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CAD MODELLING OF PASSENGER DRONE STRUCTURE

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Abstract

The objective of this project is to design a passenger drone that can fly up to a certain height and can travel short distances within the overcrowded cities. This report tells us about currently available passenger drone in the market and their abilities, also guides us about the origin of UAVs. This work also focuses on the areas and the abilities of the drone. In current scenario, drones are not merely the toys for adventure but their wide list of capabilities has changed their definition. Today drones are present from the teenager playground to the battle field and also in the deeper space exploration. This report also introduces us to similar projects going on and projects that has completed in world market. Report has different types of drone structure that are mainly used for UAVs. In this project the main objective is to design the structure of a passenger drone that can accommodate passengers with normal average height and weight, we kept the idea while designing, of enough space for the passenger as well as the power source and other peripheral devices in the drone. We made our best effort to design 3 D model of such drone with the help of CAD software CATIA.

Keywords:*History of drone, cad modelling, types of drone present in the market etc.*

1.Introduction

Drone may be defined as flying object that is combination of mechanical, electronics, computers Engineering and artificial intelligence all clubbed together to give rise to a body that have capabilities to fly and manoeuvre in air space. Drone is a kind of small flying machine. Drones or unmanned aerial vehicles have been in the use from centuries and are dedicatedly used by the military. First use of drone was came into picture in 1849 when Australian attacked Italian city of Venice with the help of unmanned balloon which was carrying explosives material. But in present Era balloons cannot be considered as Drone but the idea behind it is same as used by drones today. In 1915 during World War period British military use aerial photography to get the foot ahead in war in the battle of new way sample they took the advantage of this technology and captured more than 1500 views of German trenches. Toady 21st century scenario has changed a bit with the use of drones not only for military applications but all so for other utilities and services like a taxi and for the delivering E-Commerce products to the customer at the doorstep in 2014 Amazon a giant E-Commerce firm proposed to use drones for the delivery of products to the customers and also some real estate companies are using aerial photography and drones to shoot videos of the real estate projects. Thus it can be concluded that drones have very high potential of growth in upcoming years and use of drone will be going to increase not only in the military & domestic but also in the Industries. Drones have different types of structure depending upon the number of propeller blades and arms, there Tricopter drones, quadcopter drone with four arms and four propeller blades, similarly hexacopter, Octacopter drones etc.

Today application of drone have extended to a wide area, these include military for the access to remote areas, supplying urgent aid to the war effected areas, for the surveillance, aerial photography, drones as air taxi for the short distances in the overcrowded cities, and many more.

1.1 Classification of Drone

1.1.1 On The Basis Of Applications

1.1.2 On The Basis Of Design

1.1.1.1 *Military Drone*

Military drones are the drones that are used for Warfare by military. For triggering surgical strikes in the enemy`s territories where the casualties of soldiers maybe huge in number if direct army attack is conducted. Also huge loss of resources and property but drones in this situation makes it more acceptable and convenient way to tackle such type of situations. Drones can also go for the remote surveillance of the borders of the nation and to keep an eye on the insurgency in the adjoining areas and the border areas.

1.1.1.2 PASSENGER DRONE AS AIR TAXI

In present world passenger drones with self-guided system is most popular in developed Nations and provides a huge space for services as roads are overcrowded and the average time to travel a short distance within the city

mainly Metro politician Metropolitan cities have increased multiple times thus passenger drone provides a cheap and fast alternative to this situation. Passenger drones have capabilities to take off and land vertically hence eliminates the requirement for the runaways and a very rigid and good quality helipad is not required. Drones can easily take off from one rooftop to another destination rooftop in the cities without any problem.

1.1.1.3 DRONES FOR MARKETING AND ECOMMERCE

Today in the world of digitalization and with the deeper penetration of internet services in the remote areas which covers a huge number of people have given a strong boost to the E-Commerce business where people can find everything what they need for their basic requirements to what they want or desires on their computer screen as a result put a challenge against the E-Commerce forms to provide the customer the desired goods within minimum time. Sometime customer wants the product within a short period of time that varies from 30 minutes to 1 hour which is very less time for any scheduled delivery in such situations they cannot change the predefined and most optimized route of the delivery person that is delivering the

products to a desired location. Also incase customer place an order for perishable goods which have very short life span and to be consumed in a short period of time thus delivery is to be very fast and precise, here drones provides solution for this problem as drones have the ability of self-propulsion and self-guided system that is preprogrammed and coupled with artificial intelligence thatprovides essential skills and capabilities to the Drone. Drones on other hand are much cheaper than hiring human labor for this work.

1.*1.1.4 DRONE FOR REMOTE SURVEILLANCE*

Drone for surveillance is also so called as RMUS (remote surveillance drone) these are the drones that are primarily used by military for surveillance in the enemy territory to protect the boarders and the national security from the threats like intruders and terrorists that can cause a major threat to the people. Drones are also used for keeping an eye on the forest and wildlife reserves ,can also be used for inspection purposes in large organizations like dams national parks crowded cities and also for the inspection of solar power plants.

