A PROJECT REPORT

ON

"HOVERBIKE – DESIGN, ANALYSIS AND PROTOTYPE"

Submitted by

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In partial fulfillment for the award of the Degree

Of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

UNDER THE GUIDANCE

Of

Prof. Arshad Qureshi

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL,

NAVI MUMBAI – 410206

UNIVERSITY OF MUMBAI

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CERTIFICATE

This is to certify that the project entitled

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

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External Examiner (Prof.____)

Head of Department **Principal**

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APPROVAL OF DISSERTATION

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(Internal Examiner) **(External Examiner)**

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Date: __________

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ABSTRACT

In this report we discussed about the beautiful concept of automobiles called Hover bike. It is the combination of two automobiles of motorcycle and helicopter. It is a compact vehicle with a simple design which can be able to use both transportation medium- Airways and roadways. It can run on roadways as a bike and can hover itself in air like a helicopter in unsuitable medium for a bike.

The report presents an idea of the hoverbike in bicopter mode through the basis of a prototype. Thrust vectoring is done by the special design and technique so that it can fly or move in all direction , it can take-off vertically from the ground or at any height , it doesn't need any run way. The functional process of the prototype is determined and is explained through this report. The flight time and other parameters are evaluated

KEYWORDS . Hoverbike, Bicopter, Battery, Motor, Propeller, etc.

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Chapter 01

INTRODUCTION

A hover bike concept meets to the futuristic world and gives the more effectiveness to today's problem. Our concept is different from Hover bike existing in the market. It is a BI copter type of hover bike which simplifies the design and controlling for the pilot. We use propellers at the end of both sides of chassis and in the middle there is a space kept for the pilot. In the modern aerospace industry, primary focus is on two primary areas : Transportation and military. The transportation sector focuses on designing larger, more efficient, and more reliable Aircraft. The military focuses on designing more effective and deadly weapons. There is also a private sector in the aerospace industry. Small single engine planes, new helicopters, and other unique flying devices all fall into this category. Beyond the private sector, there are also several commercial applications that could benefit greatly from the hover bike . A hover bike looks like a simple bike but is different. This type of Bike is easy to operate and can be applied to various purposes because it does not need a runaway and is capable of hovering from any terrain. It would be able to take off and land vertically, for this reason, the military has shown continued interest in aerial vehicles . A ducted-fan bike is mobile and can be deployed rapidly, which makes it well-suited for a variety of missions such as Reconnaissance and Surveillance performed by soldiers at the platoon or squad level.

Also, it is aerodynamically efficient because the lift generated by the duct can create a Thrust force that is higher than the other VTOL vehicles, which have no duct and therefore no hovering flight mode . Ideally, such a vehicle would be able to allow people to navigate the earth in a new and unique way. Some test prototypes are in development but no commercial hover Bike has been built yet.

1.1 PROBLEM DEFINITION

Need for a vehicle for easy Transportation in places with uneven terrain and improper road formation so as to move the rider from one place to another quickly and efficiently with safe travel. The initial problems faced while building prototype are numerous and need to be overcome. First of all, an appropriate propulsion thrust generation mechanism needs to be decided. Also the calculation of thrust to weight ratio needs to be done along with figuring out how to transfer the power from engine to propellers. A simple mechanism providing motion in all directions to the propellers needs to be figured out and finalised. The calculation of minimum thrust to attain minimal speed to move the unit forward/backward is vital, too. The safety of rider is important and can be secured by using polymeric fibre material for covering the bike as a casing.

INITIAL PROBLEMS TO OVERCOME :

- Finding an appropriate Thrust generation mechanism (Motor/Engine.)
- Calculation of Thrust to weight ratio.

● Figuring out how to transfer the power from engine to propellers.

● To attain minimal speed to move the unit forward/backward.

● To ensure safety by using polymeric fibre material.

1.2 AIM & OBJECTIVES

The aim of this report is to study and design and develop the different components and systems required to lift the hoverbike and make it sufficient enough to carry some required load. Importance is given to develop, improve, and or explore transmission and substation maintenance and operations by developing or improving one or more areas of interest using Unmanned Aerial Vehicle (UAV) (HOVER BIKE). The objective is to investigate the use of UAVs (Hover bikes) for Transmission Line Inspection & Maintenance.

- Design and develop the different components and systems required to make the hoverbike lift.
- Make hoverbike sufficient enough to carry some required load.
- Investigate the use of UAVs (Hover bikes) for Transmission Line Inspection & Maintenance.
- To study search and rescue operations.
- It has the ability to carry supplies if extraction is impossible.
- The hover bike could also be used to rescue people who fall through ice since the response time would be much quicker than a helicopter, and could save many lives.

1.3 PURPOSE OF STUDY

The purpose of making this project is to analyze hoverbikes and develop a prototype to better understand the working of it. To view the current progress on hoverbikes to study already existing research and contribute in the future development of such a useful vehicle is the main purpose of this study. The vehicle can be implemented in –

1. Aerial Photography :

Hoverbikes are now being used to capture footage that would otherwise require expensive helicopters and cranes. Fast paced action and sci-fi scenes are filmed by aerial hoverbikes , thus making cinematography easier. These autonomous flying devices are also used in real estate and sports photography. Furthermore, journalists are considering the use of Hoverbikes for collecting footage and information in live broadcasts.

2. Search And Rescue :

Presence of thermal sensors gives Hoverbikes night vision and makes them a powerful tool for surveillance. Hover bikes are able to discover the location of lost persons and unfortunate victims, especially in harsh conditions or challenging terrains. Besides locating victims, a drone can drop supplies to unreachable locations in war torn or disaster stricken countries. For example, a drone can be utilized to lower a walkie-talkie, GPS locator, medicines, food supplies, clothes,

3. Transportation :

The hover bike is an efficient mode of transport on uneven terrain and can be used with ease to travel in places with no road formation for normal vehicles.

Chapter 02

REVIEW OF LITERATURE

Hoverbike is a vehicle that has captured the imagination of the world in the modern times of technology. Since 2014, Malloy Aeronautics has been developing a hoverbike that has experimented quadcopter-like lift. In 2015, the company announced collaboration with the United States Defense Department at the Paris Airshow.

