Real Time Target Surveillance with an Autonomous/Manual Controlled Unmanned Air Vehicle

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Abstract

An Unmanned Air Vehicle can be a better & effective solution for unknown target tracking. The targets such as some area to be monitored, finding explosives, monitoring of suspicious objects, detecting the human/human bodies missing during natural calamities, etc. This paper describes the design of real time Unmanned Air Vehicle with payload of wireless camera, GPS navigation system, zigbee, ARM9 microcontroller, sensors such as metal sensor, PIR motion sensor for detecting explosives, human bodies, etc. Live videos will be transmitted from wireless camera will be received at base station & recording will be done. Through GPS location information in terms of latitude & longitude will be received at base station via zigbee. The system can be configuring for manual controlled or it can be autonomous controlled for predefined mission via GUI system. Sensors such as metal sensor & PIR sensor will detect explosives in suspicious objects & human bodies respectively & informed to base station via zigbee.

Keywords— ARM9 microcontroller, GPS, GUI, IR remote, Quad-rotor an Unmanned Air Vehicle, wireless camera, Zigbee.

1. Introduction

The use of unmanned aerial vehicles (UAVs) for surveillance can be an effective solution because of their ability to operate in dangerous locations while keeping their human operators at a safe distance. Up till now many researches have been done on UAV relates UAV design, UAV with different pay loads. UAVs are also designed with different filters such as adaptive high-gain extended Kalman filter (AEKF) [1], cost reference particle filter (CRPF) which estimates 1-D "tilt" with "Accelerometer" and "gyroscope" sensors implemented for calculating & stabilizing quad-rotors against large perturbations [2]. Several quad-rotors were design with robust control law to develop an effective robust controller resisting the uncertainties in helicopter & exo-system [3]. Also some laws such as new adaptive law for attitude tracking extended state observer (ESO) were developed to investigate the problem of attitude tracking for a spacecraft model with inertia uncertainty and external disturbance [4]. Some quad-rotors were designed with Unscented Kalman filter (UKF) and an IMU with three-axis accelerometers, gyro meters & magnetometers with GPS receiver for attitude angles estimation triad algorithm was used to select reliable sensors [5]. Several designs were with payload of vision system using camera, tracking the object using image processing & also calculating distance between unmanned air vehicle & ground target to control the UAV using computer. Quad-rotor consists of a visual sensor, an image acquisition module, a vision processing module, a pan/tilt servomechanism, and video and data links for information retrieval [6]. Also some quad-rotors were designed to the map or monitoring the areas in danger zones, disaster areas, etc. These rotors were designed with payload of GPS, CCD cameras; laser scanner mounted on it and a new method of direct geo-referencing was used for laser range data & CCD images by combining kalman filter & the BBA [7]. Some UAVs were designed for road traffic management [8].

Our unmanned air vehicle is a quad-rotor designed to serve multiple applications such as searching a village, rivers, surveillance, tracking for enemy positions at border or during the time of war, disaster management, searching the humans lost in calamities such as accidents, earthquakes, floods, etc. surveying a suspicious objects, road traffic management, video shootings, collecting evidences for press reporters, land mines tracking.

This quad-copter can be operated manually via a wireless remote or it can be configured for predefined path for surveillance on which it will move, collecting the visual information of the path and sending to server. Implementation of metal sensor, PIR sensor will help us to survey or find explosives & humans.

