DESIGN OF A QUADCOPTER FOR SEARCH AND RESCUE OPERATION IN NATURAL CALAMITIES

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Bachelor in Technology in

Industrial Design

By

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NATIONAL INSTITUTE OF TECHNOLOGY ROURKELA

CERTIFICATE

*This is to certify that the thesis entitled **"Design of a Quadcopter for Search and rescue Operation in Natural Calamities"** submitted by **M Dev Prasad Murthy (111ID0272)** in partial fulfillment of the requirements for the award of the degree **BACHELOR OF TECHNOLOGY** in **INDUSTRIAL DESIGN** at **National Institute of Technology, Rourkela** is an original work carried out by them under my supervision and guidance.*

The matter embodied in the thesis has not been submitted to any other university/institute for award of any other degree.

Date: 20/04/2015

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Last but not in the least I would like to thank my mother and my friends for all their valuable suggestions and their encouragement throughout the course of this project.

Sincerely,
M Dev Prasad Murthy (111ID0272).

ABSTRACT

In the last few decades there have been a lot of climatic changes because of human interference into the nature way of working. Because of this there have arised a lot of climatic as well as weather changes in the world's climatic atmosphere. Whatever the reason may be for this, but the immediate solution for this is highly necessary which lies in ourselves. The proposed solution from my side is to save the lives of the people as well as their property from being damaged and hampered because of this ignorance caused by us till now. Unmanned vehicles can be of lot help in this regard, which can fly at high altitudes and can catch the images of the areas that are under natural problems and can provide immediate help to them as necessary. The copters can send wireless message to the sites of control which handle such delicate issues and can thus provide help to the much needy ones.

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1. INTRODUCTION

1.1. Problem Statement

In the last few decades there have been a lot of climatic changes because of human interference into the nature way of working. Because of this there have arised a lot of climatic as well as weather changes in the world's climatic atmosphere. Whatever the reason may be for this, but the immediate solution for this is highly necessary which lies in ourselves. The proposed solution from my side is to save the lives of the people as well as their property from being damaged and hampered because of this ignorance caused by us till now. Unmanned vehicles can be of lot help in this regard, which can fly at high altitudes and can catch the images of the areas that are under natural problems and can provide immediate help to them as necessary. The copters can send wireless message to the sites of control which handle such delicate issues and can thus provide help to the much needy ones.

The use of digital image processing in today's modern world has a very diverse set of applications including traffic roads, surveillance, medical applications etc. apart from its use in areas of natural calamities. Therefore, the development of image processing should just not be seen as a device for natural calamities, but also a variety of other applications. The use of object detection through image processing has a huge role to play in border security of the nations.

1.2. Objective of the Work

Providing safety to its own people is and should be the priority of any government. But not many governments are able to provide proper safety to its citizens, especially in the cases of natural calamities which are not known to happen at beforehand. The main objective of the work is to provide rescue operation the people who are effected by natural calamities such as earthquakes, floods, landslides, tsunamis, etc. right at the spot of the misshapen. As per the project work, the search and rescue operation is to be done by using a quadcopter with the use of image processing and sensing of the person from a certain distance. The designed quadcopter has to reach the needful person right at the correct juncture at the right time, so as to come in handy. Even a slight non-sync in the timing could lead to the death of the person because the device was not there for his help. The report presents the devising method to prepare a quadcopter for rescue operation and also presents a fully handmade quadcopter towards the end of the process.

The second objective of the work is to provide a solution to the field of object detection and tracking through image processing. Issues identified with object tracking include developing great tracking algoriths, checking their capability and understanding their effect on image analysis framework. One of the major difficulties in object tracking is that of noise, complex object shape/movement, partial and full object occlusions, scene illumination changes, continuous processing requirements. My project deals with the development of object detection and tracking using color feature.

1.3. Literature Review

The literature review for this project has two separate segments. One segment will be dealing with the review analysis of previous occurrences of the quadcopters, whereas the segment will be openly dealing with the history and progress of object detection and tracking through image processing.

1.3.1 *Literature Review for Quadcopters*

The use of quadcopters in the recent years in various fields of work such as warfare, natural calamities, agriculture field surveillance, etc. has given a new dimension to the meaning of it, a bit more than its name. UAVs not just in the form of quadcopters, but also bicopters, tricopters, pentacopters, hexacopters, etc. are also employed in today's era. In agriculture purposes, the quadcopters are used for surveillance of the agricultural fields against tresspassers and the unprecedented growth of the pests. So basically the copters can be used for pest controlling. The most efficient use of these copters are made by US government when it comes to the field of modern warfare. The copters can be used to have a sneak peek into the opponent's camps without their pre knowledge about the spy activities. And the most important topic for my discussion is the use of quadcopters in natural calamities where they can be used to save human lives with the best survival rate possible. The best examples can be the ones in recent news in India, during the Uttarakhand flood, where we lost millions of lives. The use of quadcopters in here, by the Indian military deserves appraisal, because of which we were able to save a lot of people which could've proved even more fatal without its use. The various types of quadcopters and their recent uses in present times are discussed below in this section.

1.3.1.2 *Applications of quadcopter in recent times*

The using of copters in today's era in different purposes including natural disasters, agriculture crop areas, war purposes, journalistic activities, etc. have achieved ample a lot of popularity and media focus. A few of them are being discussed below in this section.

1.3.1.2.1 *Extensive use of copters in last year's Uttarakhand flood issue*

The use of copter's for the purpose of rescue and overseeing use in the last year's Uttarakhand flood is quite present in everyone's mind till now. It was a clear picture of huge feat achieved by human kind in this century. The copters employed by the indian government where chiefly responsible for saving thousands of innocent human lives who would have otherwise got killed due to the inhuman torture by the nature's decision. The government's employed quad as well as hexa copters flew at huge altitudes and could capture images with great focus of the topology conditions at the basic ground level. The cameras of the copters being of very good quality could obtain high pixel images through image procesing and thus send the obtained images to the base control room present at several kilometres distance from the area of the image capture.the total toll figure of the casualties were in the range of ten's of thousands as per the data provided by the disaster management council of the union government of our country. But the figure in the absence of the high flying copters could have been much more which was not the case because of the high quality and sophisticated drones used by the indian government at that point of time. The using of copters in today's era in different purposes including natural disasters, agriculture crop areas, war purposes, journalistic activities, etc. have achieved ample a lot of popularity and media focus. A few of them are being discussed below in this section. All have to agree to the point that the use of drones in the flood area case proved to be really vital for the whole human kind in protecting a lot of thousands of people from getting killed in the monstrous flood happening the Uttarakhand issue. The whole credit goes to the people who contributed in the rescue operation and using the technology as a tool to become a saviour of the whole mankind.

Fig 7 Photo captured by Quadcopter during Uttarakhand flood

1.3.1.2.2 *Drones to keep eye on crops in MP (Madhya Pradesh)*

After the huge success of using quadcopters (drones) in the area of Uttarakhand flood effected areas, the Madhya Pradesh government has decided to employ the technically advances and highly sophisticated quadcopters in the government controlled agricultural areas, where there is a lot trespassing and mishappening taking place in the recent past. The main purpose of the drones will be to oversee the crops during the day and night times and to report any subtle changes happening to the control centres present at different areas at a huge distance to the agricultural fields. The night time capturing cameras fitted to the copters will capture the images during the day as well as night time and with great camera lens it will take high quality images.

1.3.1.2.3 *Journalists goes into the act of using copters to catch protests, wars and floods*

Big ticket news journalists and channels have understood the implying advantage and the help that can be obtained from using the copters for their own purpose. The copters can be used for detecting the areas of natural calamities and supervising them for their rescue operation that can be carried out at those areas of immediate requirements. Also the drones can be used for the purpose of sting operations by the journalists for covering any illegal activities going on in their juristic areas. The primary use of the drones is found in the place of covering any mishappening such as natural calamities or any news covering by the media professionals such as sting operations or taking news from such areas where human entrance is simply not possible. These may include places such as those covering caves or high altitude hills or dense forests areas which are thick enough not to allow any human entering or interference to these places.

1.3.2 Literature Review for Object Detection and Tracking

1.3.2.1 *Previous developments*

The imperativeness and prevalence of movement analysis has led to several previous surveys: Wang and Zhao [1] proposed the movement detection by utilizing background subtraction system. In this video sequence is made out of a progression of video images which contains the features of geometry data of the target, separate pertinent data to analyse the movement of targets then get detection results. The compression ratio was incredibly progressed.

Rakibe et al. [2] described movement detection by creating a new algorithm based upon the background subtraction. In this firstly dependable background model based upon statistical is utilized. After that the subtraction between the current image and background image is carried out based upon threshold. And after that the detection of moving object is carried out. After that, morphological filtering is carried out to remove the noise and settle the background interruption trouble.

Kavitha et al. [3] exhibited movement detection by overcoming the drawbacks of background subtraction algorithm. An effectively computed background subtraction algorithm has been utilized, which has the capacity to resolve the issue of local illumination changes, for example, shadows and highlights and worldwide illumination changes.

Shafie et al. [4] exhibited movement detection utilizing optical flow strategy. Optical flow can emerge from the relative movement of objects and the viewer so it can give critical data about the spatial arrangement of the objects and the rate of change of this positioning. Discontinuities in the optical flow can help in sectioning images into areas that correspond to distinctive objects.

Shuigen et al. [5] developed movement detection by utilizing a system based on temporal difference and optical flow field. It is great at adjusting to the dynamic environment. Firstly, an outright differential image is computed from two continuous gray images. The differential image is filtered by low pass filter and converted into binary image. Also optical flow field is computed from image groupings by Hron's algorithm. Thirdly, moving object area is discovered by indexed edge and optical flow field.

Devi et al. [6] described movement detection utilizing background frame matching. This technique is exceptionally effective technique for looking at image pixel values in ensuing still frames captured after at regular intervals from the camera. Two frames are obliged to detect movement. First and foremost frame is called reference frame and the second frame, which is called the input frame contains the moving object. The two frames are analyzed and the distinctions in pixel qualities are resolved.

Lu et al. [7] exhibited movement detection by proposing a real-time detection algorithm. In this the algorithm incorporates the temporal differencing strategy, optical flow system and double background filtering (DBF) strategy and morphological processing methods to attain to better execution.

Wei et al. [8] paper describes an interactive offline tracking framework for bland color objects. The framework attains to 60-100 fps on a 320 × 240 video. The client can consequently effectively refine the tracking result in an intelligent way. To completely exploit client input and lessen client interaction, the tracking issue is tended to in a worldwide optimization framework. The optimization is productively performed through three steps. Initially, from client's info we prepare a quick object detector that places user objects in the video based on proposed features called boosted color bin. Second, we misuse the temporal coherence to create various object trajectories in view of a worldwide best-first technique. Last, an ideal object way is found by dynamic programming.