In April 2016, British inventor Colin Furze announced he had created a hoverbike using paramotors.

The Aero-X is a hoverbike designed to carry up to two people.

The Hoversurf Scorpion 3 is a hoverbike launched in 2017. It is famously used by the Dubai Police Force.

Various academicians and researchers have contributed in the developments of Hoverbike. Some of the findings are as follows –

Kailas Gaware in 2018 concluded that Adventurous motorcyclists might be familiar with the thrill of getting airborne at the top of a rise, but the Hover Bike was set to take catching some air to a whole new level. When compared with a helicopter, the Hover bike was cheaper, so that cheaper better product will not only take over the existing market but also it will open the way for those people who cannot afford the costs of a typical helicopter.

Ninad R. Patil in 2017 concluded that the Original hover bike uses IC engine as a power source but they was proposing electric energy as a power source. So there was a contribution towards pollution control. The only disadvantage will be its high initial cost.

Umesh Carpenter in 2017 analysed that the Hover bike has been designed from the very beginning to replace conventional helicopters in everyday one man operational areas like cattle mustering and survey, not just for the obvious fact that it was inefficient and dangerous to place complex conventional helicopters in such harsh working environments but also from a practical commercial position in which bringing to market a cheaper better product will not only take over the existing market but can open it up to far more new customers who before could not afford the upfront costs of a typical helicopter and the very expensive and often unlooked for maintenance costs .

Purushottam Jadhav in 2016 concluded the advantage of hover bike or hover-craft was maintain conservation of fuels. The mechanical part was the most challenging issue. The hull of the model was made from the polystyrene due to light, low cost and easy to shape. It had high aerodynamic efficiency due to ducted fan arrangement .

Swaraj D. Lewis in 2016 concluded that it could fly at a range of around 800m, endurance of maximum 5-10 minutes, payload obtained in case of two blade propeller was 0.3kg and in case of three blade propeller was 0.5kg.

B. Lokesh in 2015 concluded that such type of bike is the need of today. The designed light weight Hover Bike could successfully achieve lift and stability during flight.

Chapter 03

METHODOLOGY

Research methodology is the specific procedure or technique used to identify, select, process, and analyse information about a topic. In this report, the methodology section allows the reader to critically evaluate a study's overall validity and reliability. This part is divided in stages

- To study and apply the blade element theory on our prototype .
- To design and analyse the data work suitable for hover bike chassis .
- To build a connection for controlling system which is similar to bicopter .

1. WORKING PRINCIPLE

The main principle behind the working of this new breed of vehicle is “3rd LAW OF MOTION”. A Hover Bike is a type of aircraft that uses rotating, or spinning, wings called blades to fly. In order to fly, an object must have “lift,” a force moving it upward. Wings are curved on top and flatter on the bottom. This shape is called an aerofoil.. That shape makes air flow over the top faster than under the bottom. As a result, there is less air pressure on top of the wing.

The Hover Bike is similar to quad copter. Control of hover bike is accomplished by turning the rotors in a particular direction. The balance of flight can be achieved as like helicopters. Hover Bike is accomplished by varying the speed of the four motors relative to each other. AS the propeller starts the rotor pushes down on the air, the air pushes up on the rotor. This is the basic idea behind lift, which comes down to controlling the upward and downward force. The faster the rotors spin, the greater the lift, and vice-versa.

2. PROPELLER BLADE THEORY

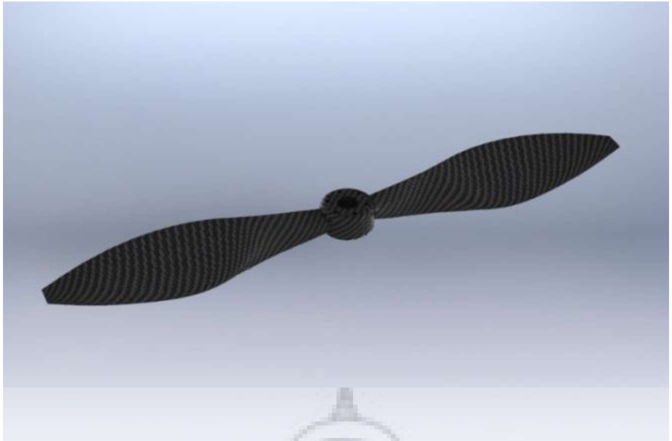
According to ***Kutta-Jukovsky*** theorem, lift force cannot be generated on a rotating propeller blade without the generation of vorticity, that is, for any cross section of a propeller blade,, where are the air density, relative airspeed and circulation. At the blade tip, where the pressure difference between the two sides of the blade cannot be supported, the lift goes to zero and this fact requires that vorticity must be shed from the blade tips of a rotating propeller and also, this shed vorticity produces the induced downwash. The propeller blade tip vortices shed follows a helical path and the region inside the helical trailing vortex system is a region of very strong downwash, which represents the air movement behind a rotating propeller.

The velocity induced by each vortex has a component in the circumferential direction because the vortex lines follow a helical path rather than a circular path at any point in space, the resultant induced velocity is the vector sum of the velocity induced by the entire length of all vortex filaments in the slipstream. Computing the velocity induced by the helical vortex system is more complex than for a finite wing and in order to predict this induced velocity we assume that the vortex sheet trailing from a rotating propeller lies along a helical surface of constant pitch and also, this induced velocity is normal to the vector sum of the rotation velocity and forward velocity.

3. PROPELLER MODELLING AND SIMULATION

A. Propeller CAD Model.

Standard propeller available in market of 10 inch and 4.5 inch pitch is used in this project. The CAD model is of a standard propeller. Propeller model was created using manual measurement.



Propeller geometry such as pitch and chord are measured by calipers. 20 cross sections are selected to measured and created propeller geometry and generated CAD (Computer Aided Design) model. CAD model as shown in figure is reconstructed using commercial AutoCAD software. For computational fluid dynamic simulation, CAD model would be modified in order to create mesh or topology.

