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Aerial Robot for Blind Navigation in Populated and Unknown Area

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Abstract**—** This research focused on develops a remotely operated Quadcopter system. The Quadcopter is controlled through RF remote controller and graphical user interface (GUI). Communication between GUI and Quadcopter is done by using wireless communication system.

In this project we have used Zigbee for wireless communication between the quadcopter and the computer. Quadcopter is equipped with ultrasonic sensor, Object sensor and a GPS module. All signals from sensors are processed by Arduino Uno microcontroller board. GUI is designed using Visual Basic 2006 Express as interface between control base and Quadcopter.

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I. INTRODUCTION

This project proposes a control strategy for a miniature aerial robot to safely perform flight missions in an unknown densely populated environment. Autonomous navigation is of extreme importance for those who suffer from visual impairment problems. Thus project can also be used by blind people and therefore the presence of possible accidental contacts with the surrounding environment has to be taken into account. To maintain stability in such a complex scenario, mechanics, and control are co-designed. Finally, we show experimental results demonstrating the aerial robot's ability to navigate accurately and autonomously in unknown environments.

Robust navigation in populated environments represents one of the main challenges to safely employ aerial systems in applications such as exploration of indoor and outdoor areas, urban search, rescue operations and inspection of buildings and power plants. When the environment is not perfectly known, most of the navigation algorithms rely upon a sense and avoid approach in which obstacles are first detected by means of suitable sensors, such as cameras, laser range finders, or other proximity sensors, and then avoided by planning a different path.

Research and development of unmanned aerial vehicle (UAV) and micro aerial vehicle (MAV) are getting high encouragement nowadays, since the application of UAV and MAV can apply to variety of area such as rescue mission, military, film making, agriculture and others. In U.S. Coast Guard maritime search and rescue mission, UAV that attached with infrared cameras assist the mission to search the target. Quadcopter or quad rotor aircraft is one of the UAV that are major focuses of active researches in recent years. Compare to terrestrial mobile robot that often possible to limit the model to kinematics, Quadcopter required dynamics in order to account for gravity effect and aerodynamic forces. Quadcopter operated by thrust that produce by four motors that attached to it body. It has four input force and six output states (x, y, z, θ, ψ, ω) and it is an under-actuated system, since this enable Quadcopter to carry more load.

Quadcopter has advantages over the conventional helicopter where the mechanical design is simpler. Besides that, Quadcopter changes direction by manipulating the individual propeller's speed and does not require cyclic and collective pitch control.

II. LITERATURE REVIEW

In [11] presents the aero-mechanical characteristics and the control design for a prototype of ducted-fan aerial robot tailored to achieve advanced robotics operations requiring physical interaction with the environment and high manoeuvrability. The distinguishing feature of the proposed aerial configuration is the redundant number of aerodynamic surfaces which can be employed by the controller. A control strategy is then proposed in which control allocation techniques exploit this redundancy to improve the accuracy and the efficiency of the aerodynamic forces and torques generation mechanism while simplifying the overall feedback design. The effectiveness of the proposed approach and the performances of the ducted-fan prototype have been demonstrated by means of flight experiments.

The use of Unmanned Aerial Vehicles (UAVs) which can operate autonomously in dynamic and complex operational environments is becoming increasingly more common. The UAV Tech Lab is pursuing a long term research endeavour related to the development of future aviation systems which try and push the envelope in terms of using and integrating high-level deliberative or AI functionality with traditional reactive and control components in autonomous UAV systems. In order to carry on such research, one requires challenging mission scenarios which force such integration and development. In this paper, one of these challenging emergency services mission scenarios is presented. It involves search and rescue for injured civilians by UAVs. In leg I of the mission, UAVs scan designated areas and try to identify injured civilians. In leg II of the mission, an attempt is made to deliver medical and other supplies to identified victims. We show how far we have come in implementing and executing such a challenging mission in realistic urban scenarios.

A crew organization and four-step operational protocol is recommended based[20] on a cumulative descriptive field study of teleported rotary-wing micro air vehicles (MAV) used for structural inspection during the response and recovery phases of Hurricanes Katrina and Wilma. The use of MAVs for real civilian missions in real operating environments provides a unique opportunity to consider human-robot interaction. The analysis of the human-robot interaction during 8 days, 14 missions, and 38 flights finds that a three person crew is currently needed to perform distinct roles: Pilot, Mission Specialist, and Flight Director. The general operations procedure is driven by the need for safety of bystanders, other aircraft, the tactical team, and the MAV itself, which leads to missions being executed as a series of short, line-of-sight flights rather than a single flight. Safety concerns may limit the utility of autonomy in reducing the crew size or enabling beyond line-of-sight-operations but autonomy could lead to an increase in flights per mission and reduced Pilot training demands. This paper is expected to contribute to set a foundation for future research in HRI and MAV autonomy and to help establish regulations and acquisition guidelines for civilian operations. Additional research in autonomy, interfaces, attention, and out-of-the-loop (OOTL) control is warranted.