Jansari et al. [9] paper describes differential approach for optical flow estimation are in view of fractional spatial and temporal derivatives of the image signal. In this paper, the correlation between background demonstrating method and Lucas-Kanade optical flow has been carried out for object recognition. Background subtraction strategies require the background model from many images while the Lucas-Kanade optical flow estimation technique is a differential two frames method, in light of the fact that it needs two frames to work. Lucas-Kanade technique is utilized which partitions image into patches and figuring a solitary optical flow on each of them.

Wang et al. [10] paper describes a real time movement detection approach that is based on the combination of accumulative optical flow and double background filtering system to accomplish better execution. The collective optical flow system is utilized to get and keep a stable background image to adapt to varieties on ecological changing conditions and the double background filtering strategy is utilized to wipe out the background data and separate the moving object from it.

1.3.2.2 Object detection and tracking description

Provided a picture or a picture in the video frame generated, the objective of object recognition is to understand if or not there are any predefined things in the frame and reply with their locations and places. The thing recognition should understand how to separate out the particular thing from anything else in the picture. Object recognition is simply a question of binary separation solution; however extra context information data from background helps in making a strong and foolproof detecting algorithm, such as co-occurring of objects (points), stark and contrasting differentiating feature in the frame.

Fig 8 Color Detection Image

Video processing is the phenomenon of finding out the path of aa point object in the picture or image frame as it alters around a scene. The major objective of point tracking is to find the relationship between the object point in successive image planes. The relation could be highly disturbing when the points are moving with speed wrt the frame speed rate. An interchanging scene may grow the unpredictable nature of the object point is the space when the tracking point may alter its spatial orientation sequentially. Our major objective is to find the path of the realtime moving points in various different image frames that re generated from the ongoing video frame rate speed with the assisting help of the devised algorithm, using the concept of color detection as a real time tracking frame work. Use of colour tracking offers a few notable advantages such as computing simple nature, robust nature in semi or whole occlusion, rotating scale and changes in resolution.

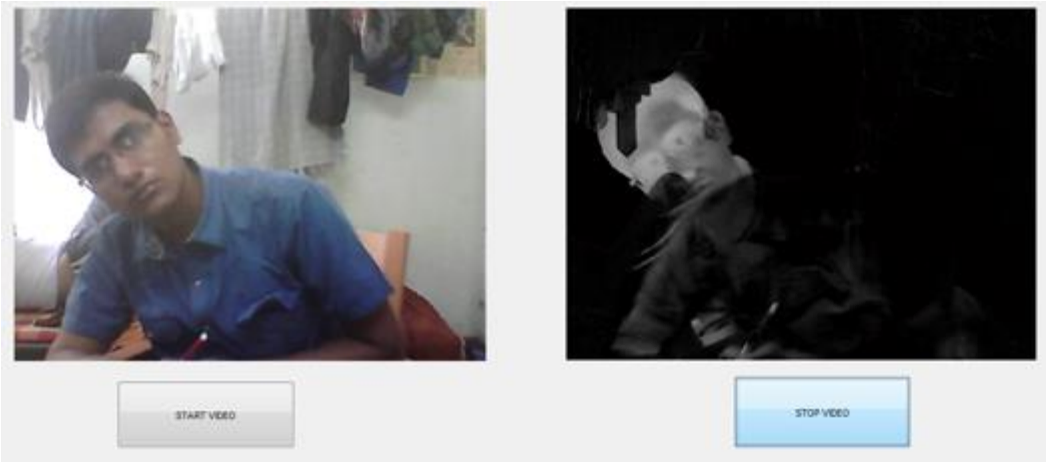


Fig 9 Motion Tracking

1.3.2.3 Applications

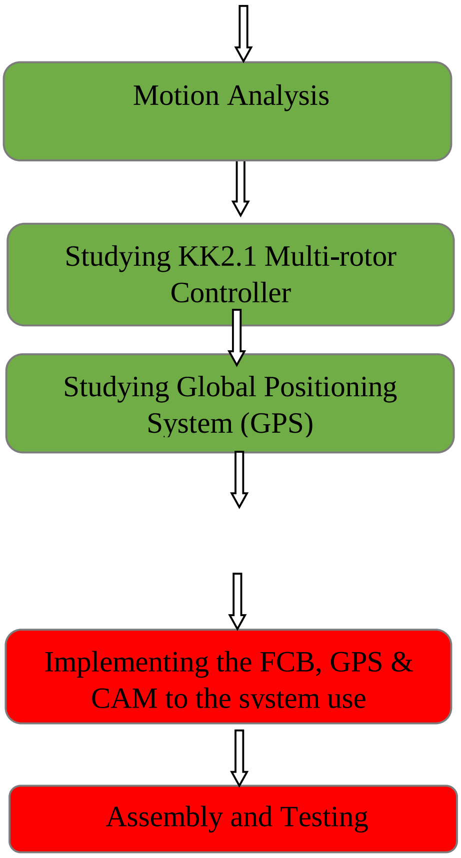
Object detection and tracking has got several industrial uses in the form of mobile robots which are assigned with the task of picking and dropping of objects to and from the shop floor. It is chiefly used in traffic control devices where video trackers target the vehicles which surpass the traffic guidelines and violate them. The field of security and surveillance also employs the technology of human tracking for the purpose of wealth and human life safety. Eg include secure areas of banks, places of exhibitions, etc.. Use of human detection and tracking in areas of natural calamities by employing flying devices such as quadcopters, have played a major role in saving hundreds of lives in recent times. The field of medical imaging uses detection and tracking for the purpose of identifying internal organs in the human bodies and accessing the right medical problem.

Fig 10 Applications of Object Detection

2 METHODOLOGY

2.1 Methodology for Quadcopter

Theoretical analysis



2.1.1 *Theoretical Analysis*

The following analysis are conducted which can be categorized under theoretical analysis. These below points under this section correspond to the major discussions involved in a quadcopter development project.

2.1.1.1 *Forces and torque acting on the Quadcopter*

A quadcopter in full motion experiences the following forces and toque acting upon it.

a) Lift generated by each motor.
b) Gravitational pull acting on total lift generated
c) Moments can be achieved by generating yaw, roll and pitch movements
d) Yawing torque is the result of four individual torques generated by spinning motors
e) Rolling torque can be produced by increasing left motor's thrust and decreasing right motor's thrust and vice-versa
f) Pitching torque can be generated by increasing front motor's thrust and decreasing back motor's thrust and vice-versa

The above mentioned forces and torques acting upon the quadcopter are chiefly responsible for uplifting of the quadcopter into the air and providing further stability to the drone at high altitude levels. It basically increases the manuverality of the copter to hover at required and designed frequency parameters without losing its stability at any cost whatsoever. As mentioned above the yawning torque provides the resultant for the four individual torques acting upon the system, the rollint torque is due to difference in between the left and right side motors. Lift and gravitational forces apply forces upon the quadcopter in two opposite directions ie upward and downward. The pitching one is caused due to uprising and down falling of the front and back motors thrust.

2.1.1.2 *Structure of Quadcopter*

The model of a quadcopter (drone) helicopter is a quite basic one, simply comprising of 4 motors that are fixed at the both ends of a symmetrical crossing symbol. The major points that are to be seen into consideration in such a model case are symmetrical base and rigid body of the cross. To let go of the unstable flying, the model body has to be as rigidity as possible, while keeping the lightest weight of the body as much as possible. The best trick to get this is by using light weight composite materials or the alloys that are very less weight in nature. Symmetrical nature is also of very high important nature for its stable flight. The centre of gravitational pull (COG) has to be as near to the middle portion of the quadcopter (drone) as much as possible.

Fig 11 Quadcopter Structure

2.1.1.3 *Electronic system integration of the quadcopter*

The electronic integration of the quadcopter system for our project work consists of several integrated sysyems for the power distribution through LiPo batteries and the PDB board that is responsible for the main power bus for the system. Then the power is supplied to the communication system which basically consists of the wireless transmitter system and the receiver that is connected to the actual quadcopter flying at huge heights. The receiver then gets the RC radio signals from the transmitter through wireless communication and then processes according to the achieved signals from the ground based transmitter base. Then comes the second most important feature of any quadcopter system that is the vision system of the drone. The vision system is responsible for the capturing of the real time videos from the environment and then recording for further processing in the base station.it is done through camera system that is attached to the system in the air itself. The AHRS system is basically responsible for gathering various parameters such as gravitational force at that height, magnetic field of the area, the latitude and longitude data and several other things. The gyroscopes which is a part of the AHRS system is mainly responsible for finding out the precise data regarding the directions and the GPS system is responsible for collecting information regarding the actual location of the copter in the air and what are its base longitudes and latitudes.

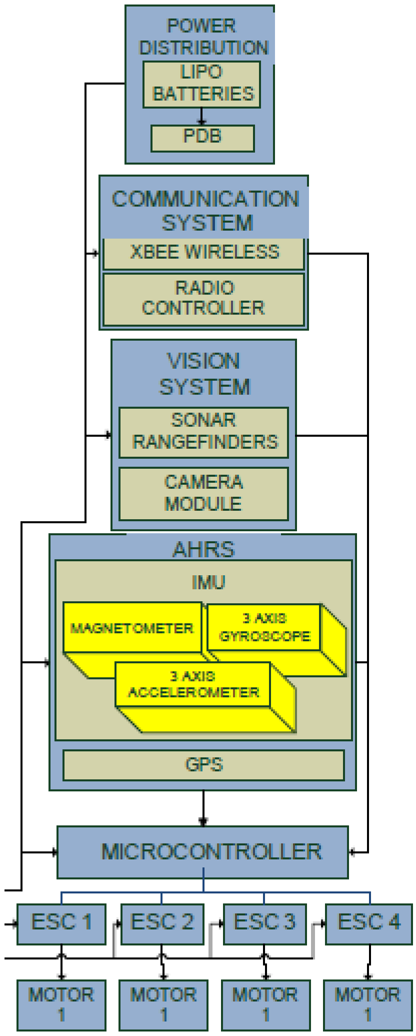


Fig 12 Electronic Integration of a Quadcopter

2.1.2 *Motion Analysis*

Like any day to day conventional type of copter (drone), a quad-rotor multi copter has 6 degrees of freedom directions, which is highly non-linear in nature, has multi variable, is strong coupling done, and is under actuating system. The major force and the moments pressing on a quad coter helicopter are given by its motor. It is definitely a simple type of setup done from its 2 motor analogue, as quad coter drones are maintained exclusive by varying in motor speed. 2 pairs of motors always rotating in two different directions is to balancing the final torque of the drone system. The below mentioned diagram shows a free sketch figure of a typically made quad copter type helicopter. As shown, only 2 reference frames are to be used (the fixed earth frame E, and the bodily based frame B), unlike to that of conventional type of quadcopter which has three inbuilt frames attached to it.