2. Real Time Target Surveillance with an Autonomous/Manual Controlled Unmanned Air Vehicle System Design

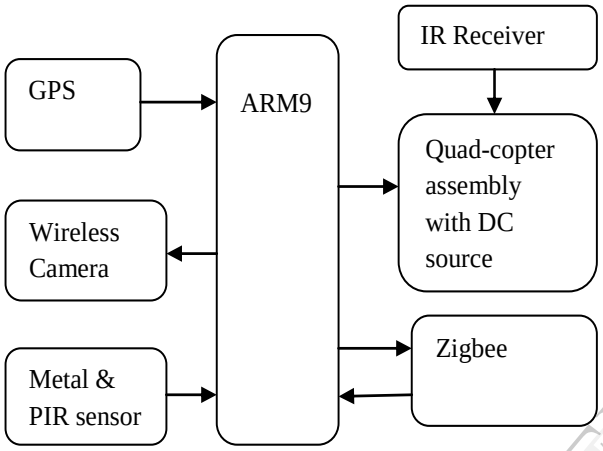

Figure1. Quad-rotor Assembly

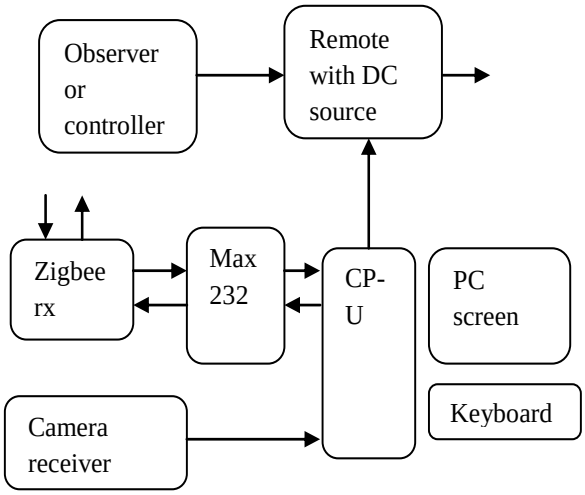

Figure2. Receiver with GUI System

2.1 MCU: (microcontroller unit)

It is the heart of system. All the controlling functions, data transmitting function are done by this unit. Following functions will be carried out by microcontroller unit.

1) Decode the signals from IR decoder & compare with stored value & make decision which function to be executed
2) Data from GPS will be received by MCU & send to server via zigbee.
3) To adjust the camera position.
4) To monitor battery voltage & check whether discharge or not & give information about battery status to server.
5) To send the information about explosives, human detected by sensors.

2.1.1Features of Arm9

1) 64MB SDRAM, 256MB Nand.
2) 2MB Nor Flash, BIOS installed.
3) 4 wire resistive touch screen interface.
4) Audio / USB / SD / 3x Serial / I2C / Ethernet.
5) Pre-loaded with Linux QT (touch enabled).
6) Supports Android, Linux, Windows CE.
7) Manufactured by FriendlyARM.

Figure3. ARM9 kit

2.2 CC2500 zigbee module:-

Zigbee CC2500 is used as a media for communication between quad-rotor & server. Zigbee uses RF link with carrier frequency 2.4 GHz. It is bidirectional with data anti collision protection.

Figure4. CC2500 Module

2.2.1 Features of CC2500 module

1) Low current consumption.
2) Easy for application.
3) Efficient SPI interface
4) Operating temperature range: -40degree - 85 degree.
5) Operating voltage: 1.8~ 3.6 Volts.
6) Available frequency at : 2.4-2.483GHz
7) Programmable output power and hi sensitivity.

2.3 Camera:

It is used to take videos of the surrounding environment.

2.4 Copter assembly:

It is used to fly the unit & take to position where we want. It consists of motors, base, fans. The payload of our copter assembly will contain ARM9 kit, GPS receiver, Video Camera, Power supply, metal, PIR sensors, etc.

Figure5. Example of quad-rotor

2.5 Power supply requirement:

Power supply required is 5v dc/2A max.

2.6 IR receiver:

It is used to receive the signals from transmitter remote.

2.7 IR remote:

It is used to send commands to fly the copter.

2.7.1 Specifications of IR remote

1) 4CH infrared control
2) Remote distance: 100M
3) Frequency 2.4GHz.

Figure6. IR remote

2.8 Metal detector

Metal detector consists of an oscillator which produces an alternating current that passes through a coil producing an alternating magnetic field. If a piece of conductive metal is brought close to the coil, eddy currents will be induced in the metal, and this produces a magnetic field of its own & then other coil is used to measure the magnetic field & one can detect metals. The output of metal detector circuit is logic 1 & logic 0, and is given to ARM9 controller. On activation of sensor ARM9 will send information of sensor & location via zigbee to server.

2.9 PIR human sensor

Sensor detects an IR radiating objects moving in its viewing range. The PIR sensors give an output of logical one when they detect a hot object's motion and a logical zero when there is no moving hot object or human. Output is given to ARM9 On activation of sensor ARM9 will send information of sensor & location via zigbee to server. Sensor works on 5v Dc.