1.1.1.5 DRONE FOR PHOTOGRAPHY AND IMAGING

In this class of drones, camera together with the radio transmission arrangement is installed in the Drone. This type of drone are used by real estate businessmen that uses drone for aerial photography he of their real estate projects. Nowadays is this type of drones are becoming more common in the parties and weddings where camera mounted drones are used for photography and cinematography also.

1.1.1.6 DRONES FOR FOREST AND HIGH ALTITUDE RESEARCH IN MOST CRITICAL ENVIRONMENTS

Today with most advanced video camera drones that possess the ability to fly for long distances and can transmit the images to central station located a far distance from deployed area, we can conduct detailed surveys on the forest cover and the increased in the forest cover also we can detect and fire or other natural hazards and can be

prevent before it turn into big disaster. Drone has capability to raise high above the troposphere thus help in weather forecasting and to find the concentration of the pollutants in the atmosphere.

1.1.2 CLASSIFICATION ON THE BASIS OF DESIGN

Truss and frame both are constructed by same triangular members and connected at joints in process joints are of pin joint type and members are free to rotate about the pin so truss cannot transfer the movement. members are subjected to axial loads are force is on the other hand members of frame are joint rigidly at joints by means of welding and bolting so joints of frame could transfer moment also in addition to the axial loading.

Hexacopter
Y-6

Octacopter
X – 8

1.1.2.1 *Tricopter Type*

In Tricopter it has three arms each connected to one motor the front of the drone tends to be between the two arms. The angle between the arms can vary but tends to be 120 degrees in order to move the air motor normally needs to be able to rotate in order to counter at the gyroscopic effect of an even number of rotors as well as the change of yaw angle.

1.1.2.2 Quadcopter

A quadcopter Drone which has Four Arms each connected to one motor the front of the Drone tends to be between the two arms but can also be along arm. In Quadcopter type Drone balancing and symmetry is easy to maintain.

1.1.2.3 Hexacopter

A hexacopter has 6 arms is connected to one. It is easy to add two additional arms and a motor to a quadcopter design this increase the total trust available that means the copter can lift more payload also if any motor fails still there is a chance that drone can land.

1.1.2.4 Y 6

A Y 6 design is a type of hexacopter but rather than 6 arms it has 3 support with a motor connected to either side of the

arm that the propellers mounted to the underside still projects the thrust downward.

1.1.2.5 Octacopter

A conventional Octocopter has 8 arms and each arm is having a motor mounted on it. The main advantage is that more rotors is equal to more trust as well as increase redundancy.

1.1.2.6 X8

An X8 design is also an Octacopter, but has only four support arms on which motor are mounted on either side of each arm, thus having in total 8 motors.

1.2 Some Passenger Drone That Are Present In the World Market

1.2.1 Chinese Drone Company Ehang 184

Young 184 who is the first passenger Drone that is manufactured by Chinese. It is a moving blade type multi rotor drone manufactured and designed by Ehang. Ehang 184 is automatically operated from ground station, and it can reach a maximum speed of 100 km per hour and can also cover a distance of 8.8 km. This company also makes another model of drone by the name of Ehang 216 which is a two seater Drone with 16 propellers. It conducted its first test flight in 2014 and from till date has made more than 1000 Flights with passengers.

1.2.2 Hoversurf

Hoversurf is a Russian startup based in Moscow Russia and Burlingame California USA. Google search Scorpion is a single seat passenger flying Drone that is capable of carrying a single passenger to preset altitude of around 10 meters above the ground. It is a quad copter type drone having four rotating blades. Also Scorpion 3 had made world record of achieving height of 28.5. Hoversurf Scorpion 3 provides full control to the rider and does not have any operator commanded ground station. It is used by Dubai police but altitude it set for 16 feet only.

Figure 7 EHANG 184
Figure 8 Hoversurf

1.2.3 IFO (Identified Flying Object)

IFO is designed by PierpaoloLazzarini which is from Italian company jet capsule. It is a two seater drone. It consists of a central cockpit capsule that can accommodate 2 passengers. The body is made up of carbon fiber with dimension of 4.70 meters. It is propelled by electric motor that pushes the IFO to a maximum speed of 120 miles per hour. Power is supplied from the battery pack and also an additional battery pack is placed near the center of the cockpit to be used during emergency situations. It can fly for around 1 hour to 1 hour 10 minutes. It is equipped with 6 foldable and extendable suspension arms that provides smooth landing. The seat elevates down from the cockpit for smooth entry to the cockpit, 2 rechargeable ports are provided for recharging batteries. In case of emergency the outer ring detaches from the capsule and parachute attached to the cockpit capsule opens and guide the passengers to the safety.

1.2.4 Project Zero

Keeping in the mind the emerging potential of electric driven aerial vehicle in future and its capabilities are much beyond the existing aircrafts. They are lightweight emission free and can be operated without pilot being physically present in the plane. August Westland took the advantage and build project zero which is a hybrid tilt rotor lift fan aircraft project zero is the world first electric tilt Rotor aircraft.