2.1.2.1 *Flight Dynamics*

The basic thrust acting diagram for a quadcopter is presented below which shows the forces acting upon the system in various state of its motion such as in case of variable flight, hovering cases, rolling or pitching motions and several other cases. In case of hovering flight, the forces generated by all the four different motors are the same. In case ofrolling motion there is a subtle difference in the front and back motors thrust generated. In pitching motion, there is a difference in the motors speed for the left and right side of the motors speed and thus the thrust generated.

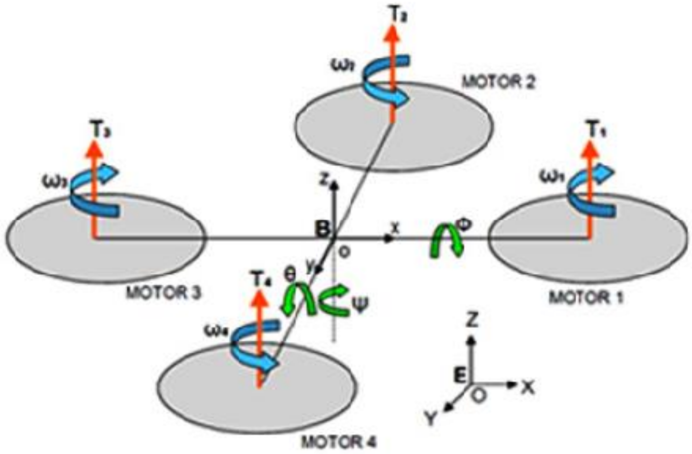
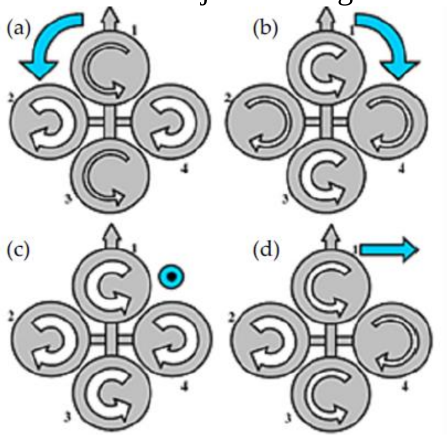


Fig 13 Quadcopter – Free Body Diagram

Though this seems to be quite simple to naked eyes, but in reality there are several considerations that has to be taken into account in order to maintain a stable flight at high altitude levels. The major challenge will be to keep the system stable at high heights.



Quad-rotor dynamics, (a) and (b) different forces generated to change the yawing angle (ψ); (c) hover motioning and vertically propulsion due to the balancing torque; and d) different thrust to change the pitching angle (θ) the rolling angle (fi).

Fig 14 Torque Mechanism

2.1.2.2 *Motion Planning (Rotor Aerodynamics)*

Momentum theory is to be used in order to provide relation in between power, thrust and induced velocity and the rotor power. Using the conservation of energy, it could be shown that in hovering,

$$T = 2\rho A v_i^2$$

where Thrust is the T, (ro) is air density, *A* is rotor's cross sectional area and *vi* is the velocity of the air that is induced at the motor. Blade element theory is chiefly helpful for air foil and performance of the motor. The moments and force developing on a wing that is uniformed in nature are modelled by,

$$L = C_L \frac{1}{2} \rho v^2 c$$

$$D = C_D \frac{1}{2} \rho v^2 c$$

$$M = C_M \frac{1}{2} \rho v^2 c^2$$

where, span of the unit, lift produced is L, profile drag and the pitching moment are D and M respectively.
V – Velocity of wing,
C – Chord length,
CL, CD, CM –are the constant that are dimensionless,
W – Angular velocity, alpha is the angle of attack and RE is the Reynold’s Number.

$$v = \omega R$$

After the integration of the lift and drag about the lengths of blades, the similiar rules are to be generated for the whole motor. Where *d* and *b* are the drag and thrust moment constants respectively.

$$F_i = b\omega_i^2 \qquad b = C_T \rho A R^2$$

$$\tau_i = d\omega_i^2 \qquad d = C_Q \rho A R^3$$

Fi – thrust made by the motor,
Ti – drag constant, R – rotor radius, CQ and CT are dimensionless constants.
Small sized motors always required high amount of speeds and high range of power than large sized rotors for producing the thrust of equal amount . The respective total thrust force and rotor torque of the system is,

$$f = \sum_{i=1}^{4} F_i$$

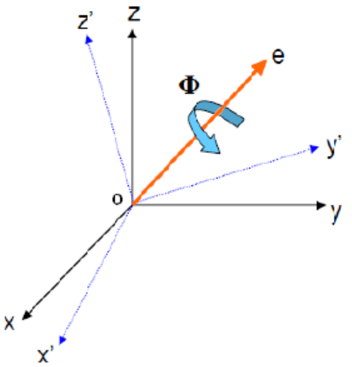
2.1.2.3 *Co-ordinate reference frame and the rotation matrix*

There are always two different types of frames in any copter (drone) system ie the earth fixed frame and the other one is the body frame. Any calculation taking place in the quadcopter system is based upon thses two frames that are inter dependent upon each other. Any changes made to the earth fixed frame will automatically result in errounious changes happening to the body frame of the system. The body frame is basically attached to the system and moves along with the system to wherever it goes. Along with it, the position coordinates of the point will also vary. Suppose the drone moves from a point of operation to a different point of use, then the GPS system that is electronically attached to the system will record and find out the physical coordinates of the system and thus keep the system away from any miss cause happening to it. Whereas the earth fixed remains as it is at the groung surface and keeps mapping the copter system to its coordinates values.

$$\begin{bmatrix} i' \\ j' \\ k' \end{bmatrix} = R \begin{bmatrix} i \\ j \\ k \end{bmatrix}$$

Where,

$$R = \begin{bmatrix} i' \cdot i & i' \cdot j & i' \cdot k \\ j' \cdot i & j' \cdot j & j' \cdot k \\ k' \cdot i & k' \cdot j & k' \cdot k \end{bmatrix}$$



Euler axis and principal angle on a rotating co-ordinate frame

Fig 15 Co-ordinate Reference Frames

The R is orthogonal rotational matrix, which is implying that the matrix to be transposed is equivalent to its form in inverse. For any type of rotation, there exists a rotation matrix, which is produced on manipulation to the original one and on further accessing, it produces a third type of matrix.

$$R'' = R \cdot R'$$

The above formula is extremely important since the resulatnt matrix can be found out from the multiplication of the three different matrixes in their respective directions of x,y and z. $R = R_x \cdot R_y \cdot R_z$

Here the rolla angle, pitch angle and the yaw angle are represted about the respective X, y and z axes and are represnted by the fi, theta and si angles respectively.

$$R_x = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\phi & \sin\phi \\ 0 & -\sin\phi & \cos\phi \end{bmatrix}$$

$$R_y = \begin{bmatrix} \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \\ \sin\theta & 0 & \cos\theta \end{bmatrix}$$

$$R_z = \begin{bmatrix} \cos\psi & \sin\psi & 0 \\ -\sin\psi & \cos\psi & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Rotation matrix R is the resultant of the above equation, in where sin and cos values are represented by their short forms,

$$R = \begin{bmatrix} c\theta c\psi & c\theta s\psi & -s\theta \\ s\phi s\theta c\psi - c\phi s\psi & s\phi s\theta s\psi + c\phi c\psi & s\phi c\theta \\ c\phi s\theta c\psi + s\phi s\psi & c\phi s\theta s\psi - s\phi c\psi & c\phi c\theta \end{bmatrix}$$

2.1.2.4 *Formulating Thrust Forces*

Step 1 – the power consumed by the copter syatem is formulated from the below given formula. It depends upon the thrust generated and the velocity of the air at the motor propellers areas.

$$P = Tv_h$$

Step 2 – in the second step, the hover velocity for the quadcoptersystem is calculated based upon the thrust and the area of cross section of the motors. Also the air density is a major deciding factor in here while using the momentum theory.

$$v_h = \sqrt{\frac{T}{2\rho A}}$$

Step 3 - Here the density of the surround airy atmosphere is r and the area sweeping out of the motor is A. Using our simple power equation we obtain,

$$P = \frac{K_v}{K_t}\tau\omega = \frac{K_v K_\tau}{K_t}T\omega = \frac{T^{\frac{3}{2}}}{\sqrt{2\rho A}}.$$

Step 4 - Generally, the torque for any force is calculated by the product of r and force. Here kt depends upon some propeller parameters and settings. By solving the total equation for torque, we find ou that it is proportional to the root power of the w ie the angular velocity of the wings.

$$T = \left(\frac{K_v K_\tau \sqrt{2\rho A}}{K_t}\omega\right)^2 = k\omega^2$$

$$T_B = \sum_{i=1}^{4} T_i = k \begin{bmatrix} 0 \\ 0 \\ \sum \omega_i{}^2 \end{bmatrix}$$

So finally, the torque acting upon the motor propellers are found out to be proportional to the frictional force sacting upon the wings. Also the torque can be separated out for its effect on three perpendicular directions of x,y and z.

$$F_D = \begin{bmatrix} -k_d\dot{x} \\ -k_d\dot{y} \\ -k_d\dot{z} \end{bmatrix}$$

If extra perfection is required, then the kd constant has to be taken into three different frictional constant, one for each direction of propelling motion. If I want to do these, then i would want to find the force in the bodily frame rather than in the earth based frame which is fixed.

