Design and Analysis of Hover bike Model

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Abstract: ***Now a days fast and comfort aspects are both important thing and automobile is one of the thing that use by human being for fast and comfort transportation but now it is world of innovation and we worked on future of automobile called as hover bike. Hover means to stay in air. In this research literature we thoroughly studied the design parameter required to design a hover bike. The detailed mathematical calculation is carried out for optimum model. The CAD model assembly of bike is design and analyzed by various loading condition for human safety. The obtain results are under factor of safety. This research literature is just a little contribution in field of automobile engineering and for its advancement.***

Keywords: engine, propellers, CatiaV5.

1. Introduction

A hoverbike is the progression of existing vehicles in automobile sector, which can hover. It looks like simple bikes. It is a compact aerial vehicle with ducted fan configuration which can able to survey and spy the surroundings. The transportation sector focuses on designing larger, more efficient, and more reliable aircraft. The military focuses on designing more effective, maneuverable, and deadly weapons. There is also a private sector in the aerospace industry.

It consists of a co-axial type propeller mounted on high speed engine which is used for cost effective design purpose In our literature for conform design requirement we chose the motor bike engine .Thrust vectoring can be done by special design and technique so that it can able to fly almost in all directions. Moreover it can able to take off and land vertically from any land. It does not need any runway. [1]

2. Literature Review

The first hovercraft is produced ever in Malaysia was by AFE manufacturing company with Japanese technology collaboration. The launching of the hovercraft in PUTRAJAYA in 2003 has paved way for new opportunity in manufacturing sector. This types bike has been designed from the very beginning to replace conventional helicopters such as the Robinson R22 in everyday one man operational areas like cattle mustering and survey, not just for the obvious fact that it is inefficient and dangerous to place complex conventional helicopters in such harsh working environments.[2]

In year 2014 Malloy Aeronautics has been developed a hover bike which was experimented with quad HYPERLINK after that, the group announced collaboration with the United States Defense Department at the Par HYPERLINK-in 2015.[3]

Aerofex tested the hover bike for speed and stability at the Mojave Desert. The hi-tech vehicle flew through the desert at speed of up to 50km/h. Although it was slower than the “Star Wars” speeder bikes, the machine proved that flying can be as easy as riding an ordinary bike. AEROFEX said that it has no plan of selling the vehicle and the technology was just intended to develop unmanned drones.[4].

California engineering firm tried to made the dream a reality by creating a futuristic flying vehicle similar to those ridden in sci-fi movies.[5]

3. Designing Parameter and Specification

A) Material choice

The frame design developed took a simplistic approach. The main ideas taken into consideration were the housing of engine and the propellers, a place for the rider to sit. We are using aluminum as a material for frame with Chassis cage pipe thickness 3mm. Structural supports were added to key areas of the frame. The added support below the propellers greatly improved the performance.[6]

Table 1: Design Parameters

Sr. no	Properties and Values	
1	Length	9.9(ft)
2	Width	3.2(ft)
3	Height	2.(ft)
4	volume area	1748130.10 cm^3
4	lift and thrust engine power	1.4 KW (1.87 hp)
5	No. of propeller	2 propeller
6	thrust method	ducted propeller
7	thrust line control by	engine accelerator
8	body material	aluminum
9	model weight (kg)	90kg (882.9N)

B) Engine specification (kk8640)

For our analytical purpose we use the standard KK BC-8640 engine. It is a unit dedicated to Range by utilizing state-of-the-art technology and quality approved raw material from all across the globe for its unmatched quality, durability and long operational life this binder in different sizes, dimensions and other related specifications. In order to meet needs of our prestigious range it is tested by experts on well-defined parameters to deliver a flawlessness range to accomplish our condition. [7]

Table 2: Engine Specification

Sr. No	Details of Engine Model	Parameter
1	Capacity of engine	40 cc
2	Power	1.4 KW (1.87 HP)
3	RPM	6600
4	Fuel ratio	500 ml/hr

4. Analytical Equation

A) Weight calculation:

For design purpose we have to consider all load which acted on chassis.

Wt=Wc+Wp+Wf+We+Wl[8]

Where,

Table 3: Types of loads

Sr.No	Types of Load	Notation	Equipment	Value
1	Crue load	Wc	Asseseries	4 kg
2	Payload	Wp	Human load	50 kg
3	Empty lode	Wl	Only chassis	15 kg
4	Weight of fuel	Wf	Fuel load	1100 ml (3kg)
5	Weight of engine	We	2 engines	2*9= 18 kg
5	**Total load**	**Wt**		**90 kg (882.9 N)**

5. Mathematical Calculation

a) Total hover produce (Lift)

From the engine rpm we can able to calculate the angular velocity of the engine propeller.