Figure 9 IFO (Identified Flying Object)
Figure 10 Project Zero

Augusta Westland is an Italian based company which conducted its first flight in June 2011. Talking about the Augusta Westland project zero which is electrically propelled aircraft or a drone therefore it has convertible pain also it can be termed as half Helicopter and half aero plane it comes with hybrid Technology G which includes a diesel engine used to run a generator on board which provides additional electric power in case of batteries got discharged also it has fixed Wings that provides extra left to the plane the structure is mostly made up of aluminum and carbon fiber project zero have a rotor blade of diameter 3 m.

1.2.5 Volocopter 2x

Volocopter 2X is an electric multi rotor helicopter that runs by battery. Volocopter 2X is of German origin two seater drone it is designed by volocopterGmbh of Bruchsal. It is it is an advanced version of VC 2. It was first introduced in 2017 in AERO FreidRichshafen Air Show. This Drone consists of 18 fixed pitch propellers which are powered by electric motors. Body consists of carbon fiber composites and also the propellers are powered by three phase synchronous Motors which run on DC power.

The Drone contains quick rechargeable Lithium ion batteries that can be recharged again within 120 minutes with cooling system. The Drone successfully completed its first test flight in November 17, 2013 at Karlsruhe, Germany. The results of a test flight were positive and with less magnitude of vibrations. The Drone has 3.2 m long

9.15 m wide and 2.15 m high and it has unloaded weight of 2,90kgs and 450 kg of gross weight. It can reach a maximum speed of 100 kmph with the range up to 27 km and is capable of operating for 27 minutes.

1.2.6 DRDO Rustom

Rustom is an unmanned aerial vehicle developed by Defense research and development organization of India for the use by all the armed forces army Navy and Air force. Rustom is a long range, medium altitude drawn of military grade. DRDO Rustom designers derived it`s design from NAL Light canard research aircraft LCRA. This drone is named after Professor RustomDamania of IISC Bangalore as he played a key role in development of national Aerospace Laboratories which comes after HAL in 1980s.

Figure 11 Volo Copter 2X

Figure 12 DRDORustom

1.3 History of Drone

Drones or unmanned aerial vehicles have been in the use from centuries and are dedicatedly used by the military. First use of drone was came into picture in 1849 when Australian attacked Italian city of Venice with the help of unmanned balloon which was carrying explosives material. But in present Era balloons cannot be considered as Drone but the idea behind it is same as used by drones today. In 1915 during World War period British military use aerial photography to get the foot ahead in war in the battle of new way sample they took the advantage of this technology and captured more than 1500 views of German trenches. All these incidents sparked Americans to develop such drone or aerial vehicles capable of performing different surveillance that could provide battle winning information without many casualties. Since 1969 during the First World War United States was able to develop aerial vehicles that are operated remotely and does not require any pilot to be physically present in the vehicle for controlling it. After the initiation of the project US Army was able to develop Kettering Bug. This was designed by Charles Kettering and the first test flight was conducted on October 2 1918. This was a great failure was an unmanned aerial torpedo just like today`s Cruise missile which was experimental. Kettering Bug was capable of striking up to range of 121 km. It was able to travel at the speed of 80 km per hour. Further in 1930 United States Navy start experimenting with the radio controlled aircraft that results in Curtiss N2C-2 drone main in 1937 .It took almost seven years to develop search craft. In the phase of World War 2 Radio Plane Company an American aviation company produce drones at large scale for being used in war. They produced around 9400 Radio Plane OQ-3 models and supplied to the military this model was designed by Reginald Denny.

In the early days of the drone arrival they were considered to be an expensive toy that could not be relied upon but as 1980s were approaching and Israel Air Force victory over the Syrian Air Force in 1980 changed the attitude of people towards the Drone. Israel used both men and unmanned aerial vehicles to destroy the Enemies and get ahead in war with Syria. In 1986 U S and Israel started a joint project to create drones for fleet operations and the drone was named as RQ2 Pioneer.RQ2 Pioneer was medium sized exploration aircraft.

As 1990s were approaching miniature and micro drones was start coming into picture in 2000 United States use Drone Predator to look for Osama Bin Laden in Afghanistan. It is clear from the past history as most of the time these flights are used for military applications but in 21st century scenario has changed a bit with the use of drones not only for military applications but all so for other utilities and services like a taxi and for the delivering E-Commerce products to the customer at the doorstep in 2014 Amazon a giant E-Commerce firm proposed to use drones for the delivery of products to the customers and also some real estate companies are using aerial photography and drones to shoot videos of the real estate projects. Thus it can be concluded that drones have very high potential of growth in upcoming years and use of

drone will be going to increase not only in the military & domestic but also in the Industries.