2.1.2.5 *Formulating Torque*

Step 1 – in order to find out the torque acting upon the copter system, we have to first find out the force acting upon the wings as drag forces. The drag force is provides below,

$$F_D = \frac{1}{2}\rho C_D A v^2.$$

r- density of fluid (air density),
A – cross section of the propeller,
CD – dimensionless constant.
Step 2 - On applying all these factors the final equation is got as follows –

$$\tau_D = \frac{1}{2}R\rho C_D A v^2 = \frac{1}{2}R\rho C_D A(\omega R)^2 = b\omega^2$$

R,w – radius of the propeller and the angular velocity. Here it is taken into assumption that the forces are acting at the wing tips and not in the middle portion. In order to formulate the total acting torque in the z direction, we follow the below formula –

$$\tau_z = b\omega^2 + I_M\dot{\omega}$$

IM – MOI that is the moment of inertia, w- angular acceleration.
Step 3 - On assuming that the flight of the copter system takes place with a constant velocity without any acceleration, we get the below mentioned equation –

$$\tau_z = (-1)^{i+1} b{\omega_i}^2.$$

Here (-1)i+1 is by nature positive if the wing is rotating in CW direction, or else it will be negative. The final torque acting upon the wing in vertical direction is –

$$\tau_\psi = b\left({\omega_1}^2 - {\omega_2}^2 + {\omega_3}^2 - {\omega_4}^2\right)$$

Step 4 - Rolling & pitching torques are obtained from mechanics observation. We can assumingly take the i = 3 and i = 1 motors to be on the roll axis, so

$$\tau_\phi = \sum r \times T = L(k{\omega_1}^2 - k{\omega_3}^2) = Lk({\omega_1}^2 - {\omega_3}^2)$$

By a similar expression the pitch torque is given

$$\tau_\theta = Lk({\omega_2}^2 - {\omega_4}^2)$$

L – centre distance from the wings. Finally, the body frame torques are abtained as –

$$\tau_B = \begin{bmatrix} Lk({\omega_1}^2 - {\omega_3}^2) \\ Lk({\omega_2}^2 - {\omega_4}^2) \\ b\left({\omega_1}^2 - {\omega_2}^2 + {\omega_3}^2 - {\omega_4}^2\right) \end{bmatrix}$$

2.1.3 *Formulating Motion Coefficients*

Various motion coefficients such as drag coefficients and several motor coefficients are formulated below in this section.

2.1.3.1 *Finding out drag co-efficient 'Cd' for the torque equation*

The drag coefficient is a value that depends upon the resiatance or backward force acting upon the wing such as due to air, water or fluidic movements.

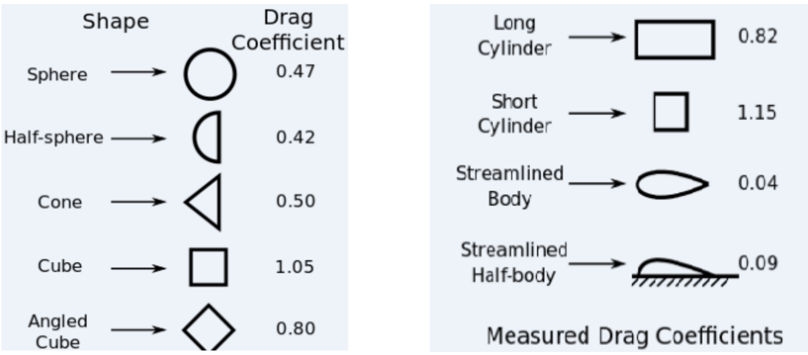


Fig 16 Values of Drag Coefficients

2.1.3.1.1 *Factors effecting Cd values*

Generally the drag coefficient is not a definite value which would remain constant for any shape. It changes its value depending upon the shape as well as the flow speed of the local fluids nearby which is specifically the Reynold's no.

Cd value	Item
0.001	Laminar flat plate parallel to flow (Re < 10^6)
0.005	Laminar flat plate parallel to flow (Re > 10^6)
0.1	Smooth sphere (Re = 10^6)
0.47	Smooth sphere (Re = 10^5)

Table 1 Drag Coefficients Value

2.1.3.2 *Finding out the constants for motor (Kt and Kv)*

2.1.3.2.1 *Torque proportionality constant (Kt)*

It describes the torque generated by the motor for a specific motor current :

Kt = T / I ;

where T = torque generated by the motor (N – m)

I = motor current (Ampere)

and Kt is in N – m/A

2.1.3.2.2 *Voltage proportionality constant (Kv)*

EMF is to be arised across a motor's brushing when its coil is to be rotating by an externally driven force – the level of the sense depending on geometrical factors and also the speed which the coil is to be rotating.

2.1.4 *Motor specifications for the quadcopter system*

For my project I decided to use DC brushless motors keeping in mind the voltage rating of the chosen motors should be good enough for my project. Also since there will be no AC power supply to the copter system, there may be chances that it will need dc power supply from already attached 4000mAh batteries.the supplies thrust by each motor has to be wiight of motor *0.5.

Final specifications

Item	specification
KV	650 Kv – 2000 Kv
No. of cells	2 – 4
Idle current	< 1.2 A
Motor shaft	4 * 27 mm
Stator diameter	35mm
Stator length	7 mm
Maximum current	Around 16 A

Item	specification
Maxim. const. power	233 W
Efficiency	> 83 %
Internal resistance	0.114 ohm
Cable length	50 – 60 cm
Mot. dimns. (dia*len)	42 mm
Weight	80 – 90 gm

Table 2 Motor's Specification

2.1.5 *Studying KK2.1 Multi-Rotor Controller*

The microcontroller that I am using for my project purpose is that of KK2.1 controller. The reason for using only this one is that it is cheaply available in the market as compared to other ones. As well as this one is good enough for my system, keeping in mind the level of accuracy that I need, since I will be using it only for my project purpose and not working model.

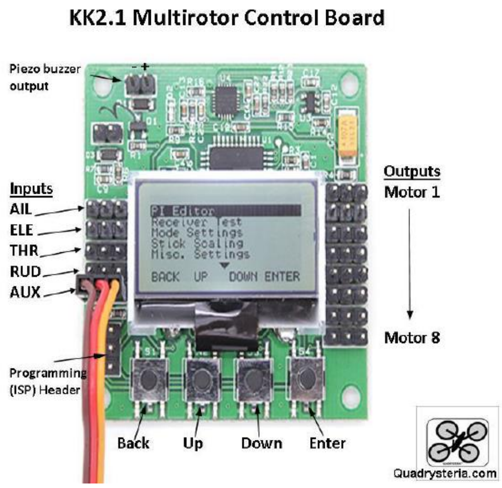


Fig 17 KK2.1 Multirotor Controller Board

2.1.6 *Studying Global Positioning System (GPS)*

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil and commercial users around the world. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver

2.1.6.1 *Basic concept of GPS*

A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth. Each satellite continually transmits messages that include

a) The time the message was transmitted

b) Satellite position at the time of message transmission

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite using the speed of light. Each of these distances and satellites' locations define a sphere. The receiver is on the surface of each of these spheres when the distances and the satellites' locations are correct. These distances and satellites' locations are used to compute the location of the receiver using the navigation equations. This location is then displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included. Many GPS units show derived information such as direction and speed, calculated from position changes.In typical GPS operation, four or more satellites must be visible to obtain an accurate result.

2.1.6.2 *History of GPS*

Since prehistoric times, people have been trying to figure out a reliable way to tell where they are, to help guide them to where they are going, and to get they back home again. The earliest mariners followed the coast closely to keep from getting lost. Unfortunately for Odysseus and all the other mariners, the stars are only visible at night - and only on clear nights. The next major developments in the quest for the perfect method of navigation were the magnetic compass and the sextant. The needle of a compass always points north, so it is always possible to know in what direction you are going. In the early 20th century several radio-based navigation systems were developed. A few ground-based radio-navigation systems are still in use today. One drawback of using radio waves generated on the ground is that you must choose between a system that is very accurate but doesn't cover a wide area, and one that covers a wide area but is not very accurate. High-frequency radio waves (like UHF TV) can provide accurate position location but can only be picked up in a small, localized area. Lower frequency radio waves (like AM radio) can cover a larger area, but are not a good yardstick to tell you exactly where you are. A transmitter high above the Earth sending a high-frequency radio wave with a special coded signal can cover a large area and still overcome much of the "noise" encountered on the way to the ground. This is the main principle behind the GPS system.

2.1.6.3 *Structure of GPS*

The current GPS consists of three major segments. These are the space segment (SS), a control segment (CS), and a user segment (US). The U.S. Air Force develops, maintains, and operates the space and control segments. GPS satellites broadcast signals from space, and each GPS receiver uses these signals to calculate its three-dimensional location (latitude, longitude, and altitude) and the current time.

The space segment is composed of 24 to 32 satellites in medium Earth orbit and also includes the payload adapters to the boosters required to launch them into orbit. The control segment is composed of a master control station, an alternate master control station, and a host of dedicated and shared ground antennas and monitor stations. The user segment is composed of hundreds of thousands of U.S. and allied military users of the secure GPS Precise Positioning Service, and tens of millions of civil, commercial, and scientific users of the Standard Positioning Service.

2.1.6.3.1 *Space Segment*

The complete GPS space system includes 24 satellites, 11,000 nautical miles above the Earth, which take 12 hours each to go around the Earth once (one orbit). They are positioned so that we can receive signals from six of them nearly 100 percent of the time at any point on Earth. There are six orbital planes (with nominally four Space Vehicles in each), equally spaced (60 degrees apart), and inclined at about fifty-five degrees with respect to the equatorial plane.

Satellites are equipped with very precise clocks that keep accurate time to within three nanoseconds. This precision timing is important because the receiver must determine exactly how long it takes for signals to travel from each GPS satellite. The receiver uses this information to calculate its position.

2.1.6.3.2 *Control Segment*

The control segment consists of a worldwide system of tracking and monitoring stations. The monitor stations measure signals from the GPS satellites and relay the information they collect to the Master Control Station. The Master Control Station uses this data to compute precise orbital models for the entire GPS constellation. This information is then formatted into updated navigation messages for each satellite.

2.1.6.3.3 *User Segment*

The user segment consists of the GPS receivers, processors and antennas utilized for positioning and timing by the community and military. The GPS concept of operation is based on satellite ranging. Users figure their position on the earth by measuring their distance to a group of satellites in space. Each GPS satellite transmits an accurate position and time signal. The user's receiver measures the time delay for the signal to reach the receiver. By knowing the distance to four points in space, the GPS receiver is able to triangulate a three-dimensional position.