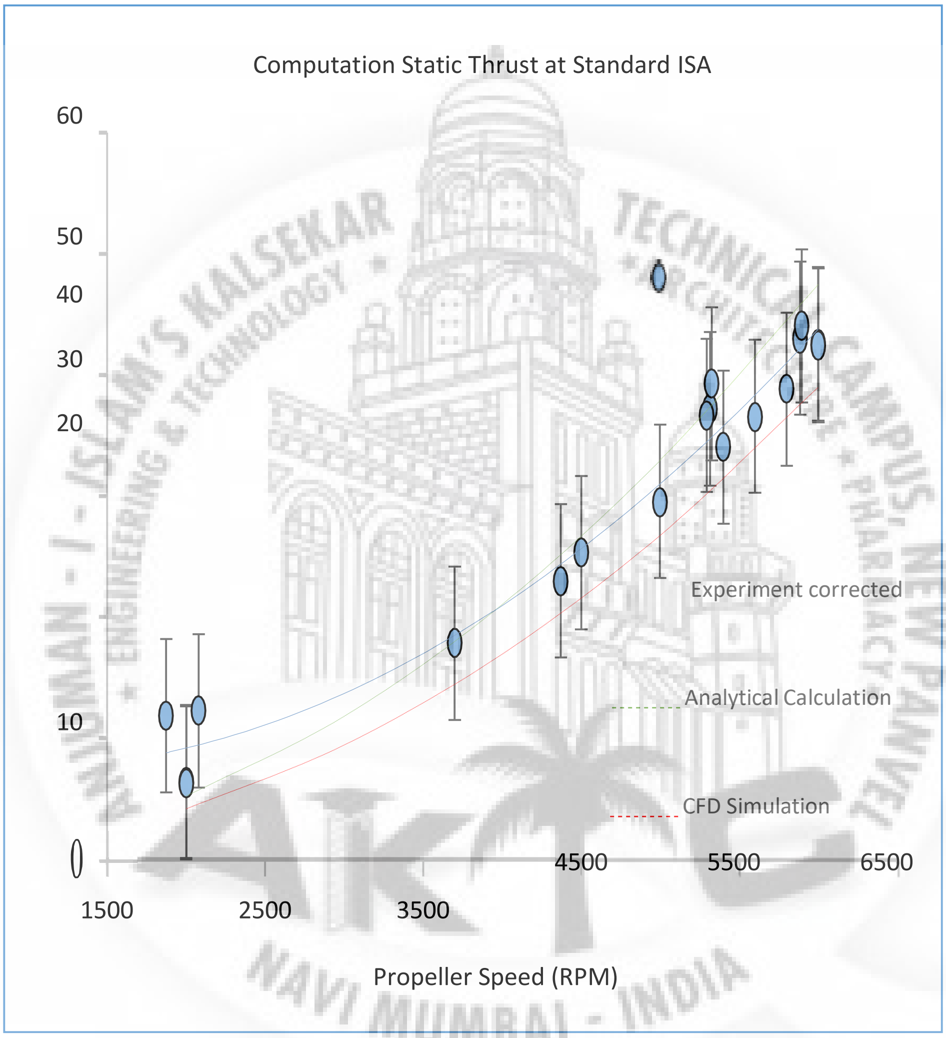
B. Analytical calculation using Vortex Blade Element Method.

Analytical calculation using vortex-blade element theory is combination from blade element theory and momentum theory method . Calculation process was iteration process using value of induced velocity and free stream velocity. Accuracy of this method determined by aerofoil characteristic. Aerofoil characteristic for this calculation was taken from CFD simulation at 70% from hub. Assumption from this calculation that aerofoil at 70% hub represented aerofoil characteristic of propeller. Even though this condition deviates from real condition but this approximation is needed to simplify calculation. The result would be compared with experiment.

C. Result and Discussion

The result of static thrust calculation are shown at Figure and Table below. Dot and blue line (experiment) is experiment data after correction with friction and conversion to standard sea level. The red line is CFD simulation and blue line is analytical calculation. As we can see, both simulation and analytical calculation showed the same tendency or trend with experiment result. The value from both calculation was in error range of experiment.

Non dimensional comparison showed analytical calculation gave accuracy 5.08%. Static thrust calculation analytically was lower than experimental calculation. Even though this differences was in error range, thrust at low speed test data was not too close with experiment. Thrust data at low rpm added to validate static thrust calculation.



Computation static thrust from Analytical Calculation

Table : Result and comparison static thrust non-dimensional parameter

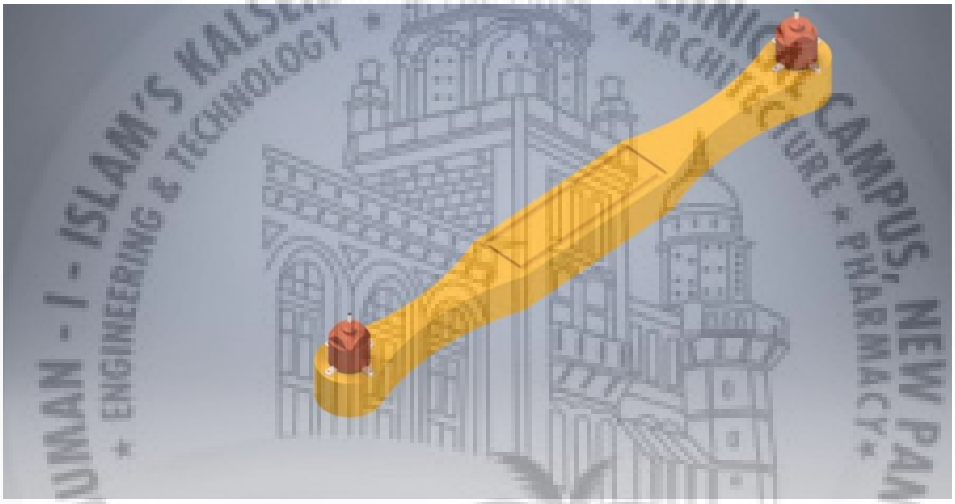
Calculation Method	Static Thrust Coefficient	Deviation from Experiment

	((kg^(1/3))/m)	(%)
Experiment	**0.59**	**0**
Analytic	**0.62**	**5.08**

4. CHASSIS DESIGN

The chassis was design keeping in optimum functional level and stability parameters.