Literature Review

Literature review describes about the research work that has been done with the help of CAD soft wares. The review includes the applications of CAD software and their areas of application. The researches that have been done in field of failure analysis with the help of CAD software are reviewed. The researches on drones and UAVs that have been done, with respect to their design, their classification, applications etc. are also reviewed. Manoj Kumar, et al (2018) designed and analyzed the structure of the solar car with the CAD software (CATIA). According to him solar vehicles is the urgent need of the present and upcoming generation as non-renewable resources are limited and depleting at very fast rate. He used cad software CATIA for the most optimized and light weight construction of the structure. Manoj Kumar et al (2018) described how CAD software is use for the analysis of different load and stress on an object without actual carrying physical experiment on the object. The result can be further validated with the actual calculation on the object.

Krishan Kumar et al (2015) studied the effect of change of material in the optimized leaf in leaf spring and study the fatigue life of the leaf. He used CATIA software for the design and analysis of the leaf spring. According to him CAD software is cost effective method in new component or any object designing. Atul Kumar Kaushik et al (2017), focused on the issues in the brake pedal in the automobiles, it deals with the leakage problem and suggested some corrections after detailed analysis through using the software like CATIA and ANYSIS. Mat, et al (2012), the construction of light weight low friction resistance car chassis that can withstand the applied loads, also protect the driver in case of accident. CAD softwares are used for the design and modelling of the design of robust chassis and FEA was carried out on the model using CATIA software. BrundabanPatro et al, Carbon fiber is the most popular in 21st century due to its light weight, high performance and excellent mechanical properties. This is widely used for the structures in the aerospace industry, aeronautical, sports applications and automotive & medical devices due to their high strength to weight unique property. Lina Tang, et al (2015), drones of different shapes and sizes have come out in the last decades, He used it for the civilian applications. Drones are flexible, low cost, uses high resolution remote sensing system. Earlier for forest research satellite images are used but with advancement in the drones forest research and practice has been improved and become easier. Drones have low running cost, high resolution data collection, absence of risk to crews. M. Hassanalian,et al (2017) Focuses on the need of drone with multiple capabilities that can be used for civilian as well as military applications he has classified rooms in different categories depending upon their weight range size he have also suggested spectrum of drones from fixed wing unmanned aerial vehicle to smart dust that includes many micro electrical and micromechanical components with sensors The spectrum range from 61 M wingspan and 15000 kg body weight 21 mm wingspan and 0.005 gram body weight. Chris Sandbrook, (2015) Studied that social impact of Thrones for using in conservation in this paper he defines the Drone according to his research based on the insurance of the Dome weight of the Drone payload carrying capacity and altitude of drone he has also explain the area that a Drone can serve and what a Drone can do he has described room safe for the user than that mend aircrafts he has also explain the areas that. Considering the data security he mentioned that the data collected should be accepted by law enforcement agency to stop hunting and other legal illegal activities in the forest reserves he suggested methods and techniques to minimize the risk of conservation drone.Endrowednes KUANTAMA, designed and analyze the frame of a quadcopter using solid works CAD Computer aided design software to check the reliability of the body frame parts to find type of rotor and propeller to ensure necessary flight acceleration. He made its best efforts to make the frame rigid and lightweight together with sufficient strength to carry the required load he used finite element analysis method for the analysis he suggested that while doing analysis of the quadcopter Drone frame one must consider the total weight which will include the weight of the electronics frame router and also the sensor .He made perforations in the structure to keep the weight of the Drone minimum and also consider the symmetry and the centroid of the frame .He divided the frame into three components leg frame, base frame ,and sting frame. Pulkit Sharma designed a Triphibian Drone capable of operating in Air, on land and also underwater. According to him the capacity of drone to carry weight can be measured by increasing the weight of all its components every time simulation is done till the structure fails. Landing of drone must be carefully studied so that the structure should have sufficient strength and stiffness and does not collapse on landing. Drone must be checked for different trust, RPM and travel speed that will provide sufficient data regarding the flight of the drone. According to him Drone must not be analyzed in static members as drone is not a single body but it is an assembly of different parts and components and must be analyzed only nearly. He used mat lab GUI (graphical user interface) to plot relationship between three different entities that is thrust, RPM and the forward speed. Solid works is used for performing simulations and analysis of drone Triphibian.

According Tadeusz Mikolajczyk development of new machining processes is mainly depends on the cutting tool and machine tools thus there is a very huge scope for new research in the new tools. He presented CAD Autodesk power shape more smart solution for the research. He innovated the design of single edge tool with circular cutting inserts in which he can adjust the angle of inclination of cutting edge and the for doing all this he used Autodesk power mill and Autodesk power shape software.

Methodology

CAD modeling is the initial phase of any project in the design .Earlier engineering drawing was used for such projects. In 18 century French mathematician Gaspard Monge formally introduced orthographic project. Earlier drawing were made with hands and from part study it is clear that making engineering drawing with hand is quite Complex, complicate, and time consuming. Also to sketch any Complex drawing with hand is nearly impossible. CAD eliminate such problem to large extent allow the designer to work smoothly with all the inbuilt tools and commands that helps in Modeling and drafting. Also we can get multiple copies of same drawing and further editing is very easy but in the earlier phase when cad was introduced in the market ,it was not economical as the cost was very high and it was quite expensive for designers to purchase such expensive item also that the time CAD software war also not so advanced. But later on in 20th century with the arrival of microprocessor accurate representation of dimensions of object and its properties become easier for the designers.