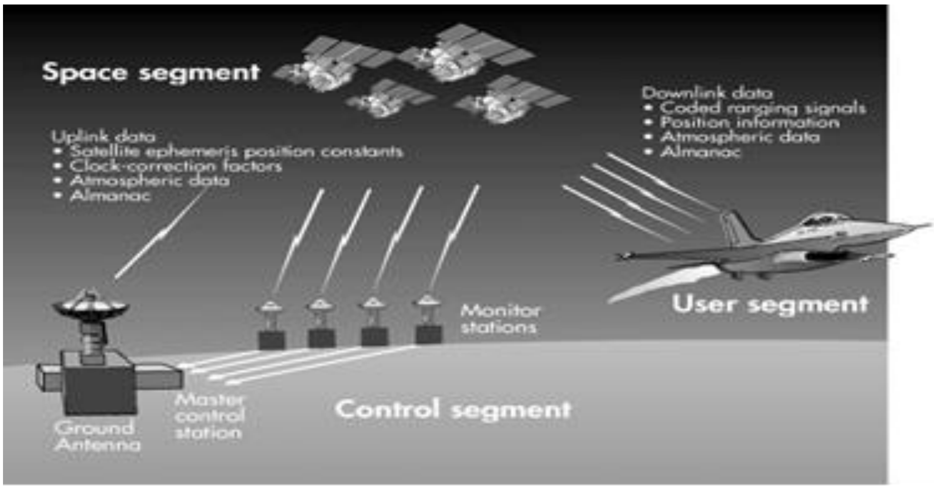


Fig 20 GPS System Working

2.1.6.4 *GPS tracking unit*

A GPS tracking unit is a device that uses the Global Positioning System to determine the precise location of a vehicle, person, or other asset to which it is attached and to record the position of the asset at regular intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location data base, or internet-connected computer, using a cellular (GPRS or SMS), radio, or satellite modem embedded in the unit. This allows the asset's location to be displayed against a map backdrop either in real time or when analyzing the track later, using GPS tracking software.

2.1.7 Studying the FS-CT6B 2.4G 6CH Radio control rc Transmitter Receiver

This rc transmitter and receiver is required to transmit signals to the quadcopter which is flying in the air. It is a typical 6 channel transmitter, with two channels at the left side rudder & throttle, two channels at the right side aileron &elevator and last two channels at the right and left top portions which are Variable A and Variable B. And then we have flagger switch on both sides. Also there is trim for the 4 main axes. The other parts are the power button, battery indicator, the bind button, a folding 2.4 GHz antenna, sink portion and the battery charging port (should never be used since the polarity is opposite of what it should be and thus might just burn the transmitter).

The receiver is a 6 channel antenna with a battery port/bind port. The bind cable is inserted to the port, the bind button is switched on and the transmitter is ready.

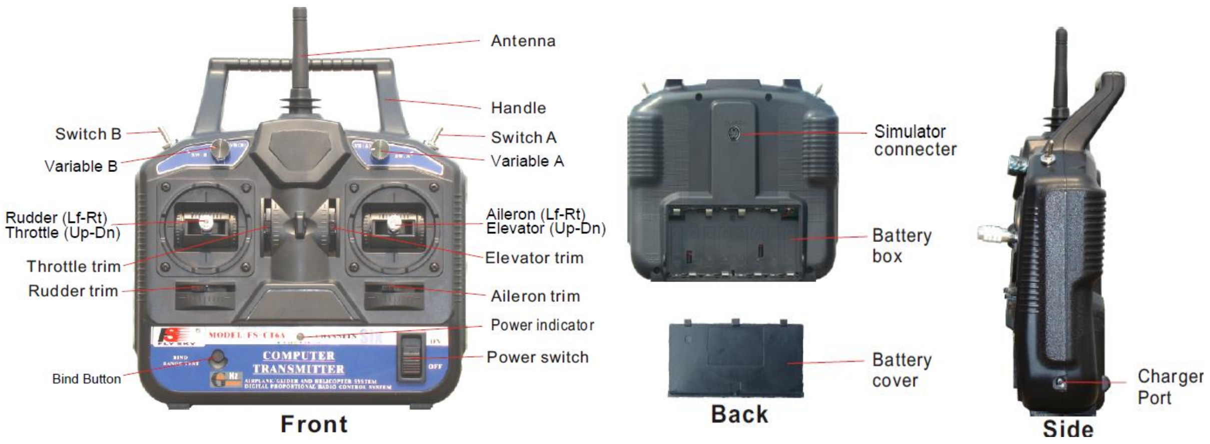


Fig 21 RC Transmitter System

2.1.7.1 *Transmitter specifications*

*Channels: 6
*Charger port: Yes
*Frequency band: 2.4GHz
*Simulator port: PS-2
*Power resource: 1.5V*8 "AA"Battery
*Program type: GFSK
*Modulation type:FM
*RF power: 19db
*Static current: ≤250mA
*Voltage display type: LED
*Size: 189*97*218mm
*Weigth: 575g
*Color: black
*Antenna length: 26mm
*Heli-140/Heli-120/Heli-90/Acro
*Sub Trim: Yes
*Thro Cuv: Programmable
*Pith Cuv: Programmable (Pitch curve)
*Support multiple user model
*Support trim movement
*Support rudder angle overturned (Sorry, this is too strange to even guess about - DBacon)
*Support rudder angle adjustment
*Support both hand software adjustment (Mode setup)
*Support swashplate adjustment
*Support programmable channel output

2.1.7.2 *Receiver specifications*

*Channels: 6
*Frequency band: 2.4GHz
*Power resource: 1.5V*4 "AA"Battery
*Program type: GFSK
*Modulation type: FM
*RF Receiver sensitivity: -76db
*Static current: ≤85mA
*Size: 45*23*13. 5mm
*Size: 25*16. 8*6. 5mm
*Weigth: 12g
*Color: Gray semi-transparent
*Antenna length: 26mm

2.1.8 *Studying the DYS Turnigy 30A ESC speed controller*

Electronic speed controllers as commonly known as ESCs are the devices that are chiefly responsible for maintaining the controllable speed of the motors as well as the changes caused to the motor's speed regarding the ESC motion controlling. It manipulates the acting state of the copter system like in case of pitching or yawing motion ie which motor speed has to be varied and which one should not be changed or so. Like in rolling motion, the motor rotating speed of the right hand motor is increased whereas the left hand side motor's speed is infact decreased below its normal level. These all things happen as per the electronic coding done to the ESC and the onspot requirements that arise at any particular point of tome. Electronic speed controllers as commonly known as ESCs are the devices that are chiefly responsible for maintaining the controllable speed of the motors as well as the changes caused to the motor's speed regarding the ESC motion controlling.

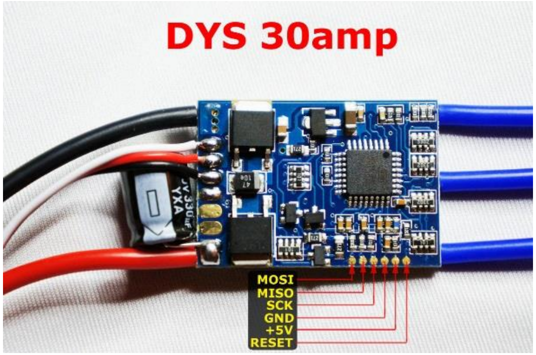


Fig 22 30A ESC

2.1.8.1 *Specifications*

Output: Continuous 30A, burst 35A up to 10 seconds.
Input Voltage: 2-4 cells lithium battery or 5-12 cells NIMH battery.
BEC: Linear 2A @ 5V
Control Signal Transmission: Optically coupled system.
Max Speed:
2 Pole: 210,000rpm
6 Pole: 70,000rpm
12 Pole: 35,000rpm
Size: 50mm (L) * 26mm (W) * 12mm (H).
Weight: 25g.

2.1.8.2 *Parameters*

High performance microprocessor brings out the best compatibility with all kinds of motors and the highest driving efficiency.
Wide-open heatsink design to get the best heat dissipation effect.
Improved Normal, Soft, Very-Soft start modes, compatible with aircraft and helicopter.
Smooth, linear, quick and precise throttle response.
Multiple protection features: Low-voltage cut-off protection / Over-heat protection / Throttle signal loss protection
Programable via transmitter

2.1.9 *Various other components integrated in the system*

a) Plastic Propeller CW/CCW pair – 10*45" size.

b) Multicopter Frame Kit – HJ 450 4 –Axis DIY Quadcopter Xcopter MWC UFO MMC10.

c) LiPo Battery Pack – Turnigy 11.1v 3s 5000mAh.

d) DC Power Supply Adapter – Imax B6 Multi-function 2198 LiPo NiCd/MH with 12V 5 Amp.

e) Camera fit to Quadcopter – Servo bracket PT Pan/Tilt.

2.1.10 *The assembly process for the quadcopter*

The assembly process for the Quadcopter starts with building the main frame for the air vehicle. For this the multicopter frame kit is assembled. Firstly, the long rods are fitted to the base chassis through nuts and screws to form the four winged simple model. Then comes the ESC's and power bus. Here four ESCs are required for 4 different motors. The ESCs are connected to the power bus at four separate ports of it. The power bus is kept clamped (fixed) to the base rectangular chassis. Then four DC brushless motors are fitted to four different propellers in CW/CCW pairs. Then, the three terminals of the motors are connected to the respective ESCs, inorder to control the speed variations in the motors. Then the four ESCs are also placed within the base chassis through upper cover clamping. Then at the top, the KK2.1 Multicopter micro-controller is clamped by using Velcro straps or clamping. Then, the ESCs are connected to the micro-controller and also the 2.4GHz receiver antenna. Lastly, the 5000 mAh battery is connected to the pwer bus to supply DC power to the Quadcopter. The Quadcopter is then binded to the FS-CT6B 6CH transmitter, inorder to receive the radio signals for communication. It has to be remembered that during flying of the quadcopter, the battery has to be connected each single time, during receiving of the transmitted radio signals from the ground based transmitter.

2.1.11 The final model of the quadcopter

Finally, the quadcopter is ready to fly are completing the assembly process. Though, there were initially some air disturbances regarding the flight control at high altitudes, me and my senior colleage were able to overcome the problems proper weight distribution in the quadcopter.

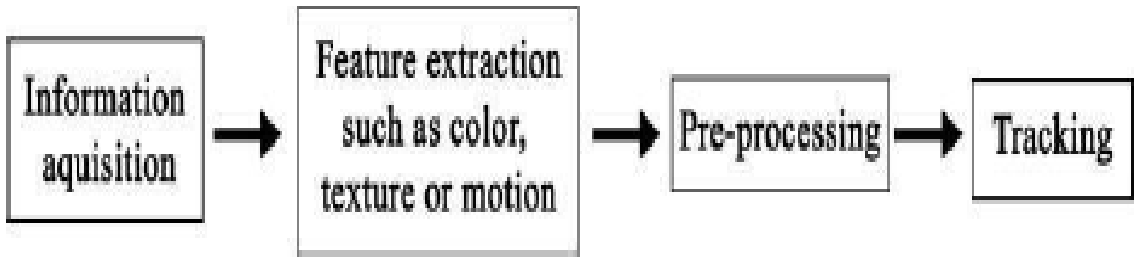
The working model is presented below –

Fig 23 Working Model of Quadcopter preparing for flight

Fig 24 Quadcopter flying at High Altitude

2.2 Methodology for object detection and tracking

The fundamental building block diagram for detecting and tracking objects using color feature and motion is as –



The fundamental block diagram comprises of Information Acquisition, Pre-processing, Feature Extraction and Tracking.

