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WAR FIELD INTELLIGENT DEFENSE FLAYING-VEHICLE

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ABSTRACT

We will introduce a development of a mini-quad rotor system for indoor application at Keokuk University. The propulsion system consists of X-UFO blade propellers and brushless direct current (DC) motors assembled on a very stiff airframe made of carbon fiber composite material. The attitude control system consists of a stability augmentation system as the inner loop control and a modern control approach as the outer loop. The closed-loop control is a PID controller, which is used for the flight test to validate our aerodynamic modeling. To perform an experimental flight test, basic electronics hardware will develop in a simple configuration. We will use an AVR microcontroller as the embedded controller, a low-cost 100 Hz AHRS for inertial sensing, infrared (IR) sensors for horizontal ranging, and an ultrasonic sensor for ground ranging. A high performance propeller system is built on an X-UFO quad rotor airframe. The developing flying robot is shown to have an automatic hovering ability with aid of a ground control system that uses monitoring and a fail-safe system.

We will introduce a new quad rotor platform for realizing autonomous navigation in unknown indoor/outdoor environments. Autonomous waypoint navigation, obstacle avoidance and flight control is implemented on-board. The system does not require a special environment, artificial markers or an external reference system. We will develop a monolithic, mechanically damped perception unit which is equipped with a stereo camera pair, an Inertial Measurement Unit (IMU), two processor and an FPGA board. Stereo images are processed on the FPGA by the Semi-Global Matching algorithm. Keyramebased stereo odometry is fused with IMU data compensating for time delays that are induced by the vision pipeline. The system state estimate is used for control and on-board 3D mapping. An operator can set waypoints in the map, while the quad rotor autonomously plans its path avoiding obstacles. We show experiments with the quad rotor flying from inside a building to the outside and vice versa, traversing a window and a door respectively.

KEY WORDS: Wireless Camera and AV Receiver, Laser Gun, Ultrasonic Sensor & GPS.

INTRODUCTION

Unmanned Aerial Vehicles (UAVs) have become a hot research topic in the last decade worldwide. Their great potential has been explored in numerous military and civil implementations. UAVs are mostly used in military applications for recognition, environmental observation, maritime surveillance and mine removal activities. Non-military applications are environmental surveillance, rice paddy remote sensing and spraying as well as infrastructure maintenance. Among various UAVs, small-scale UAV helicopter is especially attractive to the academic circle due to its small size, unique height capacities, outstanding maneuverability and low cost. Many research groups have constructed their own UAV helicopters for their research purposes. Success has been achieved in many research areas such as software design and integration, modeling identification, control techniques implementation, aerial image processing, to name a few.

Recently, quad rotor development has become more popular in academic research. Several techniques and methods for modeling, simulation, and control design have been developed. Quad rotor structures and dynamics are simpler than in conventional helicopters or coaxial-rotors; thus, a quad rotor has less control complexity. However, the quad rotor is an unstable system, so the first issue in the design of an autonomous system is the implementation of attitude stabilization control. We report on the progress made during more than one year of quad rotor development. The quad rotor has four powerful rotors running at a very high rotational speed. Key issues include attitude sensing quality and a reliable frame structure. On the vehicle, there is a high magnetic field from brushless Direct Current (DC) motors and very high vibration from the propulsion system. An adequate sensor is required measure a correct value under such conditions. Since we require a light-weight device to be attached to the frame, the challenge is to find a low-cost Inertial Measurement Unit (IMU) with good performance..

PROPOSED SYSTEM

The main objective of this project is to develop “War Field Intelligent Defense Flying-Vehicle”, A Microcontroller based Flying-robot, which will save our soldier’s life in border area, when War is going on and to minimize human casualties in terrorist attack. such as 26/11. The Flying-robot has been design to tackle such a cruel terror attacks. This robot is radio operated; self-powered, and has all the controls like a normal vehicle. A wireless camera has been installed on it, so that it can monitor enemy remotely when required. It can silently enter into enemy area and send us all the information through its’ tiny Camera eyes. Since human life is always precious, these robots are the replacement of fighters against terrorist in war areas.
Many time our army Soldiers need to venture into the enemy area just to track their activities. Which is often a very risky job, it may cost precious life. Such dangerous job could be done using small Flying robot. All the developed and advance nations are in the process of making combat flying robot design, a robot that can fight against enemy.

METHODOLOGY

1 BLOCK DIAGRAM:

The proposed flight control system is driven by an Microcontroller with an 8051 MCU that operates using a system clock at 100 MHz's The control system consists of a data acquisition system for acquiring six Degree Of Freedom (DOF) sensor data from an XA3300 AHRS at a maximum of 100 Hz, and a flight controller that implements the control algorithm. The control system drives four channels for four electronic speed controllers using i2C communication. We feel confident of the fast response propulsion system here rather than using a PWM speed controller.