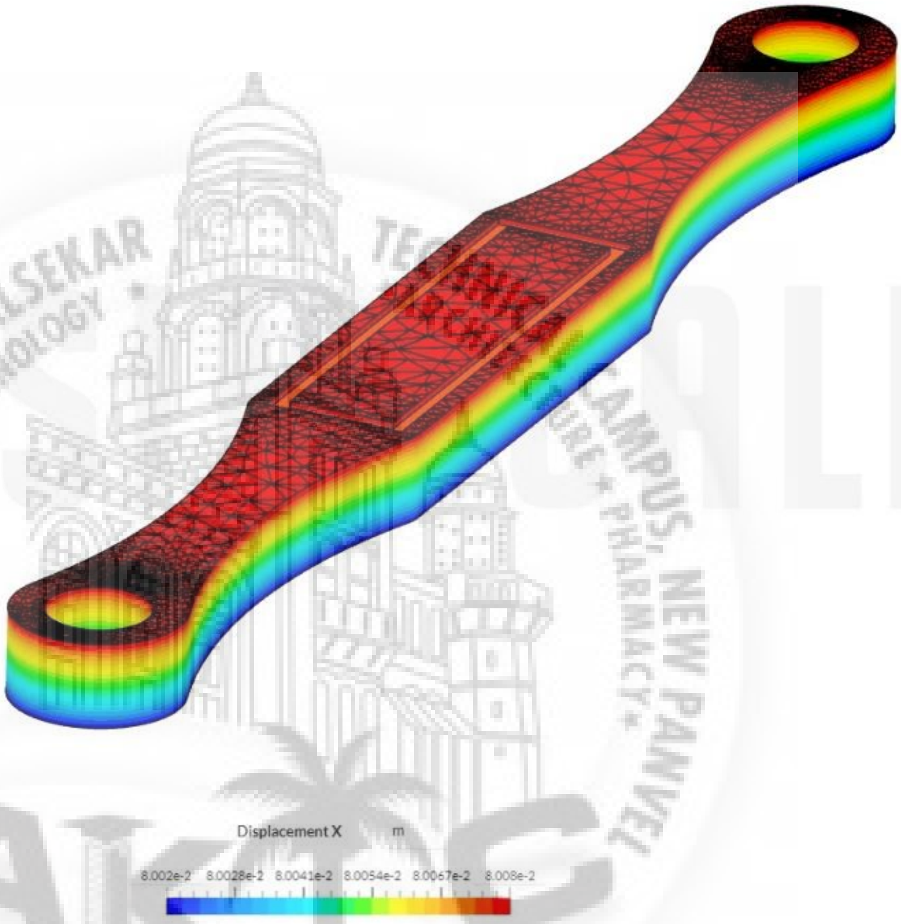
The chassis was designed on AutoCAD.



The chassis was subjected to analysis of load testing as follows –

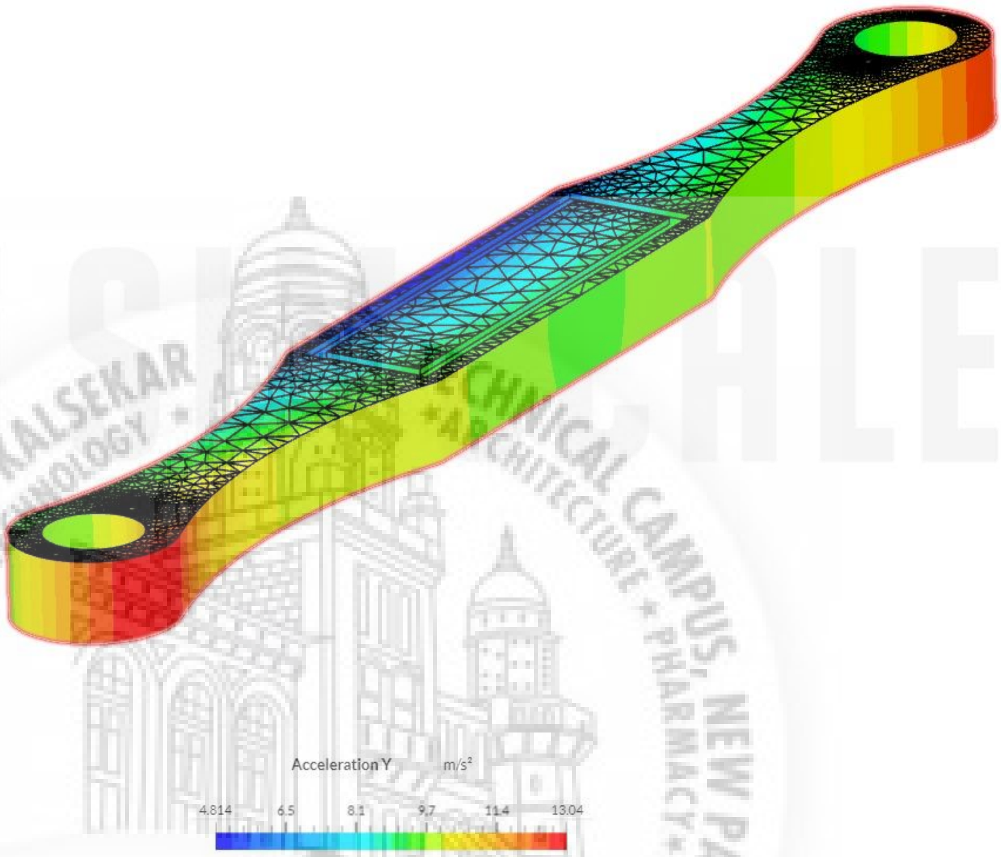
A. Displacement due to load in X – Axis

As we can see in figure below, due to pressure acting on top of chassis due to motor weight and thrust there is a displacement of chassis material from original position in the direction of x-axis. Displacement is max at top of chassis with 8.008e-2 m and min at bottom with 8.002e-2 m.