2.2.1 *Information acquisition*

Information Acquisition intends to acquire the video frames utilizing the Image Processing Toolbox. The frames are gained with the assistance of the camera exhibit in/on your framework. Information acquisition employs the wire/wireless cameras integrated to the system and is given the work of capturing the video from the environment and obtain the frames from it. After the video is captured using the Video Acquisition Toolbox, the video is being segregated into separate frames and then the frames are sequenced in a chronological order of their occurences.

2.2.2 *Pre-processing*

In pre-processing first we change the color picture to gray image, since it is easy to process the gray image in single shade rather than three shades (takes less time in handling). In pre-processing, first we change over the color picture into gray, on the grounds that it is not difficult to process the gray image in single shade rather than three shades. Gray images obliges less time in handling. At that point we apply median filter to expel clamor from images or frames got from the video. The images or frames analyzed out with the assistance of the command "medfilt2" show in the Image Processing Toolbox.

2.2.2.1 *Grayscale image forming*

The conversion of the RGB image frame into a grayscale image. In computing a grayscale or greyscale digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort, also known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest.

Grayscale images are distinct from one-bit bi-tonal black-and-white images, which in the context of computer imaging are images with only the two colors, black, and white (also called *bilevel* or *binary images*). Grayscale images have many shades of gray in between.

Grayscale images are often the result of measuring the intensity of light at each pixel in a single band of the electromagnetic spectrum (e.g.infrared, visible light, ultraviolet, etc.), and in such cases they are monochromatic proper when only a given frequency is captured. But also they can be synthesized from a full color image; see the section about converting to grayscale

2.2.2.2 *Median filtering*

At this point we apply median filtering, which is a nonlinear method used to remove noise from the images. It is widely used as it is very effective at removing noise while preserving edges.

The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighbouring pixels. The pattern of neighbours is called the "window", which slides, pixel by pixel over the entire image. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value.

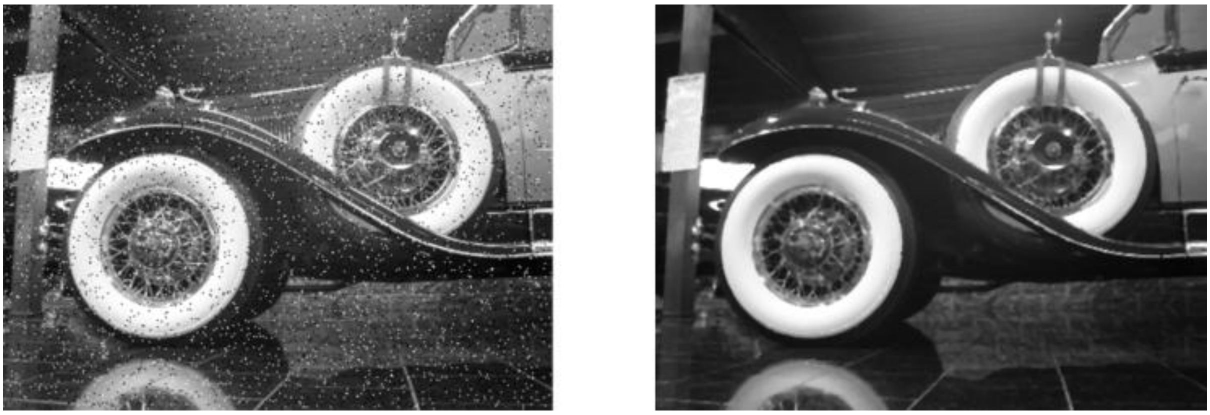
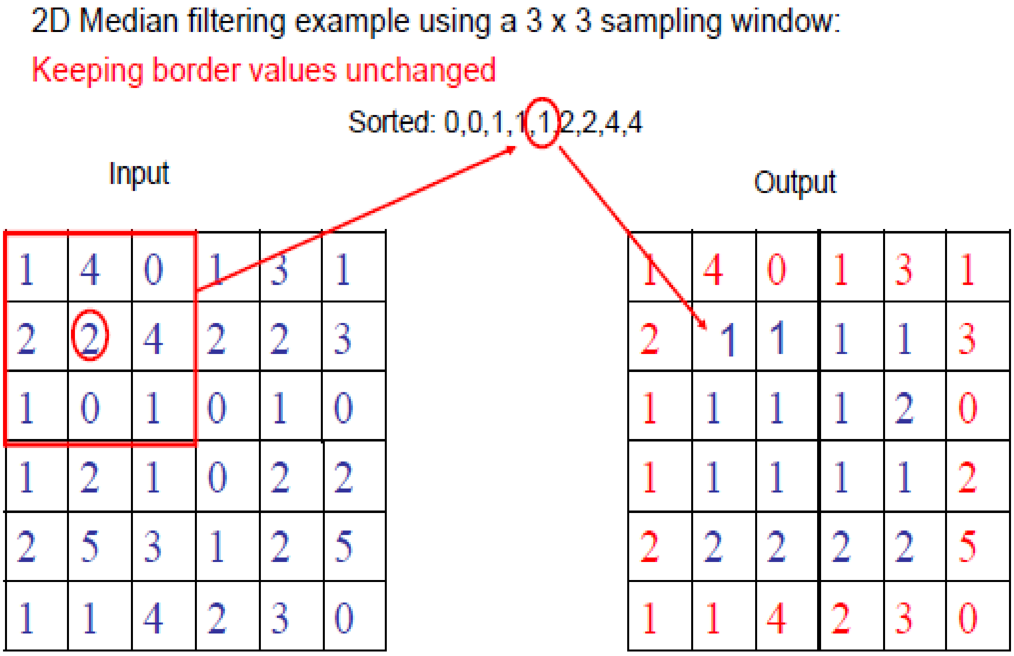
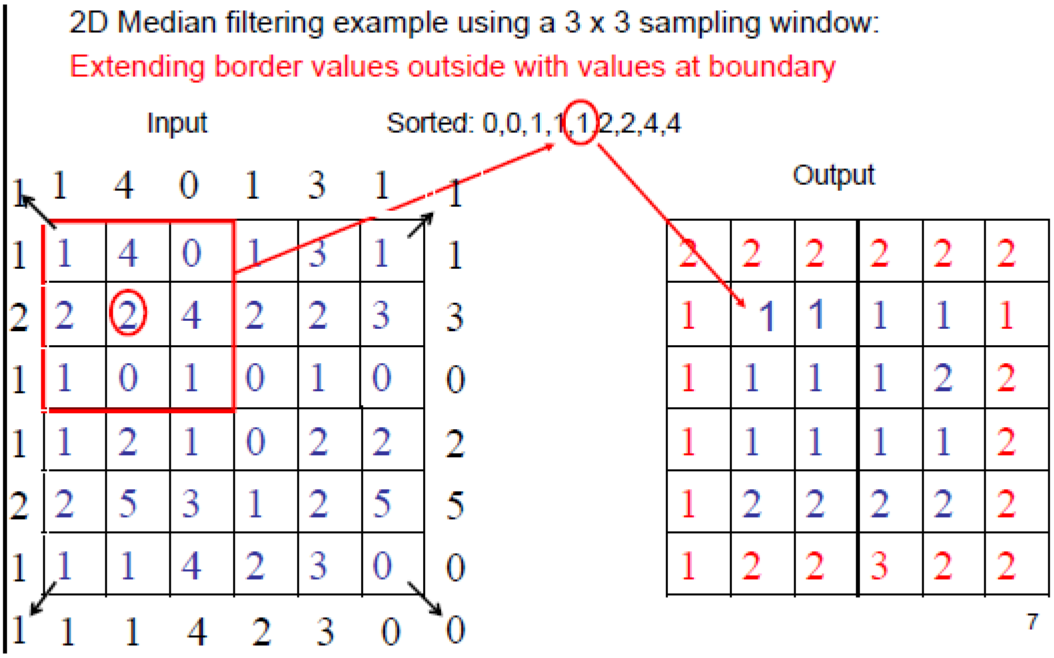


Fig 25 Output Image after Median Flitering

Detailed Description of Median Filtering –



In the above case, it can be seen that we have taken a 3*3 matrix as the window for median filtering. In the left hand side figure, a 3*3 matrix is taken, which has value 2 at its centre. It means that the boundary values of the pixels remains constant, since they form the exterior of the matrix. For filtering, the pixels are sorted in an increasing order, and then the pixel value of median element in the list is taken as the pixel value in the output. Thus the whole output filtered image is produced.



2.2.3 *Feature Extraction*

Selecting the correct feature plays the major part in tracking. The feature choice is nearly identified with the object representation. Different features needed for tracking are color, edges, optical flow, and surface or texture. In the proposed approach, we track the target object utilizing the color feature, particularly red, green and blue shade, in this way we are able to track the red, green and blue color objects in the video. After tracking the target object using color feature we are going to track object using motion. For motion detection and tracking we are using Frame difference technique and optical flow algorithm.
The reason for choosing color detection for feature extraction is that the computation becomes easy, because of simple coding and also the computation cost is less. Among three basic colors ie red, blue and green, here I will be using red color detection.

2.2.4 *Tracking*

Tracking of the target objects is carried out on the premise of the locale properties of the object, for example, Bounding box, Area, Centroid, and so forth. Here Bounding box property is utilized to track. Henceforth as the object moves distinctive areas in the video, the Bounding box additionally moves with it and hence diverse estimations of area properties are obtained. Hence the goal for tracking the objects in real-time using color feature and motion is achieved.

2.2.4.1 *Blob detection in tracking*
Blob detection refers to mathematical methods that are aimed at detecting regions in a digital image that differ in properties, such as brightness or colour, compared to areas surrounding those regions. Informally, a blob is a region of a digital image in which some properties are constant or vary within a prescribed range of values; all the points in a blob can be considered in some sense to be similar to each other. In early work in the area, blob detection was used to obtain regions of interest for further processing. These regions could signal the presence of objects or parts of objects in the image domain with application to object recognition and/or object tracking.

The blob returns quantities such as Bounding Box, , label matrix, and blob count. The Blob Analysis block supports input and output variable size signals. Here Bounding box property is utilized to track. Henceforth as the object moves distinctive areas in the video, the Bounding box additionally moves with it and diverse estimation of area properties are obtained.

