Environment monitoring sensor system design based on aircraft

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Abstract: In order to do real-time monitoring disaster prediction and life detection of flammable and explosive, high risk and highly pressure goods in the factory etc. Combination wireless sensor network node with temperature, humidity ,combustible gas concentration sensor ,using four rotor aircraft as a carrier of the monitoring sensor node to the designed region ,using decorated wireless sensor network node Zigbee form local area monitoring network by ad-hoc network. The system can not only transmit the sensor node monitoring data to the ground station by the network, but also can use the upper computer to analysis the data.

Introduction

Aircraft as a kind of intelligence robot in environmental monitoring ,security ,detection, and other fields has been widely used. With the gradual development of Micro Electrical-Mechanical System (MEMS) ,sensor network and molding technology, wireless sensor network with four axis aircraft apply to the field of environmental monitoring, not only can take advantage of the wireless network dynamic characteristics and ad-hot network, it can also use the performance of the vehicle lightweight flexible to strain various sudden emergencies, realize the performance of supervisory control and data real-time transmission.

Organization of the Text

Four axis aircraft. Four axis vehicles cross shaped ,in four endpoints were fixed with four propeller that the performance is exactly the same ,motor rotation provide enough lift to aircraft .At the same time ,the propeller adopt the design of the positive and negative propeller support to offset the torque of propeller rotation.

  Working principle. In four axis aircraft ,it is equipped with three axis accelerometer and gyroscope sensor ,they are consisting of inertial navigation module .It is can calculate the attitude as well as the acceleration ,velocity of aircraft relative to the ground at this time. Flight controllers through algorithm calculating the rotation of the force which is to keep the motion state and lift ,through appropriate power to ensure that the motor output. There are two ways for Aircraft fly is shown in Fig.1,six degrees of freedom(change of six direction) is shown in Fig.2,four control input(four motor). So ,the flight attitude is decided by the speed of four propeller ,they can realize aircraft pitch ,roll and yaw ,six direction control together.
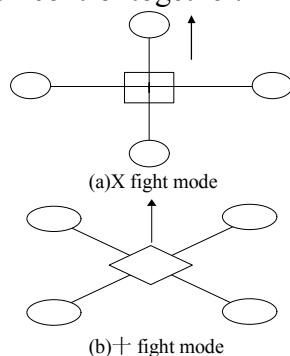

(a)X fight mode

(b)十 fight mode

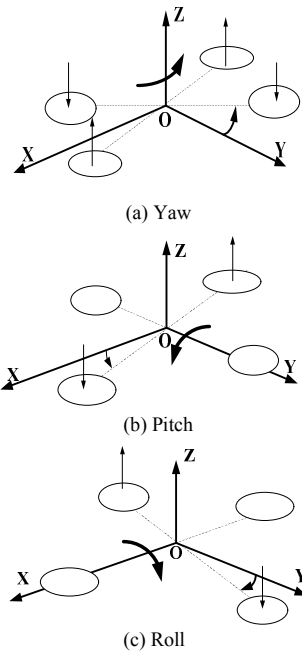Fig.1 The way of flight

(a) Yaw

(b) Pitch

(c) Roll

Fig.2 Flight attitude

System structure. To make four axis aircraft flying stability ,the aircraft hardware has three section is shown in Fig. 3, mainly include master chip, gesture detection module , drive module and other major component. In each program :(1)using the high performance, low price and power consumption STM32F103RCT6 32-bit SCM system as the core; (2)using the higher integration of mpu6050 (three-axis gyroscope + three-axial acceleration) measuring aircraft Angle and angle velocity changes on the X,Y,Z axis; (3)using the quaternion , the direction cosine matrix, Euler angles describe the body posture; (4)through the PID(proportion, integral, differential) control algorithm processing spacecraft attitude error and drive motor to maintain vehicle stability; (5)using the power triode SI2302 hollow cup motor to provide enough lift and change the aircraft flight attitude.Effect of flight is shown in Fig.4.
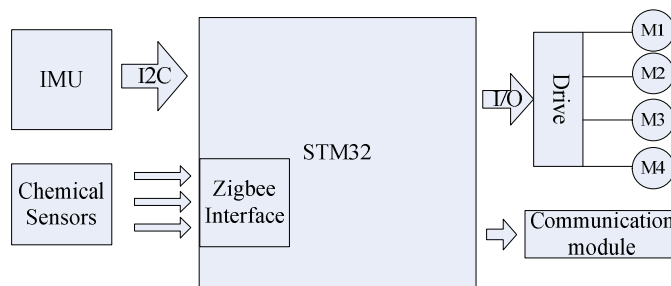

Fig.3 Flight control system hardware connection

Fig.4 Aircraft flying object

Monitoring network. Using Zigbee technology to monitor all sensor nodes in networking area .This scheme worked in the IAR EW8051 software integrated development environment ,it is based on TI/Chipcon company of Zigbee2006 protocol stack development free of charge.TI Z-Stack protocol stack is based on a rotation query type operating system.The main protocol stack process is shown in Fig.5.
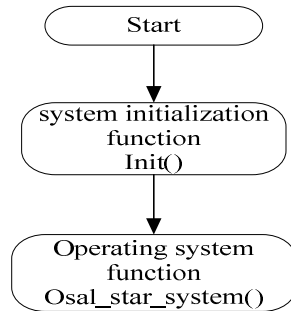
Fig.5 Protocol stack process

Data delivery. In the process of Zigbee network,throughing the coordinator network sent command. After the success of the networking,periodic send data function be called to send sensor data .

