need to introduce as well as developed automation and sensing technologies for all tasks like harvesting, seeding, grove supervision etc. Fully Robotized farm are not yet possible therefore human labours are also needed to handle the robot or for the autonomous farming. In this paper they summarized the state of art of human robot interaction in agricultural field. There are guidelines and strategies for designing a human device/robot interaction in agricultural field.

3 SYSTEM IMPLEMENTATION:

3.1 Sensor Interfacing

We are using arm cortex m3 processor and mpu6050 sensor for accelerometer and gyroscope readings. The interfacing is done by using i2c communication protocol .This mpu6050[6]

sensor supports only i2c communication protocol. I2C operates in four different modes i.e., master transmit, master receive, slave transmit, slave receive. The datasheets of both the sensor and the microcontroller gives detailed information about how to establish communication. The sequence is shown in the below table.

Master	S	AD+W		RA		S	AD+R			ACK		NACK	P
Slave			ACK		ACK			ACK	DATA		DATA		

Table2 Processor and Sensor communication sequence.

The steps for interfacing the sensor is given below: (write mode)–
In case 08[7]: we are writing the start bit and device address with read/write bit.
In case 18: we are writing the sensor register address (from which register we want to get the data).
In case 28[7]: we are setting the bits in the register of the sensor.
In read mode also the first three cases is common for both write and read.
1. In case 10[7]: we are writing the device address along with either read/write bits.
2 In case 40: we are setting the acknowledgement bit and in this case we are getting data from the sensor.
3. In case 50[7]: we are reading the sensor data into a variable.
4. In case 58: In this case first we are setting the stop condition and then setting the start condition..
5. In case 48[7]: In this case we are setting the stop condition.

3.2 PID Controller Algorithm:

PID controller is for the stability of the quad-rotor, it calculates the error of proportional and integral and derivative. It measures the difference between the set point and the measured variable. The two inputs for the PID[3] controller is set-point and the measured value.

Set-point: Actually the RC transmitter [8] receiver generates the four PWM signals, one for the motor start and the remaining are roll, pitch and yaw. The PWM signals are given as input to the motors for controlling the speed of the motor. Here the PWM signal generation is 50 hertz and pulse width on time is 1-2 milliseconds. So that we need to capture the signal of that period, there are four timers in the lpc1343 board we used each timer for one signal capturing. The capture values are in milliseconds, we need to convert these milliseconds into degrees per second. This is done by using mathematical calculation formula and that should be written in the code format.

Motor driving: After PID controller the PID[3] output is given to the motor drivers, in this motor driver we need to generate PWM signals for motor driving, by using timers we can generate PWM signals.

Measured values: We need sensor values from the gyroscope registers and those values should be converted into the degrees per second.

4 Hardware Description:

Arm cortex M3 (Lpc1343): Lpc1343[7] is an ARM 32 bit cortex m3 micro-controller, CPU clock frequency is 72 MHZ, 32kb on chip flash ROM with in-system programming (ISP) and in-application programming (IAP),8kb SRAM, usb2.0 full speed device controller, NVIC, AHB matrix, APB, UART with full modem interface and support of rs-485,ssp,i2c and 10-bit ADC with 8 channels, four timers with capture/compare, watchdog timer, system tick timer, power on reset, PMU, crystal oscillator,12 MHZ internal RC oscillator, PLL, JTAG and serial wire debug/trace port , up to 42 general purpose i/o pins.

MPU6050 sensor: The MPU6050[6] parts are the world's first motion tracking chip designed for the lower power, cost, and high performance requirements. The MPU6050[6] sensor combines a 3-axis gyroscope and a 3-axis accelerometer on the same silicon die together with an onboard digital motion processor which processes complex 6-axis motion fusion algorithms. The device can access external magnetometers or other sensors through an auxiliary mask i2c bus, allowing the device to gather a full set of data without intervention from the system processor.

ESC: ESC[4] supplies power from battery but not supplied stably, it varies according to input signal. ESC also has BEC (Battery Eliminated Circuit). BEC is nothing but 5V output from ESC that can power up receiver, servo-motor and Flight controller.

Specifications:

Output: Continuous 30A, burst 35A up to 10 seconds.

Input Voltage: 2-4 cells lithium battery or 5-12 cells NIMH battery.

BEC[4]: 5V, 2Amp for external receiver and servos.

Max Speed: 2 Pole: 210,000rpm; 6 Pole: 70,000rpm; 12 Pole: 35,000rpm

Weight: 22gms

Size: 47mm x 27mm x 12mm.