2.10 GPS Receiver

MN5010HS GPS module is used. Data from GPS will be received by ARM9 & send to server via zigbee CC2500.

Figure7. GPS receiver

2.11 Max232 PC interfaces:

Max 232 ic is required to convert TTL-CMOS or CMOS to TTL voltage levels. Zigbee will be interfaced to PC via a max232 ic. Data of location from ARM9 will be received through zigbee CC2500 and given to PC via max 232 ic.

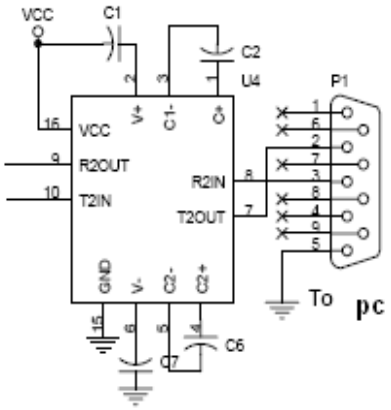

Figure8. Max 232 PC interface circuit.

2.12 Graphical User Interface:

GUI example shown below will contain location information, video recording, quad-rotor configuration, control and video screen. This will guide the observer to take the decision where to move the rotor & which area to be monitored.

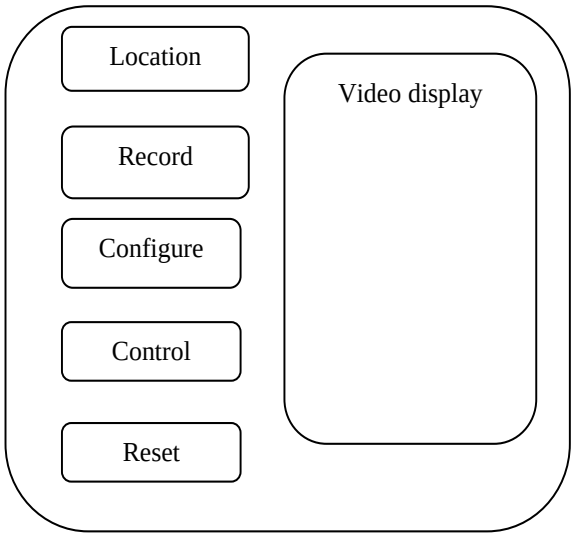

Figure9. Graphical user interface.

2.12 Server side:

1) At this side we will receive the data of position in terms of latitude & longitude given by GPS via zigbee cc2500.
2) This data is given to PC via a max232 ic which is TTL-CMOS, CMOS-TTL converter to PC.
3) PC contains GUI which will have map of area & through map we will plot position with the help of GPS data.
4) Through camera visual monitoring of the area & also recording will be done.
5) We also have control section for quad-rotor through which can configure it for manual control or autonomous control.
6) Configure option is available for defining a path on which the quad-rotor will move in autonomous mode.
7) If any human or metal is detected then the quad-rotor will send the detection command along with location information via ARM9 & zigbee to server. The server will receive this data via zigbee & max232 & in turn it will save the data in database & it will raise alarm.
8) Reset option is available for turning off the alarm.

3. CONCLUSION

Using unmanned air vehicle we will be able to monitor different areas, finding the lost persons in natural calamities or during war using PIR motion sensor, finding the explosives or monitoring the suspicious objects using metal sensor keeping operator at safe distance, quad-rotor can also be used for traffic management, covering accidents, crime scenes, collecting evidence, news, etc. By implementing different sensors one can use quad-rotor for variety of applications. This quad-rotor can also be configured for autonomous mode the mode in which the server will guide the quad-rotor on which path it has to go. It can also be manual controlled. The use of wireless camera provides the live visual that are recorded at server. The use of GPS receiver provides the location information to server via ARM9 & zigbee modules. The GUI provides the user friendly communication between user & quad-rotor system. This quad-rotor can be applicable for multiple applications depending on the user requirement were to use it.

4. Acknowledgment

The author would like to thanks Prof. R.D.Patil for providing valuable guidance for this thesis.

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