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Use Of Unmanned Aerial Vehicle (Drones) For Search Operations Aiding Disaster Management

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Abstract
The proposed paper aims at developing and employing drones in search operations during disasters. The operation, control and movement is entirely facilitated with the computer enabled programming of the controller thereby including the advancement of computer technology and virtual reality in its fold. The drone is fitted with camera to capture the images of the affected site which is sent to the rescue officials via FPV goggles to find survivors. It is also fitted with infrared, thermal and proximity sensors to detect human presence and movement under poorly lit conditions. The output from the sensors are sent to the rescue officials via GSM/GPS module which is controlled by ARDUINO UNO.

Keywords
CC3D, Arduino, UAV, Infrared, PIR, Thermal, FPV, IDE

1. Introduction

One of the most common and popular flying drone designs is the quadcopter, is a type of drone that is lifted and propelled by four rotors. Although the concept of quadcopter has been existing for a long time but its commercial use has been hampered by the inadequate technological advancement. Owing to limitations in the computing ability of traditional drones' onboard processors and the high power consumption associated with it additional computing microcontrollers are fitted to provide the required data transmission. The control of the appliances when completely taken over by the machines, the process of monitoring and reporting becomes more eventful. The air surrounding drones has changed quite a bit in the past few years. With their growing presence in the media, their potential is becoming recognized more and more. They can be used for reasons other than spying and warfare. Our system aims at making one such quadcopter commercially viable by employing it in search operations at the time of disasters. The UAV is fitted with surveillance cameras that enables live video streaming of the affected site viewed via FPV goggles that incorporates the technology of virtual reality. Under low lit conditions the UAV fitted with multiple sensors deduct the presence of survivors and other physical conditions of the affected site and send the sensor output to the rescue officials via GSM/GPS module.

Such a system
1) Enable quick search operation of survivors.
2) Reduces man power required by the disaster management teams usually required without this.
3) Is operable at low light conditions.
4) Is highly effective in search operations.

2. Methodology

Fig.1 shows the block diagram and the methodology followed which is subsequently explained as follows
1) Use of drones fitted with camera to capture images of the affected site under well-lit conditions to be viewed via FPV goggles.
2) Use of proximity, infrared and thermal sensors to deduct survivors.
3) Sending the images and sensor signal to the rescue team via GPS/GSM module.
4) The rescue team acts based on the information received.
5) Effective deduction in both well-lit and poorly-lit-conditions.
6) A digital video recorder can be used for recording and futher scrutiny.

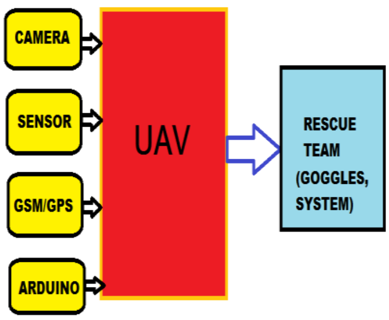

Fig 1. Block diagram

3. PLATFORM DESIGN

3.1. Hardware of UAV

The drone is constructed of Alien frame as depicted in Fig. 3, it is light weight and durable and can carry a load up to 2 kgs. CC3D controller shown in Fig. 5, is a 32-bit controller operating at 72MHz running at 5V is used for propeller control and is programmed using Open Pilot Software. Gens ace (25 C) 11.1V lithium polymer battery depicted in Fig. 4, is used to power the controller, propeller motors and camera. The C rating here is used to specify how quickly energy can be discharged by the battery. The propellers run with supply from 1000KV brushless motor depicted in Fig. 6, that are connected to ESC (Electronic Speed Control: Speeds the propeller motor according to the signal received from the transmitter) depicted in Fig. 8. A six-channel transmitter shown n Fig. 7, is used to send control signals at 2.4 Ghz frequency and is operated by the drone pilot.