Propellers: A Propeller[4] is a type of fan which converts rotational motion into thrust and transmit the generated power. These propellers shapes are different according to the clockwise and the counter clockwise rotations. The material used for the propellers are carbon fiber[4] and wooden propellers.

Li-Po batteries: To select best battery for our quad-rotor we need to consider three things, the number of cells battery consists and the battery capacity and the discharge rate. Max continuous Amp draw (A) = Battery capacity (Ah) x Discharge rate (C).

Power distribution board: In Quad-rotor and multi-rotor design this PDB's are essential because ,we need to provide battery supply to the four ESC's separately, but the battery has only one supply and neutral , so that the battery supply and neutral is connected to the PDB and from there separately supply and neutral is connected to ESC's[4] individually. These PDB's are generally two types, PDB board available separately and the other is within the frame this PDB will come.

BLDC:

Specifications: KV (rpm/v): 1300

Max Power: 190W

Max Thrust: 920 grams

Battery: 2S-4S Li-Po.

Weight: 53 grams.

A BLDC[5] motors is a type which is most suitable for applications that require high reliability, high efficiency, more torque per weight. Brushes require frequent replacement due to mechanical wear; hence, a brushed DC motor requires periodic

maintenance. Also, as brushes transfer current to the commutator, sparking occurs. Brushes limit the maximum speed and number of poles the armature can have. These all drawbacks are removed in a brushless DC motor.

Advantages of BLDC motor over brushed motors are: Increased efficiency, reliability, longer lifetime, no sparking and less noise, more torque per weight.

Advantages of BLDC motor: It has no mechanical commutator and associated problems, High efficiency[5] due to the use of permanent magnet rotor, Long life as no inspection and maintenance is required for commutator system, less electromagnetic interference.

RC Transmitter[8] and Receiver:

Features:

Channels: 6 Channels
Model Type: Heli, Airplane, Glid
RF Power: Less than 20db
Modulation: GFSK
Code Type: 2.4 GHZ No Interference
Sensitivity: 1024
Low Voltage Warning: LED
DSC Port: Yes
Charger Port: Yes.

Radio control is the use of radio signals to remotely control a device. Radio control is used for controlling the model vehicles from a hand held radio transmitter. The transmitter[5] requires a pc to modify any of the channel variables, including mixing and servo reversing.

Frame: Materials[4] used for frame are carbon fiber, Titanium, Aluminum, Fiber Glass, steel, poly-carbonate, Acrylic, Balsa Wood.

As demonstrated in this document, the numbering for sections upper case Arabic numerals, then upper case Arabic numerals, separated by periods. Initial paragraphs after the section title are not indented. Only the initial, introductory paragraph has a drop cap.

4 Software Requirements:

Kiel Software: Kiel [9] implemented the first C compiler designed from the ground-up specifically for the 8051 microcontroller. The software coding is written in embedded c coding and we can compile it for error checking. Some of the features like waveform analyzers are there for simulation analysis, we can dump the code by entering the some commands.

T6CONFIG: It is software used to test the transmitter working properly or not .By purchasing the transmitter, the CD-having software is given and installs it and a cable is given and connects USB Port[9] to laptop and other end to the transmitter and after setting we can test the transmitter performance.

Eagle: Eagle stands for Easily Applicable Graphical layout **Editor**. It has a schematic editor for designing circuit diagrams. It also has PCB[9] layout editor which allows back annotation to the schematic circuit diagram. Auto-routing option is also available, which automatically routes the traces according to the connections defined in the schematic diagram.

6 Experimental Results:

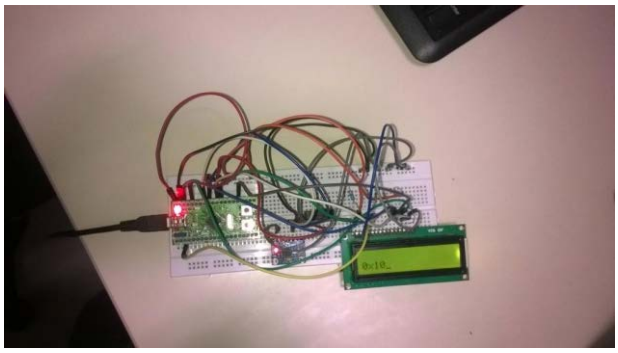

Fig 2. ARM board with MpU6050 sensor with LCD display.

Fig3. 4 PWM capture readings.