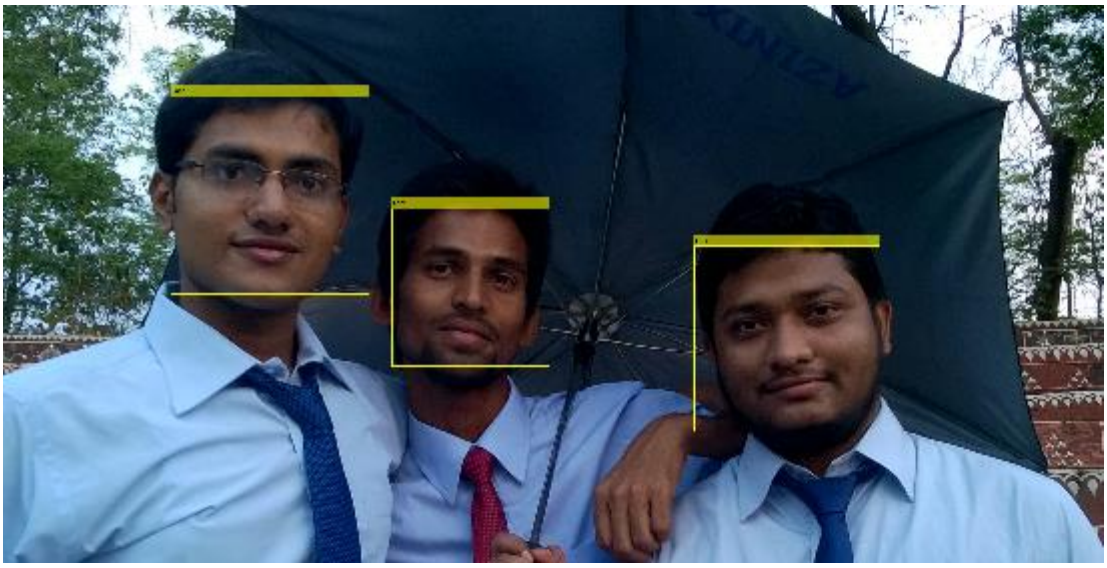
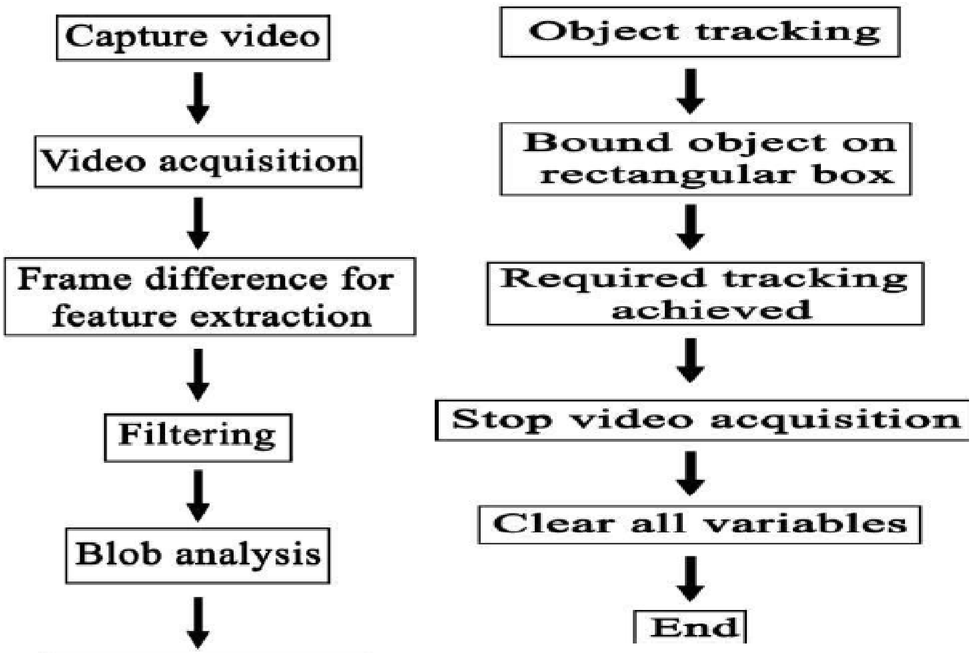


Fig 26 Blob Detection for Faces

2.2.5 *Color based object detection*

The detailed flowchart for the for the color based object detection is as follows –



2.2.5.1 *Explanation for the above flowchart*

1) Camera used for image processing or tracking the object capture the frames from video input using video acquisition function.

2) Specify the characteristics or property of video input. Begin with video acquisition.

3) Create a loop that begins after 60 frames of acquisition. This loop comprises of following steps:

a) Take the photo of the first frame from the video.

b) Presently to track the red objects continuously we need to subtract the red segment from the gray scale image to concentrate the red segments in the image.

c) Make use of median filter to remove noise.

d) Transform the gray scale image to binary image.

e) The pixels less the 300 pixels are eliminated.

f) Mark all the joined segments in the image to implement image blob analysis; here we get a set of properties for each one marked area.

g) Display the image.

h) A loop is used again to bound red color object in a rectangular formation.

i) Stop taking input from video camera.

5) Erase all data stored in memory.

6) Flush all variables.

2.2.5.2 *The Matlab code*

This is the code for detecting and tracking a red colored object.

```
a = imaqhwinfo;
%[camera_name, camera_id, format] = getCameraInfo(a);



% Capture the video frames using the videoinput function
% You have to replace the resolution & your installed adaptor name.
vid = videoinput('winvideo',1);

% Set the properties of the video object
set(vid, 'FramesPerTrigger', Inf);
set(vid, 'ReturnedColorspace', 'rgb')
```

```
vid.FrameGrabInterval = 5;

%start the video aquisition here
start(vid)

% Set a loop that stop after 100 frames of aquisition
while(vid.FramesAcquired<=200)

    % Get the snapshot of the current frame
    data = getsnapshot(vid);

    % Now to track red objects in real time
    % we have to subtract the red component
    % from the grayscale image to extract the red components in the image.
    diff_im = imsubtract(data(:,:,1), rgb2gray(data));
    %Use a median filter to filter out noise
    diff_im = medfilt2(diff_im, [3 3]);
    % Convert the resulting grayscale image into a binary image.
    diff_im = im2bw(diff_im,0.18);

    % Remove all those pixels less than 300px
    diff_im = bwareaopen(diff_im,300);

    % Label all the connected components in the image.
    bw = bwlabel(diff_im, 8);

    % Here we do the image blob analysis.
    % We get a set of properties for each labeled region.
    stats = regionprops(bw, 'BoundingBox', 'Centroid');

    % Display the image
    imshow(data)
```

```
    hold on

    %This is a loop to bound the red objects in a rectangular box.
    for object = 1:length(stats)
        bb = stats(object).BoundingBox;
        bc = stats(object).Centroid;
        rectangle('Position',bb,'EdgeColor','r','LineWidth',2)
        plot(bc(1),bc(2), '-m+')
        a=text(bc(1)+15,bc(2), strcat('X: ', num2str(round(bc(1))), '    Y: ',
num2str(round(bc(2)))));
        set(a, 'FontName', 'Arial', 'FontWeight', 'bold', 'FontSize', 12, 'Color', 'yellow');
    end

    hold off
end
% Both the loops end here.

% Stop the video aquisition.
stop(vid);

% Flush all the image data stored in the memory buffer.
flushdata(vid);

% Clear all variables
clear all
sprintf('%s','That was all about Image tracking, Guess that was pretty easy :) ')
```

2.2.5.3 *Output*

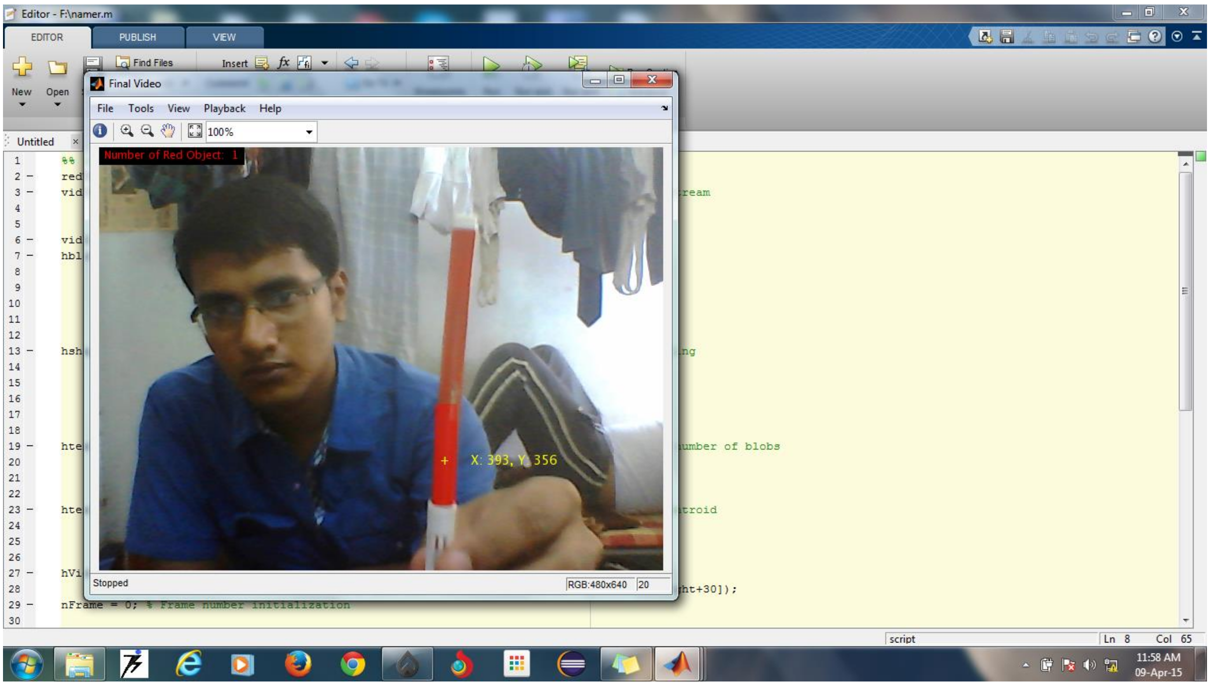
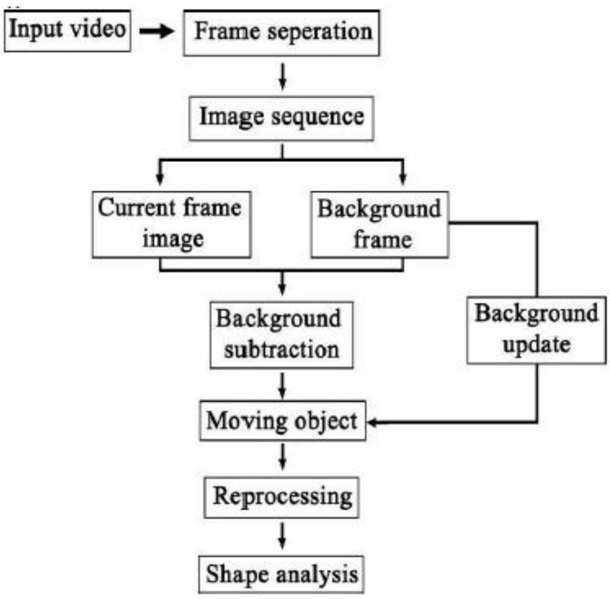


Fig 27 Red Color Object Detection (Here Red Sketch Pen)

2.2.6 *Motion detection through background substraction*

The detailed flowchart is as follows –



2.2.6.1 *Flowchart explanation*

The explanation of each block shown above is as follows:

1) Camera used for image processing or tracking the object capture the frames from video input using video acquisition function.
2) Specify the characteristics or property of video input.