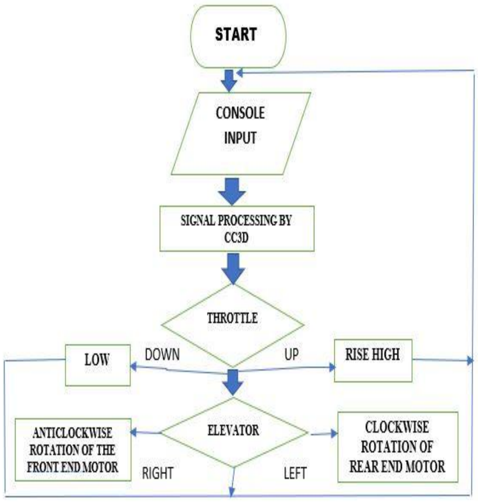

Fig 2. Flight Control Workflow

Fig.3. Alien Frame

Fig.4. Gens ace Battery

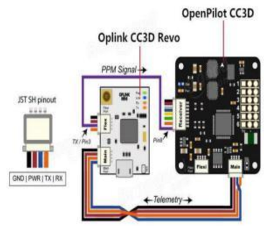

Fig.5. CC3D Controller

Fig.6. Brushless Motor

Fig. 7 Six Channel Transmitter

Fig. 8 ESC

3.2. Video Streaming

A regular 1080 pixel camera depicted in Fig. 10, is used for surveillance operations that send images to FPV goggles (shown in Fig. 9) at 5.2GHz frequency using Fat Shark antenna allowing the rescue officials to search for survivors. A Digital Video Recorder (DVR) is further used for recording the video in a digital format to a disk drive, USB flash drive, SD memory card, SSD or other local or networked mass storage network for further perusals in aiding the search operations during disasters or calamities.

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Fig. 9 FPV Goggles Fig.10 1080P Camera

3.3. Sensors, Arduino and GSM/GPS

As depicted in Fig. 11, the drone carries various sensors to deduct human presence like infrared sensors (shown on Fig. 12) to deduct body heat, proximity sensors to deduct motion of human and thermal sensors (shown in Fig. 13) to know the temperature and humidity of the site. All objects with a temperature of about more than or above absolute zero emit heat energy in the form of radiation. Usually this radiation isn't visible to the human eye because it radiates at infrared wavelengths, but it can be detected by electronic devices designed for such a purpose. The term passive in this instance refers to the fact that PIR devices do not generate or radiate energy for detection purposes. It works entirely by detecting infrared radiation emitted by or reflected from objects. The sensor outputs are gathered by the 8 bit Arduino Controller. Arduino boards (shown in Fig. 15) are generally based on microcontrollers from Atmel Corporation like 8, 16 or 32-bit AVR architecture-based microcontrollers. The important feature of the Arduino boards is the standard connectors. Using these connectors, one can connect the Arduino board to other devices like LEDs or add-on modules called shields. The Arduino boards also consists of on board voltage regulator and crystal oscillator. It also consist of USB to serial adapter using which the Arduino board can be programmed using USB connection. In order to program the Arduino board, we need to use IDE provided by Arduino. The Arduino IDE is based on Processing programming language and supports C and C++ and sends the gathered sensor information to rescue official via SIM 808 GSM/GPS module This board based on the latest SIMCOM SIM808 GSM/GPS (shown in Fig. 14) module, it offers cellular GSM and GPRS data along with GPS technology for satellite navigation. The board features ultra-low power consumption in sleep mode, giving the project incredibly long standby times. Furthermore, there's an onboard battery charging circuit that can be used with LiPo batteries. The GPS receiver is incredibly sensitive with 22 tracking and 66 acquisition channels, and also supports assisted-GPS (A-GPS) for indoor localization. The board is controlled by AT command via UART and supports 3.3V and 5V logical level. It comes with a mini GPS and GSM antenna, however a battery is optional. The various sensors are controlled by the Arduino that is programmed with Embedded C.