When we say CAD it is simply means that the use of computer in design activities it includes a large variety of technique light Computer Graphics techniques and also programming tools. To work with CAD we require some hardware and also software .Hardware includes screen or display on which the visual output is obtained and input includes keyboard and mouse basically, we can also use Touchpad on light pen for input other input device may include plotter and printer. Talking about the different kind of software which are used for different type of modeling involve different numerical techniques and methods. It is also type of automation in which program for particular activity is put into computer to perform a particular task. They include matrix multiplication also large Matrixes are used, which are solved using partial differential equations.

CATIA

In this minor project we used CAD software mainly CATIA for the modeling of the structure of the passenger drone. CATIA stands for Computer aided three-dimensional interactive application. CATIA is developed by the Dassault Systems which is a French company and IBM is marketing it worldwide. It was developed in late1970s. It is commercial software that can perform multiple tasks like designing, manufacturing and engineering. It is written in C ++ language. It was initially named as CATIA and renamed further in 1981 as CATIA. In 1984 Boeing was the first company to choose CATIA as its main 3D CAD tool and became the largest customer.

Catia is good for surfacing, can perform reverse engineering without any difficulty and it is easy for visualizing solutions and to create new, modify and, to analyze Complex shapes. It has ability to create 3D part from sheet metal mechanical assemblies, fabrication and tool parts as well as moulding. Provides facility for the designing of electronic mechanical Electrical and also many other system such as fluid systems, ventilation air conditioning and heating systems.

It is amongst the most advanced Computer aided design soft wares that are available in the market. CATIA can be used in mechanical design system engineering electrical systems and also in the fluid system designing.

Today CATIA is widely used in automotive sector, aerospace, shipbuilding, industrial equipment, hi-tech components engineering process and utilities consumer packed goods and also in the architecture. CATIA also have PLM that means product lifecycle management the unique tool used by process centric companies. PLM provide solution for product concept, product producing tooling and designing and creating value product. CATIA provides analysis simulation and also synthesis that optimize Engineering Product and produces a product validation at the each step of its design to ensure product quality and more market acceptance. It has advanced capability to collaborate engineering knowledge to boost innovation, help in the good market survival in leading the market. Many companies across the world are using CATIA as their first preferences some of the companies are Bentley Motors Limited, Volvo, Toyota, Tata Motors, Mahindra and Mahindra ,Tesla Motors, Skoda auto, Volkswagen, Audi ,BMW, or and many more. CAD Computer aided design is Computer Based designing software that is used for creating modifying, analyzing or optimizing the design. CAD soft wares are designed to increase the productivity of the designers also to enhance the quality of design improve the communication with proper documentation also that provides a huge database to find out the solutions of any project issues. CAD is also used to design electronic systems and it is known as ETA (Electronic design automation) also in mechanical design it is termed as MD or mechanical design automation or CAD. In mechanical design vector based graphics are used to detect the objects. CAD can also be used to design figures curve designs in two dimensional and also three

dimensional objects in 3D space. Since IBM system has come into picture in 90s Computer Aided Design has become more popular. It is much convenient for the designers to design and to draft any of the object or component with ease.

CAD soft wares can also be used for analysis, to optimize the design based upon their dynamic loading and also the static loading without actually doing all these things practically on the actual product. Using these analysis soft wares in CAD we can virtually find the exact results of any type of loading or stresses induced Deformation caused due to loading is a static or dynamic both type of loading, this not only saves the resources but also gives good and optimized results within a short span of time and all can be done on a computer screen. There are many such soft wares that provide this solution CATIA, ANSYS; solid works are some soft wares that have analysis capabilities.

3.1 Drafting

CAD is used for 2D or 3D drafting. Drafting in simple word, engineers do drawing normally on the drawing board but here instead of drawing on the drawing board it is done on the computer taking an example, if we want to draw a pencil on drawing sheet we have to get its length and its diameter also same procedure is done in CAD but you are required to just input the two values that is diameter and length and it will automatically sketch the item this is called drafting.

3.2 Modelling

Another activity that is associated with CAD is modelling 3D modelling or 2D modelling. When we say 3D modelling is means we are talking about representing objects, if we represent an object (say pencil) is 3D object on computer screen that means we can take view of it from any angle, we can have different views, isometric, top view, front view, side view. For 3D modelling, we can also use wire mesh, which is in 2D but model look different when we see it. Thus in CAD surface can be modeled by mesh of wire to form 3D model. Modelling is an essential assistance to visualization. Modelling we want to look the object from different angles. If we want to complete solid modelling we need to model the curves and surfaces that come in or on it. Does in 3D modelling it is not just representing the solid as it is but we have to represent the curves and surfaces from which the solid is made up of and only these curves and surfaces will define the solid. Does we can say 3D modelling it includes surface curves solid and soon.