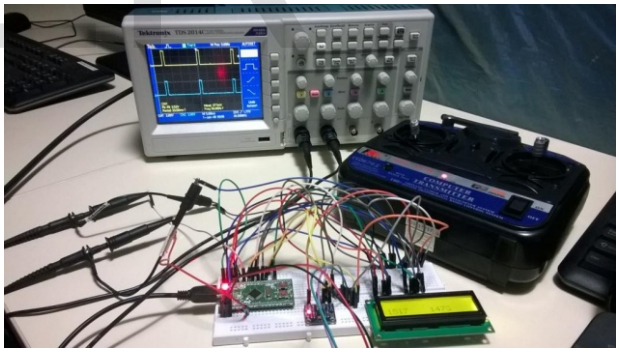

Fig4. PWM signal generation.

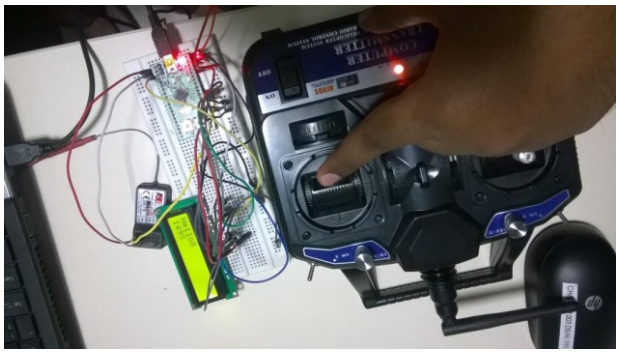

Fig.5 .Sensor gyroscope values.

Fig.6. Quad-copter in Surveillance mode.

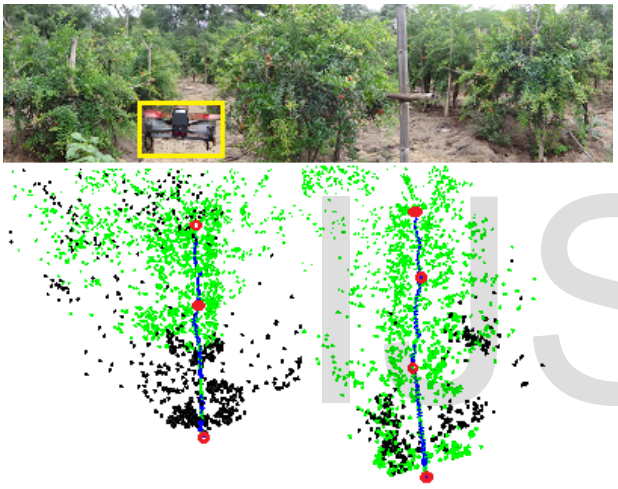

Fig.7.Estimating the Crop.

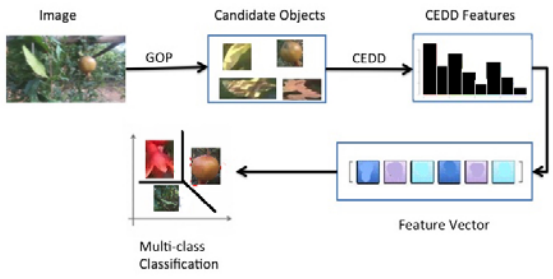

Fig.8. Process Flow of Crop Estimation

7 Future Work

In this project I have dealt mainly with Surveillance and monitoring of the crop. There are some limitations of this project: (i) The battery backup is very limited and so only for an hour the system works perfectly with all the required expectations. (ii) The peripherals that could be attached to the ARM flight controller are quite limited. (iii) The stability of the system is a challenge in itself especially in the harsh environmental conditions and it is yet to be tested in these conditions.

The future work in this regard will be as follows: (i) Installing and interfacing Solar Panels onto the board so as to get the battery backup 24x7. The weight and the stability will be the challenge to be faced. (ii) Instead of the ARM flight controller I will be using the Zed board which is a combination of FPGA and ARM controller. Many more peripherals could be added upon the board and much more dynamics could be visualized through Quadcopters. (iii) The harsh conditions wherein the human life has got a threat to venture is a challenge in itself. The motor capacity and the self-adjustment it makes to the conditions in the fraction of seconds play a vital role.

8 Conclusion

In this paper, I have discussed about the Quad copter with ARM flight controller which is mainly used for surveillance and monitoring of the crop. I have dealt with the work so far done in this regard. I have given the system implementation with all the sensor interfacing and Algorithm. I have also dealt with the Hardware and Software requirements of the project. I have also given the experimental results that are very crucial in the project. In this regard I have also discussed the future work in progress as well as the challenges being faced in the current progress of the work.

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