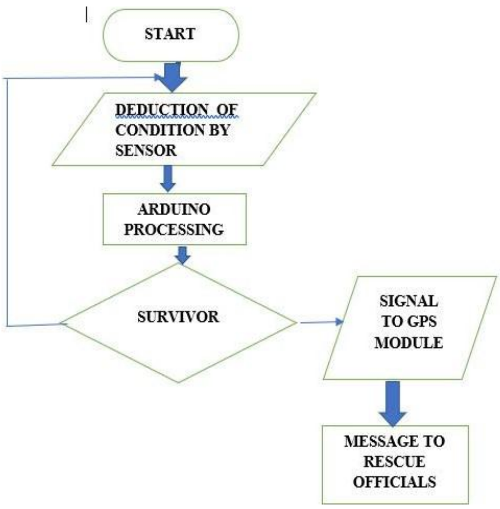

Fig.11. Sensor and Arduino Workflow

Fig. 12 Infrared Sensor

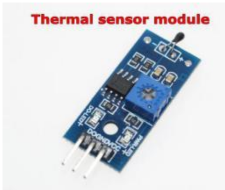

Fig. 13 Thermal Sensor

Fig.14. SIM808

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Fig.15. Arduino

4. Design dynamics of drone

In order to derive quadcopter dynamics, consider the two frames in which it will operate. The inertial frame is defined by the ground, with gravity pointing in the negative z direction. The body frame is defined by the orientation of the quadcopter, with the rotor axes pointing in the positive z direction and the arms pointing in the x and y directions.

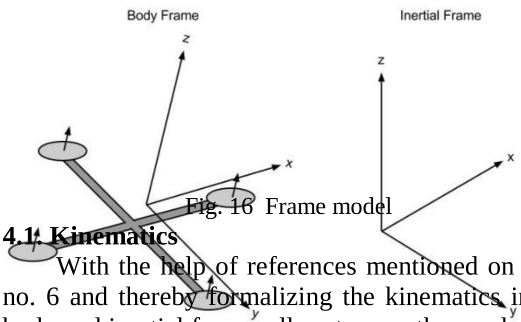

Fig. 16 Frame model

4.1. Kinematics

With the help of references mentioned on page no. 6 and thereby formalizing the kinematics in the body and inertial frame, all motors on the quadcopter are identical, so a single one is analyzed without loss of generality. Also, the adjacent propellers, however, are oriented opposite each other; if a propeller is spinning "clockwise", then the two adjacent ones will be spinning "counter-clockwise", so that torques are balanced if all propellers are spinning at the same rate. Brushless motors are used for all quadcopter applications. For electric motors, the torque produced is given by

$$t=K_t(I-I_0) \quad (1)$$

where t is the motor torque, I is the input current, I0 is the current when there is no load on the motor, and K_t is the torque proportionality constant. The voltage across the motor is the sum of the back-EMF and some resistive loss:

$$V = IR_m + K_v \omega \quad (2)$$

where V is the voltage drop across the motor, R_m is the motor resistance, w is the angular velocity of the motor, and K_t is a proportionality constant (indicating back-EMF generated per RPM). We can use this description of our motor to calculate the power it consumes. The power is

$$P= IV = \frac{(\tau+K_tI_0)(K_t I_0 R_m+\tau R_m+K_tK_v\omega)}{K_t^2} \quad (3)$$

4.2. Forces

The power is used to keep the quadcopter aloft. By conservation of energy, we know that the energy the motor expends in a given time period is equal to the force generated on the propeller times the distance that the air it displaces moves (P · d t = F · d x). Equivalently, the power is equal to the thrust times the air velocity

$$(P = F\, /dt)$$

$$P = Tv_h \quad (4)$$

4.3. Torques

Now that we have computed the forces on the quadcopter, we would also like to compute the torques. Each rotor contributes some torque about the body z axis. This torque is the torque required to keep the propeller spinning and providing thrust; it creates the instantaneous angular acceleration and overcomes the frictional drag forces. The drag equation from fluid dynamics gives us the frictional force:

$$F_D = 1/2\, \rho C_D A v^2 \quad (5)$$

where ρ is the surrounding fluid density, A is the reference area (propeller cross-section, not area swept out by the propeller), and C_D is a dimensionless constant.