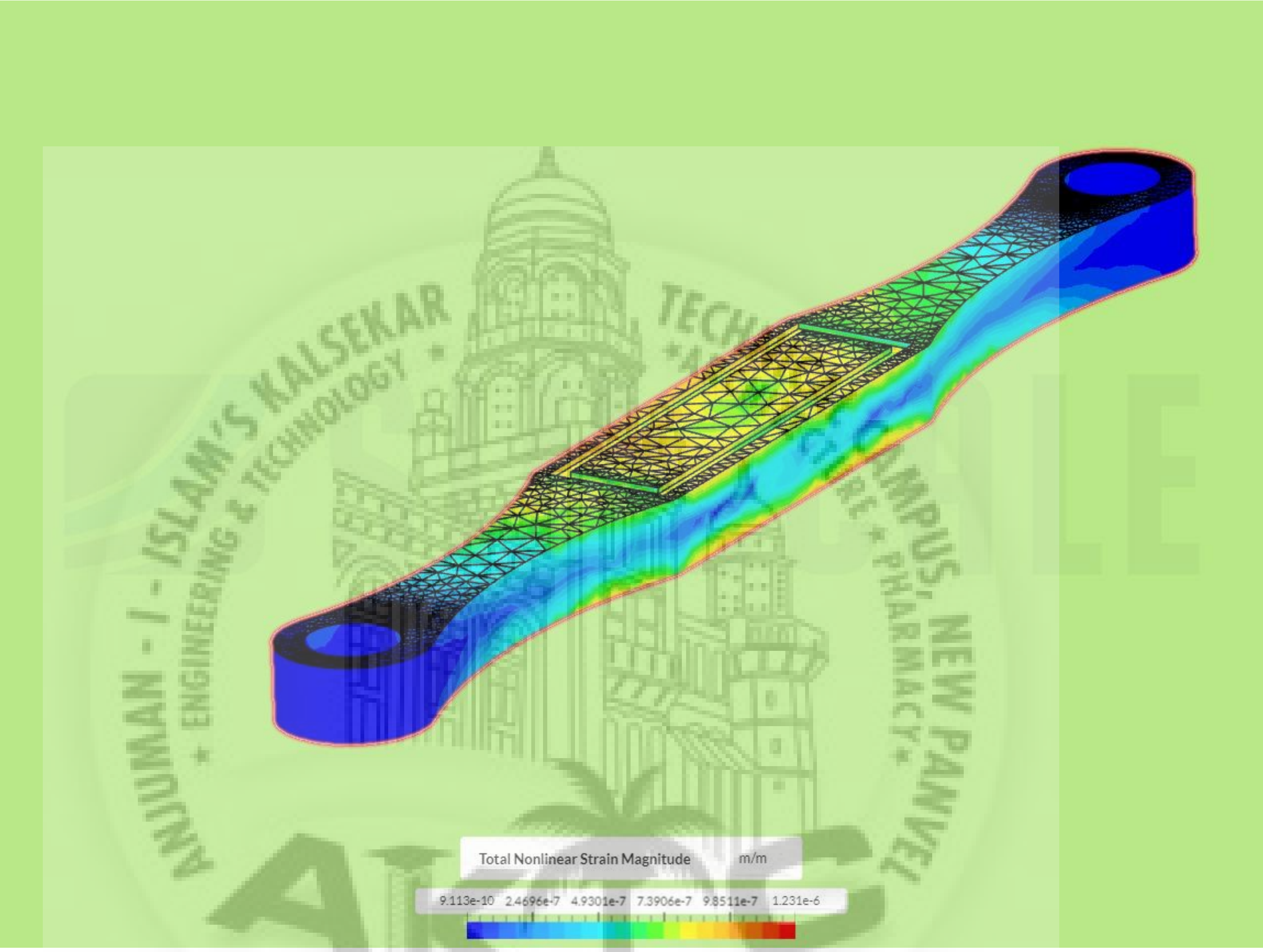
B. Acceleration

The chassis develops an minimum acceleration of 4.814m/s² in middle and maximum of 13.04 m/s² at ends