3) Begin with video acquisition. Separate the frames from the video input.

4) After separating frames from the acquired video generate image sequence.

5) Perform background subtraction by subtracting background frame from current frame. In the event that the pixel difference is more than the set threshold T, then it confirms that the pixels occur in the moving object, otherwise, as the background pixels.

6) Image obtained after subtraction contains motion region and noise. Median filter is used to eliminate noise.

7) Morphological technique is used for further processing. Vertical along with horizontal projection is utilized to detect the height of motion part.

8) After detection of moving object, object can be tracked using the area and centroid.

2.2.6.2 *Results*

Fig 28 Motion Detection Through Background Substraction

2.2.7 *Face Detection in Matlab*

2.2.7.1 *Required algorithm*

a) Firstly we read the image.

b) Then get the FaceDetector Object – It is an object which has the information of detecting the faces. It is just an implementation of the algorithm which can detect faces out of an image.

c) Then use the FaceDetector Object on the image and get the faces. Here, we study another function, which will use this face detector on our image and get the details of the faces. Details – the function will output all the geometric details of the faces, which is precisely the number of faces, the (X&Y) co-ordinates, width and height ie co-ordinates and size. Precisely, the output will be a m*n matrix; where m – no. of faces and n will be 4. These four parameters will be x,y width and height. So, this is called the BoundingBox of the image.

d) Annotate the faces on the top of the image. Here, we mark the faces back to the image.

e) Then, we display the number of faces in a string ie. how many faces it will detect.

The final list of functions used here are –

a) FaceDetector Object.

b) Use FaceDetector on image and get the BBOX.

c) In annotation, we see how to annotate an existing image. We will pass the image here and details of the BBOX and how we can label them.

d) Lastly, in displaying, we use some display functions.

2.2.7.2 *The Matlab code*

```
%Read the image
A = imread('213.jpg');

%Get FaceDtector Object
FaceDetector = vision.CascadeObjectDetector();

%Use FaceDetector on A and get the faces
BBOX = step(FaceDetector, A);

%Annotate these faces on the top of the image
B = insertObjectAnnotation(A, 'rectangle', BBOX, 'Face');
imshow(B), title('Detected Faces');

%Display the number of faces in a string
n = size(BBOX, 1);
str_n = num2str(n);
str = strcat('Number of detected faces are =', str_n);
disp(str);
```

2.2.7.3 *Output*

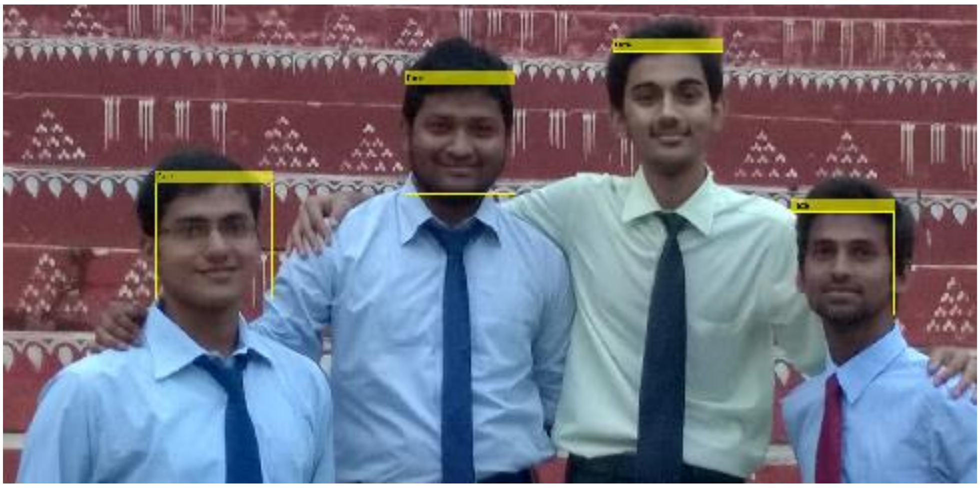


Fig 29 Face Detection for an Input Image

Here, the number of detected faces are 4.

3. RESULTS AND DISCUSSIONS

The theoretical analysis and motion stud for a quadcopter system is completed. The various motion and motor coefficients are formulated. Based upon the requirements for our quadcopter design such as load capacity, Wi-Fi camera weight and the thrust required, the final specifications for the motor are confirmed. The flight controller board that we used in the research project is finalized to be KK2.1 Multi-Rotor Controller Board. And also its study and interfacing method is done. The use of Global Positioning System (GPS) for pin pointing the co-ordinates of the flying quadcopter is also studied and so is the working principle of the GPS system. This is followed by the study of the FS-CT6B 2.4G 6CH Transmitter and receiver system and then analysing the 30A ESCs that we used 6 in nos. in our project. Then, the final assembly of the quadcopter was done and the assembled system was flown at high altitude.

Regarding the image processing for image capturing and face detection for the system, so as to self-process the captured images and cater immediate help to the needy person, we have written separate code in Matlab. The code is such that it takes the captured images as input and processes them for face recognition and object detection on color basis (here red color). Also the code for motion detection is formulated which processes the input real time video on the basis of background substraction and gray scale image formation.

Then the generated Matlab code is run on the live quadcopter system using the inbuilt system cameras, so as to capture the real time images and process them for face recognition. Here, the input file for the Matlab code is an image file which is snapped from the real time environment. The below presented figures show the real time images taken from the camera integrated to the quadcopter system, which are then processed in Matlab system for face recognition.

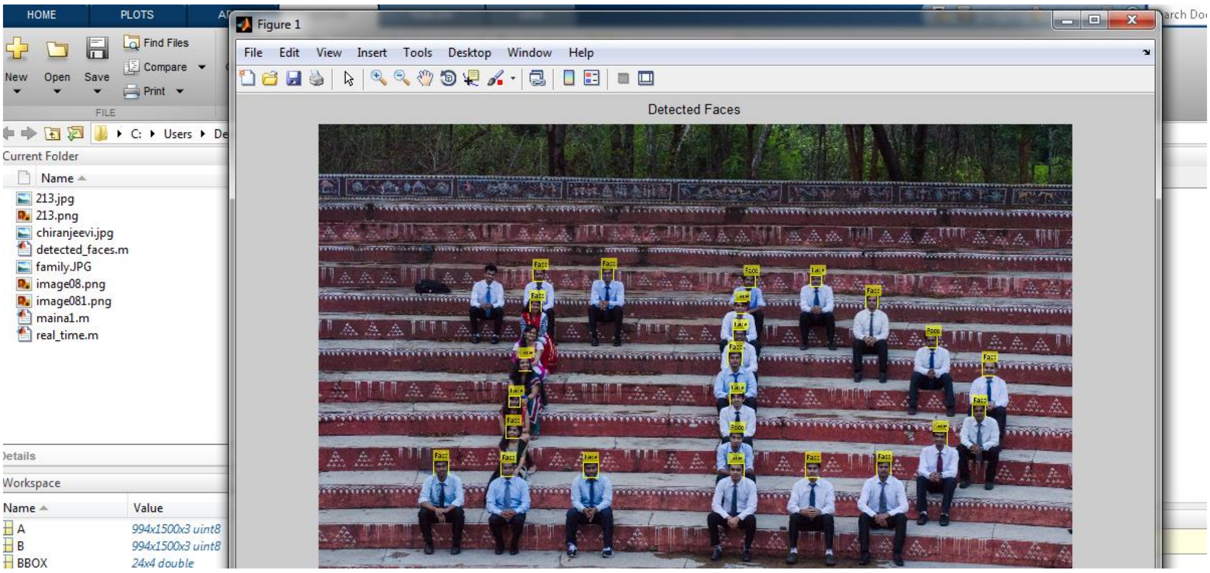


Fig 30 Face-Image processing by the quadcopter system

4. FUTURE SCOPE AND DEVELOPMENTS

The presently built quadcopter system accompanied with the image processing system needs a lot of further developments, so as to be able to be used in real life examples. The presently built system capures only images from the environment for image processing, whereas the real challenge in real life working will be to use them to capture real time videos from the environment and then process them to separate out the frames from them and sequence them in chronologic order for image processing. The real challenge is to process the ongoing real time videos captured from the quadcopter system for person detection and rescue operation. The presently used rescue quadcopters in the world are much more capable then the one that is made by me because they are able to make stable flight in the air without the syatem going wary and are also able to capture the real time videos from the environment and process them for further person detection. I genuinely believe that if ever my project is carried forward for further developments and making it capable for real life working, then my contribution will be of great help to the fellow research scholar and myself work will be acknowledged then.

4. CONCLUSION

Unmanned aerial vehicles can provide a critical support for search and rescue operations. However in order to achieve their full potential, it is necessary to properly account for all the parameters that can affect the flight of the UAVs such as quality of sensory operations (that can depend on the position of the UAVs for instance), energy constraints, environmental hazards or data sharing constraints between UAVs and rescue teams. In future work, we intend to investigate more complex scenarios and to account for energy and connectivity constraints. We also intend to study how search algorithms based on large scale when the number of states increases. The sensitivity of the camera that is used in the system has to be improved. The sensitivity of the sensing of the code generated has to be improved, so as to be able to process the captured real time videos with much more sensitivity. Also there has to be a lot of development in the field of real life video processing for image analysis instead of working upon the captured images.

The most important role in the advancement of the uses of multicopters in regions effected by natural calamities as well as other areas of critical issues, lies with the government of any country. These quadcopters have a high usage in future, where the technology would be a lot more advanced from now.

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