Angular velocity: $\omega = \frac{2\pi N}{60}$ [8] eqn. (a)

$$\omega = \frac{2 * \pi * 6600}{60}$$

$$\omega = 691.15\ rad/s$$

As we considered the two propeller propulsion and from historical data we considered the coefficient of lift for propeller as follows.

$$L = \frac{1}{2} * V_b{}^2 \rho A C_L [8] \quad \text{eqn. (b)}$$

Where,

V_b= Linear velocity of air due to rotation of blade.

ρ = Density of air.

A = Area of rotating blade.

C_L =coefficient of lift.(0.4-2)

V_b= Linear velocity of air due to rotation of blade.

$$V_b = \omega * R \text{from eqn. (a)}$$

$$V_b = 691.15 * 80 * 10^{-2}$$

$$V_b = 552.92 \frac{m}{s}$$

Normal air velecity (V) = 18 m/s

i. Density of air = 1.29kg/m^3 standerd value

ii. Area of rotating blade $= \frac{\pi}{4} d^2$

$$A = \frac{\pi}{4} * 200^2 * (200^{-2})^2$$

$$A = 3.1415\ m^2$$

iii. C_L = coefficient of lift =1.5 or 1.2

$$L = \frac{1}{2} * 552.92^2 * 1.29 * 3.14 * 1.3 \text{from eqn (a)}$$

$$L = 804928.5168 \frac{kg - m}{s^2}$$

For 1 sec $L = 7893129.03\ W$

$L = 804.928\ KN$

for $V = 18$ m/s

$L = 173.91\ kg$

b) Total thrust generate

To start off with, we can make the assumption that the rotors of engine form a thin disk which 'pushes down' air when rotating fast enough. We can look at how the pressure (p) and velocity (v) vary before and after the disk (drawn paint image) .To make the analysis as simple as possible, we can ignore compressibility effects and use Bernoulli's principle on each of the two arrows before and after the disc. [8]

Before the disc:

$$p_0 + \frac{1}{2} * \rho * v_0{}^2 = p_1 + \frac{1}{2} * \rho * v_1{}^2$$

After the disc (Pressure returns to ambient far downstream of the rotor):

$$p_0 + \frac{1}{2} * \rho * v_3{}^2 = p_1 + \frac{1}{2} * \rho * v_2{}^2$$

because the disc is negligibly thin, we can assume that v2=v1

$\text{Thrust} = m * (v_3 - v_0)$. [9]

$\text{Thrust} = \rho A v * (v_3 - v_0)$.

$\text{Lift} = \text{Thrust}$.

$m * (v_3 - v_0) = \rho A v * (v_3 - v_0)$.

$$v_3 = 2v_1$$

$$\text{Thrust} = \rho A v * (v_3 - v_0)$$

$$\text{Thrust} = \rho A v * (2v_1 - v_0)$$

$= \rho A v * (2v_1)$

$v_0 -$ negligible value

$\mathbf{Thrust = \rho A v * 2v_b}$

$$= 2 * 1.29 * 3.14 * 18^2$$

$$\text{Thrust} = 267.56\ kg$$

$$\text{Thrust} = 2 * 267.56 * 9.81 = 5249.52N$$

$\text{Thrust} = 535.125\ kg$

c) Drag force:

Drag acting on the blade due to air stream

$$F_{Drag} = \frac{1}{2} * V_b C_D \rho A \qquad [8]$$

Where,

C_D =coefficient of Drag =0.5

$F_{Drag} = \frac{1}{2} * 18^2 * 0.5 * 1.29 * 3.14$

$F_{Drag} = 328.09\ N$

$F_{Drag} = 33.44\ kg$

d) Centrifugal force:
It is the force that counteracts centrifugal force by keeping an object a certain radius from the axis of rotation.

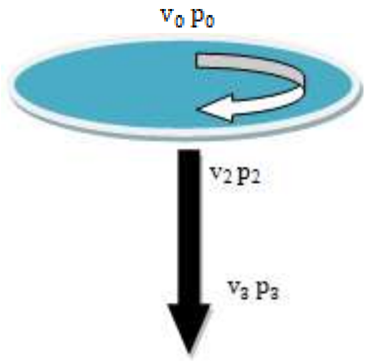

Figure A: Rotating blade

$v_1\ p_1$

$$F_c = M_b \omega^2 * R \quad [8]$$

Where,

M_b = mass of blade in kg

ω = angular velocity in $\frac{rad}{sec}$.

R = Redius of prof.