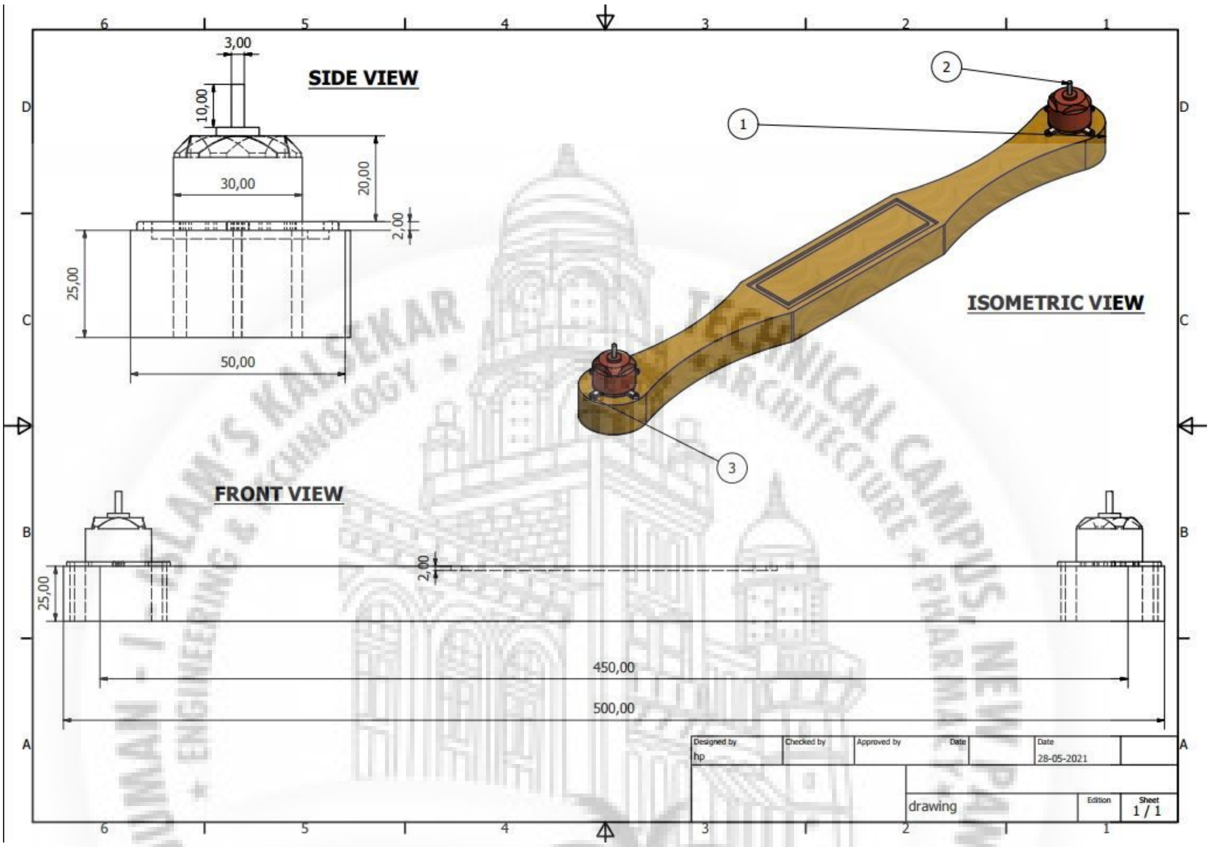
C. Total Non Linear Strain

Due to the force generated by the propellers required for thrust, the body of vehicle undergoes a strain. It is maximum in the middle of the body with 1.231e-6 m/m and minimum at the ends with 9.113e-10 m/m.



5. PROTOTYPE CAD MODEL

The figure below shows the CAD model of the prototype of Hoverbike with dimensions.



6. CONSTRTUCTIONAL DETAILS

Hover Bike is a compact aerial vehicle with a ducted fan configuration which is able to survey and do reconnaissance. A simple design is used for commercial purposes like a motor bike. A simple framework of propeller bicopter Hover Bike is used. It consists of high pitch type of propeller mounted on a high speed brushless electric motor and powered by rechargeable Li-Po fuel cells. It is designed with a ducted fan so that the slip of air is less. Hence its aerodynamic efficiency is high. Moreover it can able to take off and land vertically from any terrain.

Components used to build a hover bike prototype are as follows :

- Material - Aluminium Alloy
- BLDC motor
- Servo
- ESC 30 amp
- Propellers 1045
- Battery 2200mah
- Flight controller KK2.1.5 / Arduino Uno
- RC transmitter and receiver
- Wood plates & wires(aluminium)

- **Material (AISI 4130)**

AISI 4130 alloy steel contains chromium and molybdenum as strengthening agents. It has high carbon content, and can be used for the frame due to high strength and light which helps to increase the thrust.

Composition Specifications of AISI 4130 Alloy Steel in % :

Range	C	Si	Mn	P	S	Cr	Mo
Min	0.28	0.15	0.4	-	-	0.8	0.15
Max	0.33	0.35	0.6	0.035	0.04	1.1	0.25

Mechanical Properties :

Properties	Metric	Imperial
Tensile strength, ultimate	560 MPa	81200 psi
Tensile strength, yield	460 MPa	66700 psi
Modulus of elasticity	190-210 GPa	27557-30458 ksi
Bulk modulus (Typical for steel)	140 GPa	20300 ksi

- **BLDC motor 2200 kv**

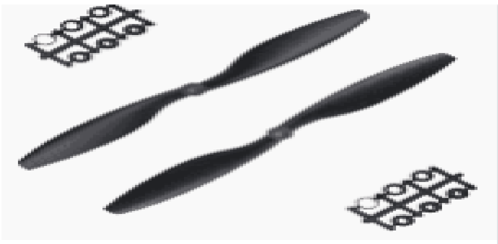
This brushless motor has 22000 rpm . Electric motors are use to deliver the power from battery one to power each propeller. The main advantage of using an electric motor is that it could be mounted directly above the propeller, or integrated directly with the propeller, meaning the motor drives the propeller without any need of a drive train.

The Important factor consider for BLDC Motor were that it should provide quick acceleration and speed of the motor should be high. We are using a brushless DC motor of 22,000 RPM which helps to get desirable thrust mounted on the chassis at both ends.

- **ESC 30 amp**

Electronic speed controller is used to control the speed of the BLDC motor which have the capacity of 30 ampere. They control the speed of the brushless motors. The first considered when selecting ESCs is what size of ESC is needed for setup. Of course, when we talk about 'size' of ESC, we do not mean the physical size of the module, but of the amount of amperage it supplies to your motor. The standard range of ESC sizes is 12A-40A ESCs for quad-copters and other multi-rotors but we can get smaller and larger ones. To choose the right ESC for our needs, we have also consider what motors we are going to use, and what propellers. The size of ESC that we need depends on our multi-rotor setup i.e. ESC 30A

- **Propellers**



This 1045 propeller can be used with brushless motors with a 800-2200 kV rating. With a low kV motor (800 - 1400 kV), this propeller offers smooth flights with longer flight times perfect for FPV and aerial photography. With a high kV motor (more than 1200 kV) this propeller offers fast flights perfect for acrobatic flights. This propeller can be used with our A2212 1000KV, 1400KV, 1800KV and 2200kV motors and our 30A ESC. It has a diameter of 10" (25.4 cm) and a Pitch: of 4.5" (11.43 cm). 10.45" propeller is used according to the dimensions, weight of the body and to get desirable thrust.