3.3 Analysis And Simulation

As I have discussed earlier 3D modelling is done to get visualization from different angles. Now we have a complete 3D model can analyze it for different forces that are acting on it, different displacements that object will experience. Analysis can be done for stress it can also be done for deflection. In analysis actually we simulate the object just like it operates in real condition. With the help of simulation in CAD, we can take simple example of passenger Drone that we are dealing with we construct a simulation in which a passenger will be sitting inside the drone and flight is conducted and also, landing of drone is simulated in the same real manner as it will be done experimentally but this all is happening on computer screen that is simulation. In simulation we visualize how the object works, its mechanism will work in actual space, for that we select objects motion and animate it on computer screen. Simulation is very essential part of analysis; if we take again an example of drone with passengers get crashed then, how the structure will deformed, what will be the stress that passenger experience, and what will the forces on different component of the drone.

We are using computer tool for drawing of each component of drone and modelling is first done then it is used for analysis with the help of special tools meant for analysis. After analysis we get Optimization i.e. also the dimensions, necessary modifications that must be done to get the proper design.

3.4 Finite Element Analysis

Finite element analysis is the simulation of any given physical process which uses the numerical technique called finite element method. It is used by engineers to minimize the number of prototypes and experiments and also for optimization of the component in the design. The knowledge of mathematics is necessary for the comprehensive understanding of any physical process like structure behaviour of fluids, thermal effects and many other processes. Most of the processes are defined by partial differential equations PDEs. Solving of PDEs is time consuming task; therefore we need computer to solve these equations. Computer will solve the equations when a program corresponding to it is feed into it. From past decades such numerical techniques have developed, that can solve the problems in minimum time and with precision. Finite element analysis is one of search technique. Differential equations are used to describe the natural process as well as the process associated with the engineering mechanics in finite element analysis.

PDEs are complex and must be solved in order with respect to the quantities of a structure, it can be strain & stress to get exact information and result how it behave

under different loading conditions. FEA is a mathematical approach for getting optimized results and it only provides approximate results. If I simplify it, FEA is a mathematicalnumerical based approach to predict the behaviour on the different loading conditions. Today modelling simulation software are based on finite element analysis, which help in finding the area under tension, high stress points in the product and the maximum deflection points in the product design. Colour scale is used to show the results of simulation in a finite element analysis. Finite element analysis is originated from Euler`s work in 16th century, but mathematically it is given by Schellbach (1851) and Courant (1943). Finite element analysis is a simple tool that can be used for analysis of complex as well as simple structures. The application of finite element analysis is not restricted to mechanical engineering alone. There are other disciplines that use finite element analysis also. FEA is also extensively used for electronics engineering, electrical engineering, and also for the electromechanical systems & microelectronic mechanical systems. FEA simulation is used in manufacturing for simulating the process and for optimizing manufacturing operations and processes, for example, plastic moulding ,welding of sheets, Welding of different components of assembly ,structure, heat transfer, heat treatment, forming, Dynamic and static loading conditions, fluid flow and thermal analysis. In 1943 FEA was initially developed by R .Courant to find solution of vibration related problems. FEA were initially written for small computers & mainframe type of computers. FEA have a wide application area and can deal with wide variety of problems related to automobiles, railway coaches, ships and containers, aerospace, defense and many more. As discussed earlier in this report FEA (finite element analysis) is a numerical method which involves modelling of structure that is to be analysed with finite number of small interconnected triangulations are interconnected elements.

3.5 Method

If we want to perform analysis without computer, we have to do all the tasks a computer does behind the screen to perform analysis. It starts with modelling of structure. Then dividing the structure into number of nodes more the number of nodes more accurate result will be obtained, but as stated earlier the result of analysis through FEA is approximate, that does not provide the exact results. After all this, displacement function corresponding to nodes is prepared in matrix form.

3.6 Steps In Finite Element Analysis

There are many steps involved in finite element analysis of any object for a structure which are done by computer program. Some of them are listed below:-

3.6 .1 Selection Of Element Type And Discretization

It is the first step in FEA procedure, in which the object is discretized find the size of element is solid decided by the designer or analyzer

3.6 .2 Selection Of Displacement Function

Displacement function selection is the next step of the FEA. Displacement function is defined using nodal values of the element. The displacement function can be quadratic, linear or cubic polynomial. All elements use the same displacement function.

3.6 .3 Defining Stress- Strain Relation

After the selection of suitable displacement function, next step is to define the stress strain relationship which is an essential part of FEA.

3.6 .4 Construction of Elemental Stiffness Matrix

To form elemental stiffness Matrix one can use different approaches which can be equilibrium approach, work energy method, or residual approach. For designer if using equilibrium method then equation corresponding to nodal, force and equilibrium will form the stiffness matrix. If designer is using energy method then minimum potential energy principle and concept of virtual work and other theories like Castigliano theory of failure will form the stiffness matrix.