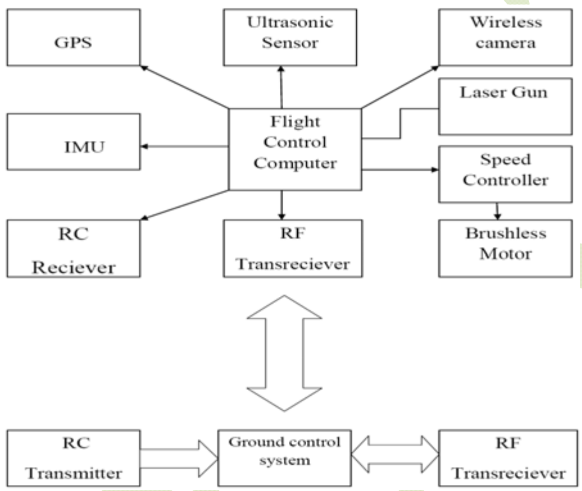

Fig. 1. Block diagram of quad rotor hardware.

In the configuration shown in Fig. 1, the quad rotor system is controlled autonomously by a ground control system using 900 MHz Radio Frequency (RF) modem, and a Radio Control (RC) pilot can take over manually. The Flight Control System (FCS) also has the ability to auto-lock the command input in a standby mode as a safety feature, then wait to receive a special command input as a password to unlock the system. A 1200 mAh 11.1 V Li-Po battery was used to drive all the electronics and the four 2500 rpm/V DC brushless motors. A battery checker system in the FCS can prevent an uncontrolled situation when the power goes down or is depleted during the flight; thus, the quad rotor can make an automatic landing.

Fig2. Quad rotor vehicle with frame protector.

Figure2. quad rotor with a frame protector that can reduce heavy damage from a crash. Because of its light weight and high elasticity, carbon rod was used for frame protection. On the vehicle, there is a high magnetic field from brushless direct current (DC) motors and very high vibration from the propulsion system. An adequate sensor is required measure a correct value under such conditions. Since we require a light-weight device to be attached to the frame, Inertial Measurement Unit (IMU) with good performance. A control approach will then take role and give advantage satisfying the stabilization based on the available configuration.

Figure 3 shows the proposed Ground Control System (GCS). Laptop computer will use for the GCS, which will based on the C# programming language. The GCS consists of a manual mode and an automatic mode. The manual mode is for experiments and detailed scouting. The automatic mode is for autonomous flight based on a GPS signal.

Fig. 3. Ground control system for quad rotor vehicle.

2 FLIGHT TEST:

Figure 4 shows the flight test instructions. The RC controller will connected to the GCS through a USB port. The RC controller sent the signal to GCS, and the control signal will transfer to quad rotor.

Satisfying the all gain conditions through experimental direct tuning on the test bed resulted in “able to fly” performance, as shown in Fig.4 the validated control model based on the flight data. As shown in Fig. 4, our model includes feedback control as a stability augmentation system that use the same gain as the control model. The pilot adjusts the throttle input due to the voltage drop in order to maintain the vehicle in a hovering flight state during the flight test. When the battery power decreases after a number of flights, the throttle input should be increased to generate the same thrust.

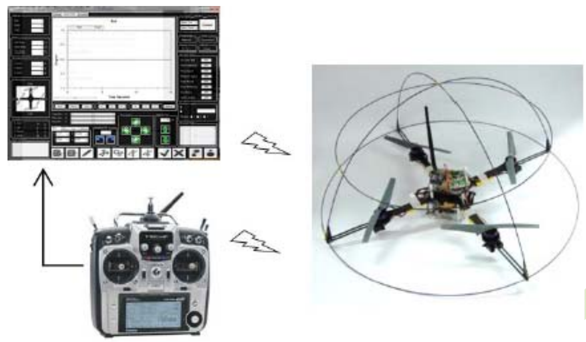

Fig 4. GCS, RC controller, and quad rotor vehicle for flight test.

We implement a compensator in the simulation to consider a variable value from the joystick of the radio control that will recorded in the flight data. The compensator adjusts the throttle coefficient factor due to battery voltage drop during the flight. Our outdoor flight test will successful.

HARDWARE DESIGN

1 WIRELESS CAMERA AND AV RECEIVER:

Wireless camera will send real time video and audio signals which could be seen on a remote monitor and action can be taken accordingly.

Figure 5. AV Receiver and Wireless Camera

A TV capture card is a computer component that allows television signals to be received by a computer. It is a kind of television tuner. Most TV tuners also functions as video capture cards, allowing them to record television programs onto a hard disk. Digital TV tuner card is as shown in the Figure 5. The card contains a tuner and an analog-to-digital converter along with demodulation and interface logic

2 LASER GUN:

A laser gun has been installed on it so that it can fire on enemy remotely when required; this is not possible until a wireless camera is installed. This Laser gun rotating in 360 degree angle.

3 ULTRASONIC SENSOR & GPS:

Ultrasonic Sensor measures the height of the flying robot and GPS is using for the automatic mode for autonomous flight based on a GPS signal.

CONCLUSION

Our proposed quad rotor will able to fly with a PID controller as the inner loop control. The established model included the same feedback control as the real system using a Stability Augmentation System (SAS). Validation in hover was adequate for the design of an optimal control based on modeling, such as the linear quadratic controller that was already implemented in simulation. Since the system in simulation was slightly different from the real system, it needs to be improved in our future work.

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