ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

Quadcoptor Robot for Autonomous Flight Missions in Populated and Unknown Area

Prof. M. Naseeruddin [1], Samiya Khan [2]

HOD, Dept. of Electronics and Communication Engineering, Anjuman College of Engineering, Nagpur, Maharashtra, India[1]

PG Student [ECE], Dept. of Electronics and Communication Engineering, Anjuman College of Engineering, Nagpur, Maharashtra, India[2]

ABSTRACT: UAVs are becoming more common in our modern world. UAVs are mostly associated with war due to the coverage of their use in the recent wars in Iraq and Afghanistan, but have the ability to do much more. UAVs are helpful tools in assessing damage after a disaster, keeping rescuers safe while they help those in need. UAVs are useful tools in monitoring crops to ensure the maximum yield is realized. The use of UAVs is also being used for monitoring remote land areas that are difficult to reach by foot. Amazon recently received approval from the FAA to research the use of UAVs for delivering packages. The uses of UAVs are endless.

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.

I. INTRODUCTION

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.

A. HISTORY

The first UAV can be credited to French brothers Joseph and Jacques Montgolfier during the development of the first hot air balloon in 1782. Joseph burned paper beneath an opening at the bottom of a silk balloon, which in turn caused the balloon to rise 70 feet before returning to the Earth when the air cooled inside the balloon (Karwatka 2002).

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

Although the Montgolfier brothers achieved their ultimate goal of developing a hot air balloon large enough to lift people in November 1783, their successful prototype can arguably be considered the first UAV. The use of hot air balloons equipped with incendiary devices can be traced back to Union and Confederate forces in the Civil War, where both sides launched balloons with the idea they would land in enemy supply or ammunition storages, ignite and wreak havoc (Garamone 2002). Japanese forces used a similar technique when they launched balloons equipped with explosives during World War II. The belief was that high-altitude winds would carry the balloons into the United States where they would fall and ignite fires (Garamone 2002). These attempts at using a UAV for attack proved to be ineffective.

The first UAV ordered by the United States military came when the country became Involved in World War I in 1917 and the U.S. Navy placed an order for the Curtiss N-9 seaplane (Cook 2007). The Curtiss N-9 seaplane used an automatic control system that was developed by Elmer Sperry with Peter Hewitt, but this seaplane unfortunately was never used in battle as it was prone to crashes and engine failure during the Navy testing in late 1917 (Cook 2007). Despite the failures in the Navy trials, the US Army decided to continue the development of the UAV and awarded a contract to Charles Kettering in 1918 for his "Kettering Bug" biplane UAV (Cook 2007). Although there were successful tests sprinkled among the failures, the "Kettering Bug" UAV never saw combat (Cook 2007).

During World War II the Germans successfully developed a one-way unmanned aircraft called the V-1 "Buzzbomb", which reached speeds up to 400 mph and was unleashed on England in June of 1944 (Olson 1964). Although it was not a UAV in the sense that it was recoverable, the V-1 was the first successful unmanned aircraft used for combat.

In the late 1950s, the U.S. Air Force awarded a contract to Ryan Aeronautical Company for the development of the remote controlled BQM-34A "Firebee" drone for the purpose of performing photographic surveillance missions and returning to base (Cook 2007). The creation of the BQM-34A marks the beginning of the modern era of UAVs.

The Vietnam War is the first significant use of UAVs in military operations by the U.S. (Cook 2007). During the war, the "Firebee," "Lightning Bug," and "Buffalo Hunter" UAV's, all developed by the Ryan Aeronautical Company, were used to successfully fly several surveillance missions deep within enemy territory (Zaloga 1998; Cook 2007; Garamone 2002).

In 1982, the Israelis successfully used UAVs as decoys to draw missile fire from Lebanon during the Israel/Lebanon Conflict of the late 1970s and early 1980s (Cook 2007). The success of the UAVs led to the Israelis development of more sophisticated UAV systems that utilized lightweight video cameras to provide real-time surveillance on the battlefield (Zaloga 2008).

In the Gulf War of 1990-91, U.S. forces utilized the Pioneer UAV, an offshoot of Israeli UAV technology (Garamone 2002). The success of the UAVs in the war led the U.S. to invest in the development of the Predator UAV platform, a UAV equipped with color video cameras, radar, and the ability to be outfitted with missiles (Garamone 2002). The Predator UAV would be considered the "drone that changed the world" in that it allowed an operator to perform surveillance or attack a target on the other side of the planet with complete immunity (Terdiman 2014). This safety is attributed to the Predator's ability to remain airborne for up to 40 hours, fly at an altitude up to 25,000 feet, and has the ability to hover over a specific area for up to 14 hours (Garamone 2002).