4.4. Noise abatement

Aircraft noise is typically dominated by propulsion. In small delivery drones, electric Propulsion can eliminate the noise sources associated with IC engines. Many rotor-design parameters affect noise: tip speed, thickness, blade count, sweep, tip shape, and blade twist. Of these, the rotor tip speed has perhaps the greatest impact: Maintaining a moderate subsonic tip speed is essential for controlling noise. Distributed electric propulsion offers further potential for noise improvements. Disk loading is the ratio of weight to total rotor disk area. Further as the drone is powered in hover mode with four rotors, each spinning at 1,000 revolutions per minute (RPM), then the rotor tip speed will be 110 ft per second. The ability to turn off rotors in different phases of flight and to optimize different rotors for hover and cruise can help a drone achieve better flight efficiency and optimal disk loading.

5. Future works

The advancement in Embedded and Computer technology can facilitate the following advancement:

(1)Employing high powered drones to perform rescue operations as well.

(2) Use of Internet to drive the Drones. Use of voiced commands to drive drones.

6. Acknowledgement

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7. References

[i] B. Andrievsky and A.L. Fradkov "Adaptive Coding for Manuering UAV Tracking Over the Digital Communication Channel," in *Proc. Int. Confr.Ultra Mod/Telecom-Mun. Control Syst. Workshops (ICUMT)*, Saint Petersburg, Russia, Oct.2014, pp 236-241.

[ii] K.Boudjit and Target tracking with a quadrotor using Logic," *in Proc. Int. Conf. Inform.Control, Autom. Robot. (ICINO)*, Colmar, France, July. 2015, pp. 223-230.

[iii] S.Shen , N. Micheal, V. Kumar, "Tightly-coupled monocular visual-inertial fusion for autonomous flight of rotorcraft MAVs," *in Proc. IEEE Int. Conf. Robot.Autom. (ICRA)*, Seattle.,WA, USA, May 2015, pp. 6235-6240.

[iv] S.Darma. J.L. Buesler, G. Hermann, J.P.Urban, and B. Kusumoputro, "Visual Serving Quadrotor Control in Autonomous Target Search," *in Proc. IEEE Int. Conf. Syst. Eng. Technol. (ICSET)*, Shah Alam, Malaysia, Aug. 2013, pp. 319-324.2004.

[v] . H.Lim and S.N. Sinha, 'Monocular Localization of a moving person onboard a quadrotor MAV,' on *Proc. IEEE Int. Conf. Robot. Autom. (ICRA)*, Seattle, WA, USA,May 2015, pp. 2184-2189.

[vi]. D.Exner, E.Bruns, D. Kurz, A. Grundhofer, and O. Bimber, 'Fast and robust CAMShift tracking,' in *Proc. IEEE Conf. Comput. Vis. Pattern Recognit. Workshops(CVPRW)*, San Francisco, CA, USA. Jun.2010, pp. 9-16.

[vii]. A. Chakrabarty , R. Morris, X. Bouyssounnouse, and R. Hunt, "Autonomous indoor object tracking with Parrot AR.Drone," in *Proc. Int. Conf. Unmanned Aircraft Syst. (ICAUAS)*, Arlington, VA.USA, Jun. 2016, pp. 25-30.

[viii] D.Abeywardena, P. Punds, D. Hunt, and G.Dissanayake, "Design and development of ReCOPTER: An open source ROS-based multi-rotor platform for research," in *Proc. Austral . Conf. Robot. Autom. (ACRA)*, 2015, pp. 1-10.

[ix] C. Stanffer and W. E. L. Grimson ," Adaptive background mixture models for real-time tracking ," in *Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CPVR)*, Fort Coffins, CO, USA, Jun. 1999, pp. 246-252.

[x] H.Bay, T.Tuytelaars, L.Vn Gool,"SURF: Speeded up robust features," in *Proc. Eur. Conf. Comput.Vis. (ECCV)*,2006, pp. 404-417.

[xi] I. Colomina and P. Molina.," Unmanned aerial systems for photogrammetry and remote sensing: A review," *ISPRS J. Photogramm. Remote Sens.*, vol.92, no. 2,pp. 79-97, 2014.

[xii] N. Micheal , D. Mellinger, Q. Lindsey, and V.Kumar ,"THE GRASP multiple micro-UAV testbes,"*IEEE Robot.Autom. Mag.*, vol. 17, no. 3, pp. 56-65, Sep. 2010