In the system networking,the coordinator send address by broadcase ways,each node in the network begin to monitor and choose to join this network. After the success of the nodes join the network,they will get IDs which is distribed by coordinator.All networking process is shown in Fig.6. Among of them,the coordinator send the address and the frame structure of address is : the device address low 8 and high 8 bit device address.
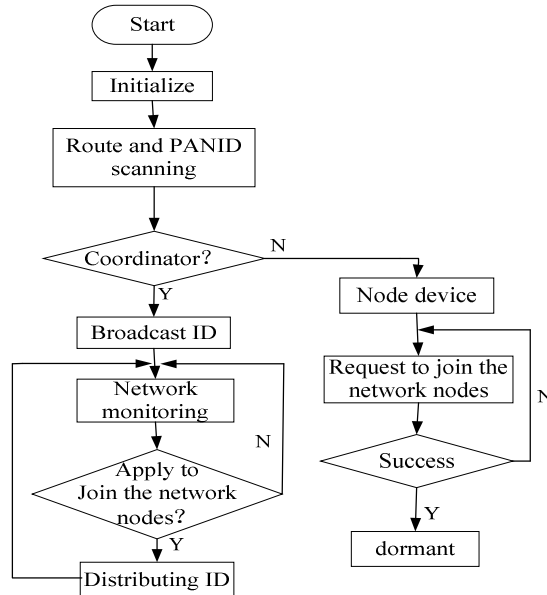

Fig.6 Zigbee Networking process

After each node be assigned address by coordinator includeing aircraft carrying node,each nodes can be targeted for data transmission. As is shown in Fig.7,Zigbee nodes that on the Aircraft can col lect sensor data after the ADC sampling, then operating system Osal invokes the periodic send funct ion SampleApp_SendPeriodicMessage to send.
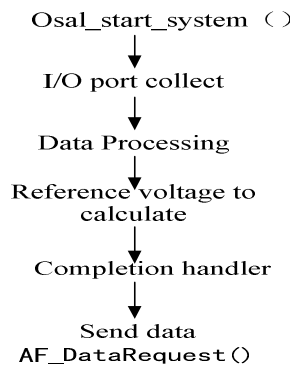

Fig.7 Sensor data sending process

Data reception. On aircraft Zigbee nodes, it has received the temperature ,humidity,carbon dioxide density data.Each node could through this network transmission data to coordinator and the data will be send to upper computer after coordinator received the data.

In the scheme,the common gas monitoring are using TN901,HR202,MQ-2 sensors.Three kinds of sensor integration module through the figure interface connected with Zigbee nodes I/O is shown in Fig.8.
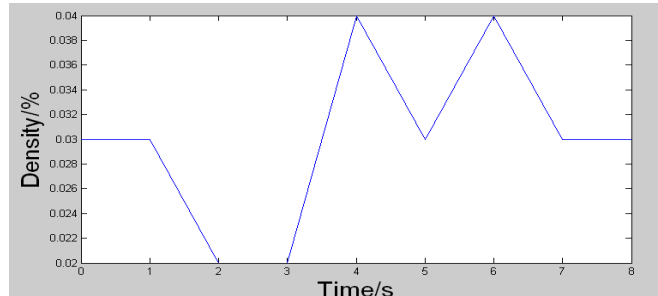
The coordinator default device address 0x0000 in the process of ad-hoc network, so,aircraft node transfer the sensor data to this address. After data be deliveried to the address of 0x0000,the coordinator operating system Osal function begin receive data by AF_INCOMING_MSG_CMD function ,the received data protocol is shown in Table 1,then the data would be send to the serial port by HalUARTWrite function,the data curve is shown in Fig.9.

Table 1 Node data reception frame structure

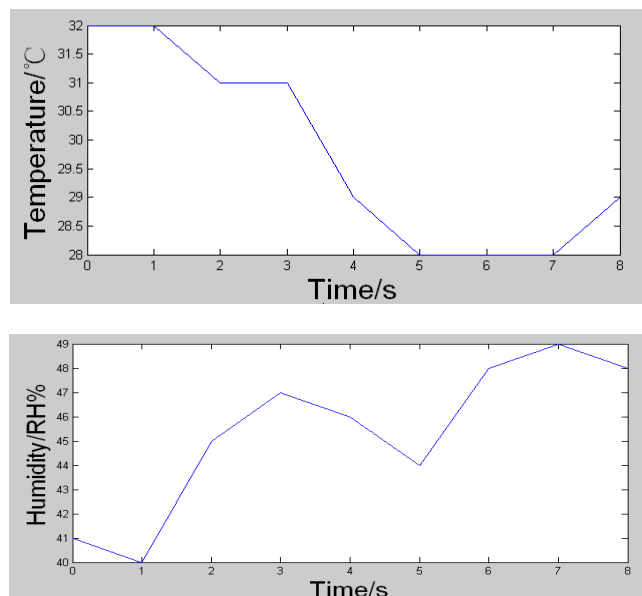| Byte0:	1	2	3	4	5	6
Identifier	High humidity eight	Low humidity eighth	High temperature of eight	Low temperature of eight	High concentration of eight	Low concentration of eight

Fig.9 The data of PC receives

Conclusion

This system take advantage of four axis aircraft carrying wireless sensor network Zigbee node and chemical sensor,using wireless sensor network delivered data to the monitor in real-time.Finally,the design achieved the expectes effect in the laboratory. Spacecraft successfully tested and make use of the wireless sensor network Zigbee mesh topology of local area network,each terminal node sensor

acquisition the value successfully and transmitted to the PC interface.The design for extreme environment of environmental monitoring has certain reference significance.

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