- **BATTERY LIPO 3s 2200 mAh**

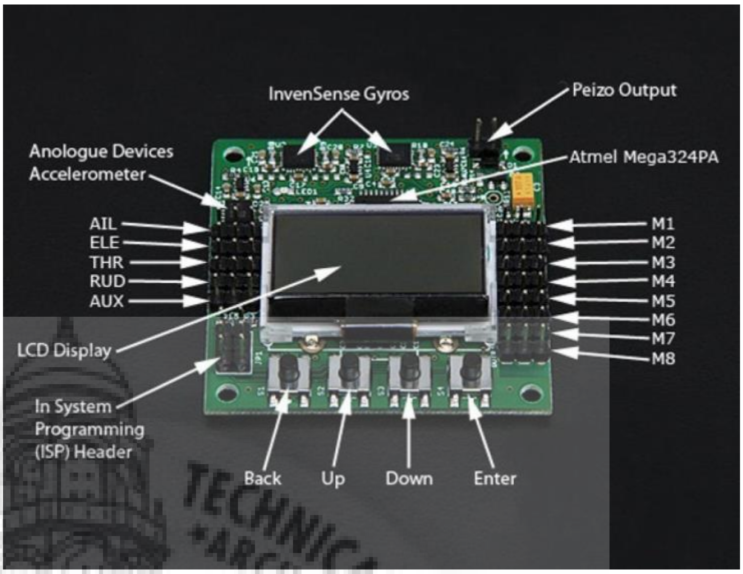
11.1V 2200mAH Lipo battery is capable of maximum continuous discharge rates up to 30C, placing this battery among the most powerful Li-Po battery packs in its range. It offers an excellent blend of weight, power, and performance. The use of bike engine in the hover is quite difficult because of its weight and leads to difficulty in operating efficiently, but Electric motors are quiet, energy efficient, and environmentally friendly. The use of electrical power from a battery to move vehicles has been around for over a century. Earlier it was not widely used because it was less understood, and harder to implement. In modern days there has been much research done on improving batteries and electric motors to increase efficiency and power generation. Battery 2200 mAh 3S Li PO battery is used for smooth and durable flight time. It supplies the power to Power Distribution boards.

- **Control system and Power Distribution board**

This is a general purpose microcontroller that allows us to build our own flight controller by buying the parts we want to install, and assembling the controller on our own. We can use Arduino Uno board to control the flight and also drive the motor of bike or use the KK2.1.5 multi-rotor flight controller. The Power Distribution board distributes the required power to all the parts.

The KK2.1.5 Multi-Rotor controller is a directly programmed and built for flight control board for multi-rotor aircraft (Tricopters, Quadcopters, Hexcopters etc). Its purpose is to stabilize the aircraft during flight. To do this it takes the signal from the 6050MPU gyro/acc (roll, pitch and yaw) then passes the signal to the Atmega644PA IC. The Atmega644PA IC unit then processes these signals according the users selected firmware and passes control signals to the installed Electronic Speed Controllers (ESCs). These signals instruct the ESCs to make fine adjustments to the motors rotational speed which in turn stabilizes your multi-rotor craft. The KK2.1.5 Multi-Rotor control board also uses signals from your radio systems receiver (Rx) and passes these signals to the Atmega644PA IC via the aileron, elevator, throttle and rudder inputs. Once this information has been processed the IC will send varying signals to the ESCs which in turn adjust the rotational speed of each motor to induce controlled flight (up, down, backwards, forwards, left, right, yaw).

- **RC transmitter and receiver**



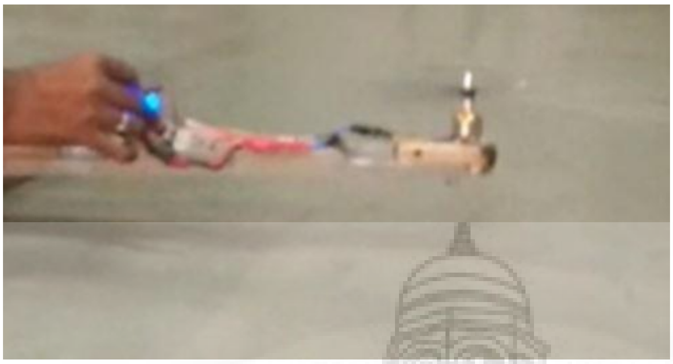
KK2.1.5 Flight controller

Works in the frequency range of 2.405 to 2.475GHz.This has been divided into 142 independent channels, each radio system uses 16 different channels and 160 different types of hopping algorithm.This radio system uses a high gain and high-quality multi-directional antenna. It covers the whole frequency band. Associated with a high sensitivity receiver, this radio system guarantees a jamming free long-range radio transmission . Each transmitter has a unique ID when binding with a receiver, the receiver saves that unique ID and can accept only data from the unique transmitter. this avoids picking another transmitter signal and dramatically increase interference immunity and safety. This radio system uses low power electronic components and sensitive receiver chip. Intermittent signals are used by RF modulation thus reducing even more power consumption. AFHDS2A system has the automatic identification function, which can switch automatically current mode between single-way communication mode and two-way communication mode according to the customer needs.AFHDS2A has built-in multiple channel coding and error-correction, which improve the stability of the communication, reduce the error ratio and extend the reliable transmission distances.

7. TOTAL COST OF PROTOTYPE

No	Item	Quantity	Cost
1	Material of Chassis	-	NA
2	BLDC Motor	2	× 350 = 700 Rs
3	Servo	2	× 300 = 600 Rs
4	ESC 30 amp	2	×325 = 650 Rs
5	Propeller	2	×300 = 600 Rs
6	Battery with charger	1	1800 Rs
7	KK2.1.5 flight controller	1	1900 Rs
8	Rc transmitter and receiver	1	3000 Rs
9	Wires & etc	-	500 Rs
10	Electrical Tape	1	NA
11	Wood plates	-	NA
		Total	**RS 9750**