The wars in Afghanistan and Iraq brought about the next wave of UAV warfare by the U.S. military. Besides using the Predator, the U.S. military operated the RQ-170 Sentinel, a reconnaissance and surveillance UAV with stealth capabilities (Fulghum 2010). The RQ-170 drone was used to gather intelligence before, during, and after the raid on Osama bin Laden's compound in Pakistan in May of 2011 (Ambinder 2011).

With the wars in Iraq and Afghanistan over, the civilian market is looking to capitalize on the UAV technology that has been so successful on the battlefield.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

UAVs have the ability to mitigate some of the problems involve with projects such as the collection of aerial imagery and monitoring land. Advanced, larger UAV's are useful tools in emergency responses after natural disasters where it is difficult for workers to assess and monitor damage with the aerial imagery that is captured (Adams and Friedland 2011). Micro-UAV sequipped with digital cameras can deliver near real-time imagery for monitoring and mapping purposes (Gademer et al. 2009).

UAV's come in a variety of shapes and sizes (Anderson and Gaston 2013). Large fixedwing crafts that resemble airplanes require large areas for take-off and landing, and fly in long, straight paths, which is useful in monitoring pipelines. Small quadcopter crafts, on the other hand, do not need much room for take-off and landing, and have the ability to hover and turn in mid-flight, making them ideal for monitoring projects that require data collection in a variety of spots within a site. UAVs are an ideal tool for monitoring sensitive areas and subjects that may be threatened or destroyed if humans tried to monitor them manually (Jones IV, Pearlstine, and Percival 2006). The wide range of shapes and sizes also has an effect on the abilities of these crafts. Fixed wing aircrafts cannot stop and hover in one place like a quadcopter can, but the quadcopter cannot fly as long. These differences are determining factors in the selection of a UAV for a research project.

In recent years micro-UAVs have become popular due to their ability to give the user an instant bird's-eye view (Anderson 2014). Other reasons for their popularity include their short learning curve to operate, ability to carry small cameras, and affordability due to advancements in technology. More people are experimenting with the aerial point of view--from realtors who want to gain a different perspective for marketing a property to hobbyists who may be looking to capture a unique video of some friends surfing. Social media has also helped fuel this interest with the ability of users to easily post and share the latest extreme sports action captured from the sky.

Prior to the wars in Iraq and Afghanistan, UAVs did not receive much attention in the public arena. Now, companies like Amazon.com are looking to use UAVs to deliver products to the customer's doorstep within hours of placing an order to provide faster service. The uses of UAV technology are endless.

II. 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.

A. TRANSMITTER DISCRIPTION

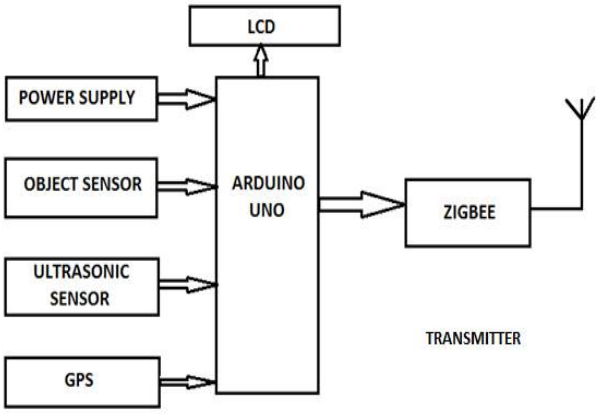
- There are four inputs to the Arduino board (i.e.) power supply, object sensors, ultra-sonic sensors and GPS.
- The power supply given is of 5v dc.
- The object sensor and the ultra-sonic sensor will detect the coming object and the range.
- The GPS is to see the location of the robot.
- At the output a zigbee transmitter is given to transmit the signals to the pc.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

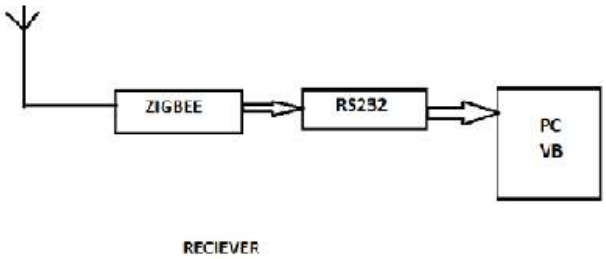
Vol. 5, Issue 6, June 2016



.

B. RECEIVER DESCRIPTION

- 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.



II. OVERVIEW OF THE DEVICE USED

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.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

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.

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.