$F_c = 2 * 1 * (691.15)^2 * 80^{-2}$ fig. A

$F_c = 764.301$ KN

Normal air velecity (V) = 18 m/s

$$F_c = 2 * 1 * \frac{18^2}{80^{-2}} = 810 \text{ N}$$

$F_c = 810$ N

e) Effect of loading on forces:
For structural design we must have to specify the all forces and actual load of the system. Before going to the analysis part the main challenge is to know the exact weight of the total system. According to our consideration by changing different material and comparing with their properties, it must have to sustain the self-weight and human weight with it tends to fly.

Table 4

Forces evaluation with the load							
S No	Weight (kg)	Thrust (kg)	Lift (kg)	Drag (kg)	Centrifugal force (N)	Estimated lift engine Power (KW)	Max gross weight
1	60	535.1251	173.91	328.09	810	1.4	90
2	90	802.68	260.86	492	1215	2.1	120
2	120	1070	374.82	656.15	1620	2.8	140

6. Design & Analysis

A) Chasis design
After studying various literature we found that circular and square cross section chassis is well capable to withstand such types of forces as well as simple in constructional view. According to finalized dimension and minimizing the different types of challenges also we try for provide comfort, attractive and light weight chassis.

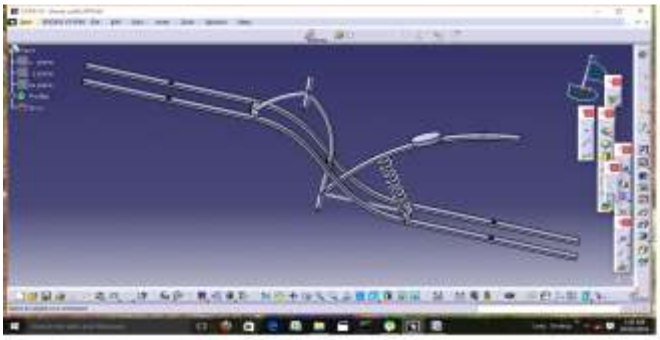

Figure B: chassis design in CAD

B) Chassis analysis in CATIA V5software:

1) Structural analysis
Aluminum is most likely to play a more important role in future car generations. Its material properties give it some advantages and open the way for new applications in the automotive industry. One of these is its use in car bodies. As per our designing parameter aluminum material which has less weight and it consist all beneficial properties. Aluminum material frame withstand the forces during the flight with all these components over the materials like stainless steel and brass, whose major drawback is that it has a density of 7850 kg/m3 and 8553 kg/m^3respectively which is more than 2710 kg/m3 of aluminum. [8] [9] [10]

Table 5: Applied load resultant

Fx	=	1 . 199e-009	N
Fy	=	8 . 475e-008	N
Fz	=	-7 . 640e+002	N
Mx	=	-1 . 209e+003	N-m
My	=	7 . 729e+001	N-m
Mz	=	-8 . 379e-009	N-m

The loading conditions are assumed to be static. The model of existing chassis as per the dimension is created in CATIA V5 as shown in table no 1. The model is then imported into CATIA workbench. Fig. C shows the imported model in ANSYS workbench.

Table 6: Material Selection

Material	Aluminum
Young's modulus	7e+010N/m2
Poisson's ratio	0.346
Density	2710kg/m3
Coefficient of thermal expansion	2.36e-005/Kdeg
Yield strength	9.5e+007N/m2

Above results of analysis revealed that the location of maximum deflection and maximum stress agree well with the theoretical maximum location of simple beam under uniform load distribution. The calculation of the stress produced in chassis is calculated by the moment distribution method. This method is basically a displacement method of analysis.

The chassis is the central frame of a vehicle which has to carry all the components and support all the loads. Fix support for analysis purpose are provided at the contact region of chassis as shown in Fig. C. [11] [12]

Figure C: Structure computation

2) Loading and boundary conditions:
The analysis done on the chassis model gives the maximum generated von-Mises stress on landing bar -7. 640e+002 N (table A). The generated von-Mises stresses are less than the permissible value hence the design is safe. The von-Mises stress and deformation are as shown in Fig. D and E. [13] [14]

Following fig. D and E shows the von-Mises stress test and displacement pattern for the aluminum chassis.