III. SYSTEM HARDWARE ARCHITECHTURE

This chapter will divide into two phases. The first phase is understanding the Quadcopter structure and it basic mathematical modeling. The last phase deals with design and construction of the Quadcopter. It will be built by splitting the design into different component whereby each component will be tested to ensure its working properly. This step is to minimize the risk of accidents which will lead to increasing number of component cost.

Quadcopter can described as a small vehicle with four propellers attached to rotor located at the cross frame. This aim for fixed pitch rotors are use to control the vehicle motion. The speeds of these four rotors are independent. Take-off is movement of Quadcopter that lift up from ground to hover position and landing position is versa of take-off position. Take-off (landing) motion is control by increasing (decreasing) speed of four rotors simultaneously which means changing the vertical motion. Forward (backward) motion is control by increasing (decreasing) speed of rear (front) rotor. Decreasing (increasing) rear (front) rotor speed simultaneously will affect the pitch angle of the Quadcopter. For left and right motion, it can control by changing the angle of Quadcopter. Yaw angle can control by increasing (decreasing) counter-clockwise rotors speed while decreasing (increasing) clockwise rotor speed.

The second phase consist of hardware and software design. The Quadcopter body must be rigid and light weight in order to minimize the Quadcopter weigh. For software part, Microsoft visual basic 2006 is used to design GUI as interface between control base and Arduino Uno.

- ❖There are four inputs to the Arduino board (i.e.) power supply, object sensors, ultra-sonic sensors and GPS.
- ❖The power supply given is of 5v dc.
- ❖The object sensor and the ultra-sonic sensor will detect the coming object and the range.
- ❖The GPS is to see the location of the robot.
- ❖At the output a zigbee transmitter is given to transmit the signals to the pc.
- ❖At the receiver end a zigbee receiver is connected.
- ❖As the zigbee receiver cannot be directly connected to the PC a RS232 IC is connected in between them.
- ❖The input signals which are coming from the receiver can be seen on the visual basic window on the PC.

1. LCD

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs.

2. ARDUINO

The ATmega328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328P achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. The device is manufactured using Atmel’s high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core.

3. ULTRASONIC SENSORS

The Parallax ultrasonic distance sensor provides precise, non-contact distance measurements from about 2 cm (0.8 inches) to 3 meters (3.3 yards). It is very easy to connect to BASIC Stamp® or Javelin Stamp microcontrollers, requiring only one I/O pin. The sensor works by transmitting an ultrasonic (well above human hearing range) burst and providing an output pulse that corresponds to the time required for the burst echo to return to the sensor. By measuring the echo pulse width the distance to target can easily be calculated.

4. GPS

It is a third generation POT (Patch Antenna On Top) GPS module. The POT GPS receiver providing a solution that high position and speed accuracy performances as well as high sensitivity and tracking capabilities in urban conditions & provides standard NMEA0183 strings in “raw” mode for any microcontroller. The module provides current time, date, latitude, longitude, speed, altitude and travel direction / heading among other data, and can be used in a host of applications, including navigation, tracking systems, fleet management, mapping and robotics. It is a standalone GPS Module and requires no external components except power supply decoupling capacitors. It is built with internal RTC Back up battery. It can be directly connected to Microcontroller's USART. The module is having option for connecting external active antenna if necessary.

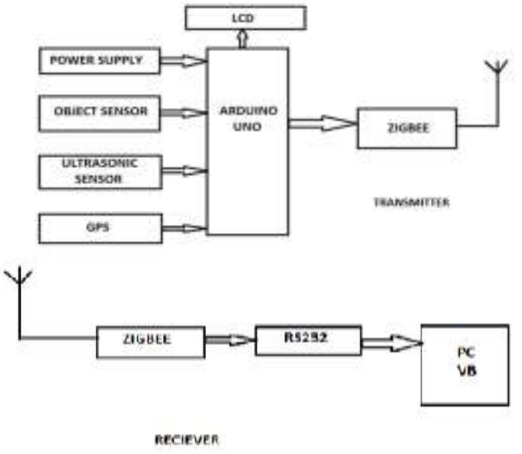

Fig 1: Block Diagram Of Proposed Aerial Robot For Blind Navigation System

5. ZigBee RECIEVER

The XBee Series 2 OEM RF Modules were engineered to operate within the ZigBee protocol and support the unique needs of low cost, low power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between remote devices.

The modules operate within the ISM 2.4 GHz frequency band.

6. VISUAL BASIC

Visual Basic is a tool that allows you to develop Windows (Graphic User Interface - GUI) applications. The applications have a familiar appearance to the user.

Visual Basic is event-driven, meaning code remains idle until called upon to respond to some event (button pressing, menu selection ...). Visual Basic is governed by an event processor. Nothing happens until an event is detected. Once an event is detected, the code corresponding to that event (event procedure) is executed. Program control is then returned to the event processor.

IV. CONCLUSION

The project deals with designing a simple and low cost quadcoptor that can attend fully autonomous flights in unknown and densely populated area without a prior map, relying solely on sensors onboard the vehicle. This model can be used area where the humans can't practically travel, during natural calamities etc. We believe that there is great potential for future ex- tensions of such platforms to operate in fully 3-dimensional environments.

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