III. CIRCUIT IMPLEMENTATION

Proteus (***PRO****cessor for* ***TE****xt* ***E****asy to* ***US****e*) is a fully functional, procedural programming language created in 1998 by Simone Zanella. Proteus incorporates many functions derived from several other languages: C, BASIC, Assembly, Clipper/dBase; it is especially versatile in dealing with strings, having hundreds of dedicated functions; this makes it one of the richest languages for text manipulation. Transforming data from one form to another is the main usage of this language

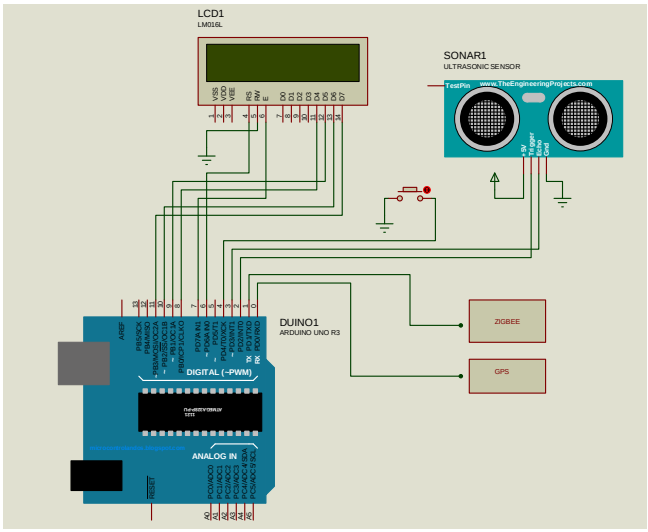
Before implementing the hardware we try simulation of circuit in proteus for simulation. The number of nodes is connected to each other to form a network.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

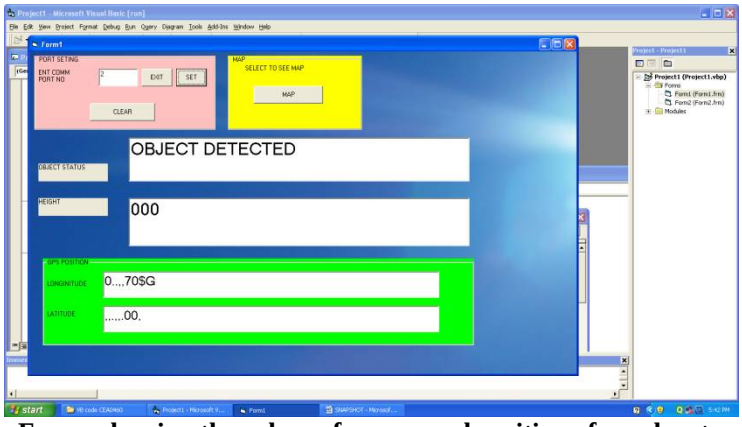
(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016



Circuit implementation showing Arduino Uno with LCD, Ultrasonic sensor, Button in place of object sensor, GPS module and Zigbee module.

After the data has been proceed by arduino board and transmitted over zigbee module it is fed to data base and the value of the sensors are displayed on front end designed in visual basic. Fig below shows the values of sensor and also the position of quadcoptor.



Frame showing the values of sensor and position of quadcoptor

The values shown at the figure is the value which is been provided to us by the sensors which is also been displayed on the LCD. These sensors keep on updating the values regarding the change in position of quadcoptor and if the object is detected.

IV. CONCLUSION

In this work, we have developed a quadrotor helicopter that is capable of fully autonomous exploration in unstructured, unknown and densely populated outdoor environments without a prior map, relying solely on sensors onboard the vehicle. By reasoning about the key differences between autonomous ground and air vehicles, we have created a suite of algorithms that accounts for the unique characteristics of air vehicles for estimation, control and planning. Having developed a helicopter plat- form that has many of the capabilities of autonomous ground robots, we believe that there

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

is great potential for future ex- tensions of such platforms to operate in fully 3-dimensional environments. The presented model and control methods were tested only with simulations.

The paper also presents a way to adjust thrust of the rotors via voltage supply to perform standard flight operations and to position the quadcopter into certain angular orientation depending on the circumstances of a particular flight routine. Moreover, it also illustrates the different behaviors of the copter mathematically that might be observed within a range set of angles.

Future Scope

- Sensors such as temperature, humidity and others can be added as we are using arduino board (which has in build ADC).
- GSM can be used for large range, we just have to put the SIM card into the quadcoptor as the SIM card communicates directly with the satellite and thus the range is extensively extended.
- Voice control can be added i.e. the quadcoptor can be controlled with the help of voice commands.
- It can be made fully automatic.
- Face recognition can be added, during the time of natural calamities it can help to rescue people.
- Object recognition can be added, so that it can recognize the objects which are coming on it's way and can doge them.