3.6 .5 Global Stiffness Matrixes

After the construction of the elemental stiffness matrix, global stiffness matrix construction is next step, in this step all the elemental stiffness matrixes are clubbed together to form a global stiffness matrix

3.6 .6 Evaluation of Matrix to Find Nodal Displacement

After the successful construction of the Global stiffness Matrix, it is evaluated forgetting nodal displacement; in this boundary conditions are used to find the solution.

3.6.7 Evaluations of Elemental Stress And Strain

In this step in FEA, we have strain available from the displacement matrix and with the help of hook's Law stresses are calculated. Depending upon the designer, different failure theories can be implemented like von-mises theory of failure. After all that results are compared with nodal data. All these analysis can be repeated by varying number of nodes to find more accurate results.

3.7 Types of Analysis

3.7.1 Dynamic and Static Analysis

The analysis of mechanical objects to find deflection and

stress is known as dynamic and static analysis. In static analysis the object is analysed in the state of rest without any motion that is there is no velocity and acceleration associated with the body it is in complete rest and only a static load or uniform load is applied on it means there is no variation in load with time during the analysis. Dynamic analysis, the structure or object is put into motion which means the body will experiences acceleration and have certain velocity during the analysis and load is not static it is variable, changing both in magnitude as well as direction during the analysis procedure.

3.7.2 Thermal Analysis

FEA is also used to study the effect of thermal energy on anybody, also used for the effective utilization of thermal energy in energy sector. In this different objects are studied for their different response with change in temperature, it may be expansion or contraction due to change in temperature or occurrence of cracks due to thermal variation or many times thermal stresses.

3.7.3 Heat Flow & Fluid Flow Analysis

FEA is also used for solving many Complex problems related to heat flow and fluid flow. This is widely used for design of heat exchangers in critical projects and in nuclear power plants and also in thermal power stations. FEA is also used to study the behaviour in turbine pumps to effectively improve their efficiency. For fluid new field called CFD that is Computational Fluid Dynamics have been developed as its application & scope is very wide. This software has reduced the number of experiments to a large extinct.

FEA has penetrated into many areas related to the fluid and heat flow for example power generation sector which includes wind mills, coal and gas fired power stations, nuclear power plants, refrigeration and air conditioning for ventilation and also other applications. As far as CFD is concerned, CFD is capable of predicting the approximate results of new components even before they are actually being made.

3.7.4 Linear and Nonlinear Analysis Of Structures And Objects

There are two sub categories that linear and nonlinear analysis of structure and mechanical objects. An analysis is said to be linearly analysis if the stiffness of the object or the structure to be analyzed is not varying during the analysis period it is termed as linear analysis. Nonlinear analysis, an analysis is said to be no linear analysis if the stiffness of the structure or the object is varying during the analysis.

CAD Modeling

Development of any product starts from the designing of product, in which a designer keeps in mind, the application of the product, its quality, customer`s expectations, ergonomics of the product, ethical values (if any), its working, feasibility to manufacture, average life, and failure of the product. CAD modelling is the computer program used by the designers for designing models which are termed as geometric models and Computer is used, it is known as CAD modelling. In CAD modelling of any product we use the tools that are provided in the Cad software by the developer, which varies from software to software, but the task performed by the tools are same in most of the software, the only variation is in the tool icons and their names. Modelling means representing objects in 2D or 3D. In 2D modelling the object is represented in only one plane and can only show on view of the object, while in 3D modelling the object is represented in 3D space, any we can see the object from directions and angles. 3D model give the clear representation of the object is considered most suitable model. We can also take projections of the 3D model in 2D. Example if we represent an object (say pencil) is 3D object on computer screen that means we can take view of it from any angle, we can have different views, isometric, top view, front view, side view. For 3D modelling, we can also use wire mesh, which is in 2D but model look different when we see it. Thus in CAD surface can be modeled by mesh of wire to form 3D model. Modelling is an essential assistance to visualization. Modelling we want to look the object from different angles. If we want to complete solid modelling we need to model the curves and surfaces that come in or on it. Does in 3D modelling it is not just representing the solid as it is but we have to represent the curves and surfaces from which the solid is made up of and only these curves and surfaces will define the solid.

4.2 Different CAD Modelling Methods

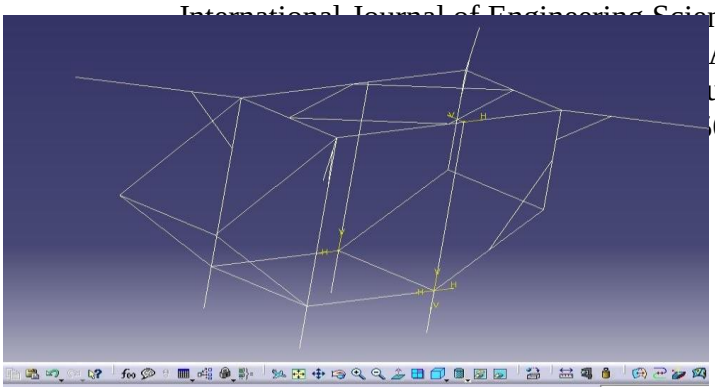
4.2.1 Wireframe modelling method

In wireframe modelling as the name suggests wires are used for the representing the object in the 3D space. For creating a wireframe model lines are used to represent the edges of the object. Wireframe models are made for the object with its periphery; it is also used to get clear idea of the basic structure of the object.