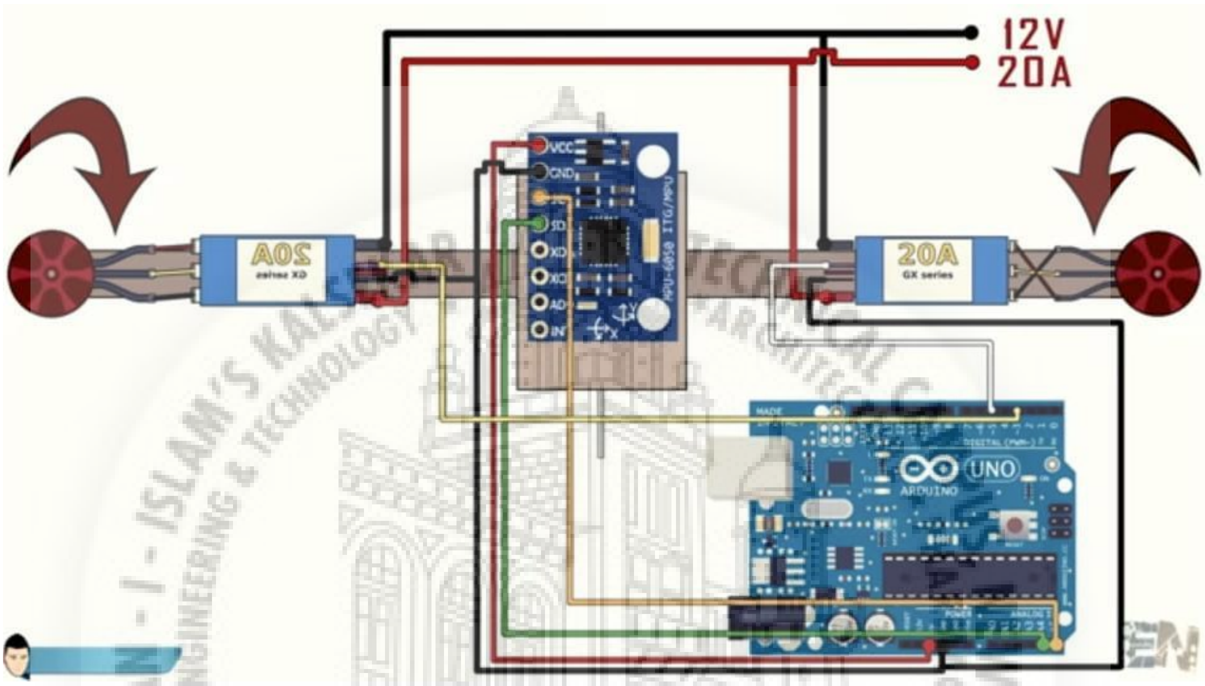
8. WORKING



The chassis was made of aluminium with a wooden mechanism built on it through which the servo was to able to change position of motor and give directions to the propellers. The motors were mounted on wooden plate controlled in direction by servo upon which the propellers were locked. The motors were mounted on two ends of the chassis for optimum stability. The Vibrations produced by motor are reduced by adding wooden block.

The motors on both sides were connected to 30 amp ESC which was connected to the kk2.1.5 flight controller. It is known that flight controlling can also be done with the use of Arduino Uno by building and programming a flight controller by assembling the circuit required for it as shown in figure below. But for our part we used kk2.1.5 flight controller due to its ease of use. The servo was connected to it too. The connections of receiver (Rx 700) and kk2.1.5 controller were done as necessary. The power supply to both the ESCs was given through a single battery by joining the two ESCs.

The kk2.1.5 controller was put on factory reset and calibrations were done as necessary and required by the prototype. The 2 motors rotate in opposite direction- one clockwise & the other anticlockwise for flight generation. The two servos and the two motors were synchronized with the controller. The RC flight controller comprising of transmitter was used to transmit signals to the receiver and the prototype was able to generate flight. All the apparatus was strapped to the chassis using rubber bands and electrical tape. Depending on the Lipo 3s battery it had a decent flight time.



Circuit Diagram

Chapter 04

ADVANTAGES, DISADVANTAGS, FUTURE SCOPE AND APPLICATIONS

1. ADVANTAGES

Hoverbike has the ability to take off and land vertically. It does not need any runway. The use of battery implies that the Hover-craft leads to the conservation of fuels. The hover bike would be able to reach some areas inaccessible to road vehicles and helicopters. Cities can be connected in a shorter duration as it doesn't depend on roads. Travel on rivers, over snow, lakes etc. Is possible with Hoverbike. It is designed with ducted fan, so that the slip of air is Less. Hence its aerodynamic efficiency is so high.

2. DISADVANTAGES

Some disadvantages are that the initial cost is high which means only the privileged will be able to afford it. The driver needs to be and should be trained before riding the hover bike. More power is consumed since the drag is comparatively more.

3. FUTURE SCOPE

The prototype being built can be used as a reference to build a scaled actual model of a hovercraft with manual or auto control. The prototype can be fitted with camera and extra sensors to make it more versatile. The bicopter functionality of the prototype can be further studied and modified in a large scale model. The attachment of wheels on the body and modifications in control and stability can further the versatility of the prototype craft to such an extent that it may be possible to use the hoverbike for both purposes – As a VTOL and as a normal road bike.

4. APPLICATIONS

The hoverbike can be used for agricultural purposes like sowing of seeds, sprinkle pesticides on crops. It can be used in policing duties. It may be possible to use the vehicle for traffic spotting. Sports events film coverage and aerial photography are some possible uses. The surveillance of coastal borders, road traffic, etc. becomes more easy through the use of such a vehicle. Using hoverbike in disaster and crisis management , search and rescue operations may prove quicker and fruitful. It has the ability to carry supplies if extraction is impossible. The full scaled model could be used as a future mode of Transportation.

Chapter 05

RESULT AND CONCLUSION

1. RESULT

Certain parameters of the vehicle were determined by the known parameters. They are the following –

The motor speed = 2200 rpm/kv = 22000 rpm

Thrust generated by propellers = 1.2 kg

Total weight = 0.867 kg

Safety Buffer weight = around 0.3 kg

Flight Time = 15-20 minutes. (Rechargeable Battery)

2. CONCLUSION

The work done on Hover Bike leads to the conclusion that when hover bike is like a helicopter but different, the Hover bike is comparatively economical, more tough and easier to use , and represents a whole new way to fly. While testing the prototype, the understanding that the stability of quad-copter Hover Bike may be or probably is greater than bi-copter Hover Bike in air was achieved.

The replacement of engine leads to possible pollution control. It is achieved by replacing engine in hover bike with electric motor and battery and the construction of Hover Bike is simplified. The use of electric motor and batteries leads to a disadvantage driving the initial cost on a higher side.

The overall weight of the prototype vehicle is 867 grams is checked and verified at every stage of testing and mounting of every part and kept within the prescribed limit. The thrust generated by the propellers is around 1.2 kg and gives a certain safety buffer to the prototype by around 0.3 kg. The prototype had a flight time of around 15-20 minutes upon which the battery needs to be recharged. Depending on the Lipo 3s battery it has a decent flight time.

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