REFERENCES

[1] Allison Ryan and J. Karl Hedrick (2005). "A mode-switching path planner for UAV- assisted search and rescue." *44th IEEE Conference on Decision and Control, and the European Control Conference 2005*.
[2] Atheer L. Salih, M. Moghavvemil, Haider A. F. Mohamed and Khalaf Sallom Gaeid (2010). "Flight PID controller design for a UAV Quadcopter." *Scientific Research and Essays Vol. 5(23), pp. 3660-3667, 2010*.
3] A. Zul Azfar and D. Hazry (2011). "Simple GUI Design for Monitoring of a Remotely Operated Quadcopter Unmanned Aerial Vehicle." *2011 IEEE 7th International Colloquium on Signal Processing and its Applications*.
[4] Ashfaq Ahmad Mian, Wang Daobo (2007). "Nonlinear Flight Control Strategy for an Underactuated Quadrotor Aerial Robot" 2007 *IEEE Journal*
[5] Duckgee Park, Moon-Soo Park, Suk-Kyo Hong (2001). "A Study on the 3-DOF Attitude Control of Free-Flying Vehicle." *ISIE 2001,Pusan,KOREA*
[6] Frank Hoffman, Niklas Goddemeier, Torsten Bertam (2010). "Attitue estimation and control of Quadcopter" *2010 IEEE/RSJ International Conference on Intelligent Robots and Systems*.
[7] Jun Li, YunTang Li (2011). "Dynamic Analysis and PID Control for a Quadrotor" *2011 International Conference on Mechatronics and Automation*.
[8] Kong Wai Weng (2011). "Quadcopter" *Robot Head To Toe Magazine September 2011 Volume 3, pp. 1-3*.
[9] Markus Achtelik, Tianguang Zhang, Kolja Kuhnlenz and Martin Buss (2009). "Visual Tracking and Control of a Quadcopter Using a Stereo Camera System and Inertial Sensors." *Proceedings of the 2009 IEEE Conference on Mechatronics and Automation*.
[10] Matilde Santos, Victoria López, Franciso Morata (2010). "Intelligent Fuzzy Controller of a Quadrotor" *2010 IEEE Journal*.
[11] R. Naldi, A. Torre and L. Marconi, "Robust Control of a Miniature Ducted-Fan Aerial Robot for "Blind" Navigation in Unknown Populated Environments", accepted to IEEE Transactions on Control Systems Technology, 2014.
.[12] Bachrach, R. He, and N. Roy, "Autonomous flight in unknown indoor environments," Int. J. Micro Air Veh., vol. 1, no. 4, pp. 217–228, 2009.
[13]P. Doherty and P. Rudol, "A UAV search and rescue scenario with human body detection and geolocalization," in Proc. 20th Australian Joint Conf. Advances Artificial Intelligence, Gold Coast, Australia, 2007, pp. 1–13.
[14]A. Bry, A. Bachrach, and N. Roy, "State estimation for aggressive flight in GPS-denied environments using onboard sensing," in Proc. IEEE ICRA, St Paul, MN, USA, May 2012, pp. 1–8.
[15]D. Mellinger, M. Shomin, N. Michael, and V. Kumar, "Cooperative grasping and transport using multiple quadrotors," in Proc. Int. Symp. Distrib. Autonomous Syst., Lausanne, Switzerland, 2010, pp. 545–558.
[16]Q. Lindsey, D. Mellinger, and V. Kumar, "Construction with quadrotor teams," Auton Robot, vol. 33, no. 3, pp. 323–336, 2012.
[17] A. Klaptocz, L. Daler, A. Briod, J. C. Zufferey, and D. Floreano, "An active uprighting mechanism for flying robots," IEEE Trans. Robot., vol. 28, no. 5, pp. 1152–1157, Oct. 2012.
[18] P. Pounds and A. Dollar, "UAV rotorcraft in compliant contact: Stability analysis and simulation," in Proc. IEEE/RSJ Int. Conf. Intell. Robots Syst., Sep. 2011, pp. 2660–2667.
[19] M. Fumagalli, R. Naldi, A. Macchelli, R. Carloni, S. Stramigioli, and L. Marconi, "Modeling and control of a flying robot for contact inspection," in Proc. IEEE/RSJ Int. Conf. Intell. Robots Syst., Oct. 2012, pp. 3532–3537.
[20] R. R. Murphy, K. S. Pratt, and J. L. Burke, "Crew roles and operational protocols for rotary-wing micro-UAVs in close urban environments," in Proc. 3rd ACM/IEEE Int. Conf. HRI, New York, NY, USA, Mar. 2008, pp. 73–80.