Figure 13 Wireframe model

4.2.2 Solid modelling method

In solid modelling there is no wire; sheets, or hollow parts, whole object is made up of solid material. We cannot see what is inside the object; it is completely filled with the solid material, only the outer surface is visible. The type of



modelling is mostly used in the engineering application. Take an example of solid shaft, or a solid cube which is completely solid.

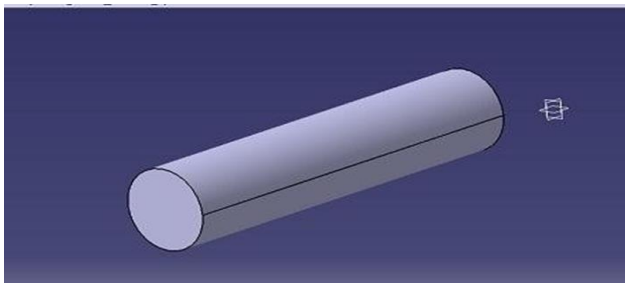


Figure 14 Solid Model

4.2.3 Surface modelling method

In surface modelling the surface are used to represent the body in 3D space. Different surfaces are arranged in a well-defined pattern to get a 3D object. This type of modelling is used for automobiles, locomotives cabins, aero plane cabin, i.e. the industries that manufacture the products which has outer surfaces and hollow cavity inside it.

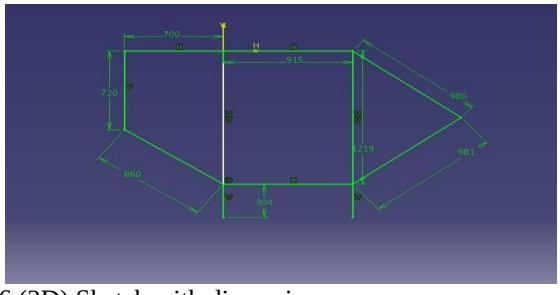


Figure 16 (2D) Sketch with dimensions

Figure 17 Wireframe model of the passenger drone

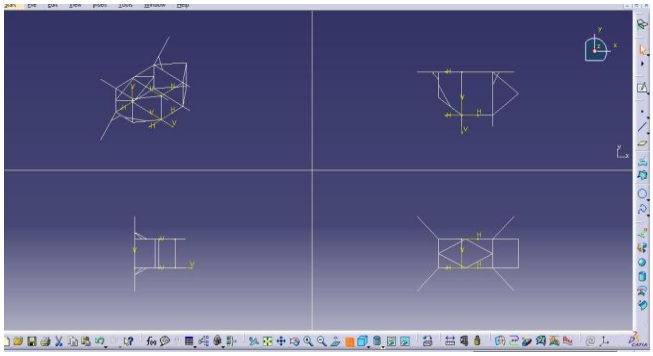


Figure 18 Multi views of the wireframe model

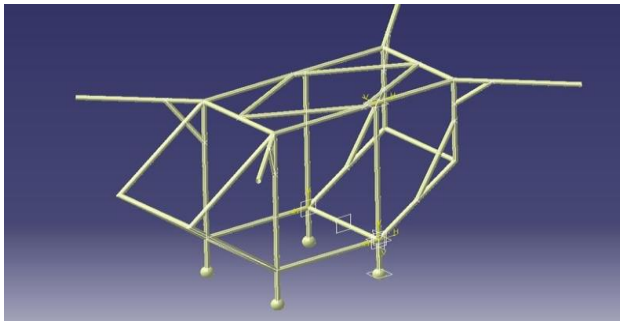
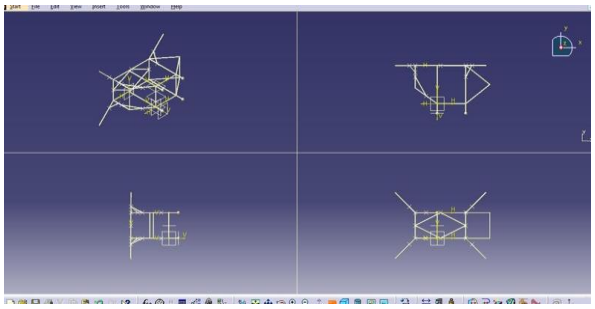


Figure 19 Surface model of the passenger drone



Conclusion

Drone is a very usable flying machine and is getting wide application now days. The machine is being used for various purposes like- photography, carrying passengers, ferrying, food &delivery of essential commodities. The wide application of drone prompted researcher to investigate all the related features. Drone has been classified into two categories based on the application &

design. In this research, the modelling of drone shape & size has been taken. The modelling software CATIA has been used. The CATIA is very powerful software to model 2D & 3D features of the periphery of the drone body, which is aimed to optimize all the parameters for cost and viability feature.

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