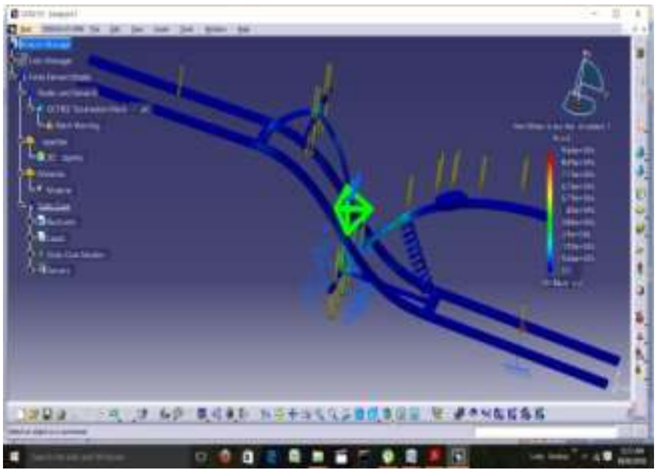

Figure D: von-Mises stress for aluminum chassis

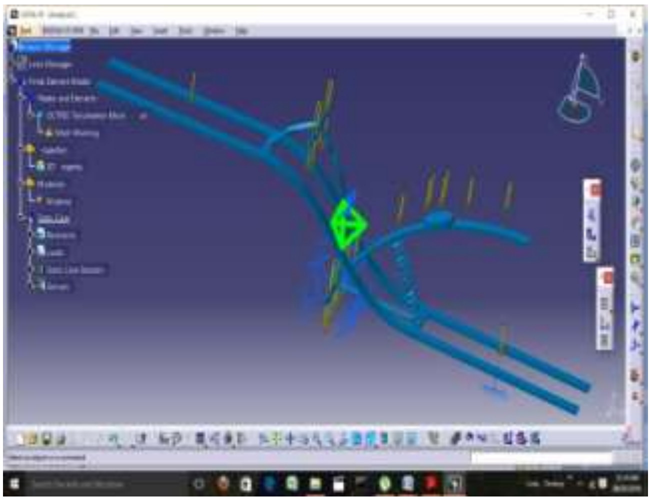

Figure E: Displacement pattern for aluminum chassis.

The stress and displacement distribution of the chassis subjected to scattered loading. Maximum stress of is observed at the front of the chassis where the distributed point load is applied. Maximum displacement of 0.2 mm occurs at the middle uprights. This is actually one of the more severe fatigue loading conditions where most of the stress is supported at the back flange portion of the chassis.

In actual, bike will be subjected to load due to the gravity when it live the ground position all lodes acted towards downward direction. In this condition, the stress will be evenly distributed and the value will be increase as high.

Figure G: Trantional imla cement

3) Human body posture analysis:
As per the various designing parameter like mass piloting system , gyroscopic effect , yaw and roll thrust vectoring by considering all of this it is also maintain its stability with human load .So that human comfort as well as with maintaining the center of gravity it is one of the tricky work for designer. By human posture analysis add-on Human Builder allowing the user to quantitatively and qualitatively analyze all aspects of manikin posture. Whole body and localized postures can be examined, scored and iterated to determine operator comfort and performance when interacting with the product in accordance with published comfort databases. User-friendly dialogue panels provide postural information for all segments of the manikin and color-coding techniques ensure that problem areas can be quickly identified and iterated to optimize posture. Human Posture Analysis allows users to create their own specific comfort and strength library for the needs of each individual application.[15]. Established comfort and strength databases from Wisner and Rebiffe, Human Scale and others are provided as default for postural analysis .By checking the human posture analysis color coding techniques mean that problem areas can be quickly identified and updated to an optimized posture.

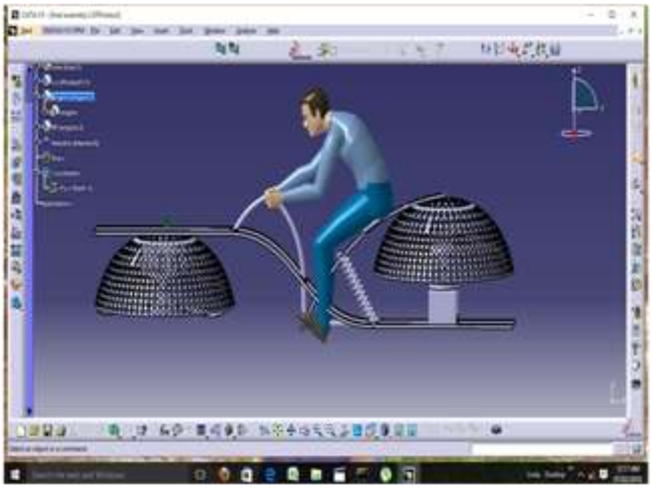

Figure 7: Human body posture analysis

7. Advantages

a) This vehicle can lift 103kg (227 lb) and can fly to the same speed and height as a typical light helicopter, but unlike a helicopter it can operate safely close to the ground and around people, and can be done so, with little or no training.
b) hover-craft is maintain conservation of fuels
c) It can use for search and rescue operations.
d) It has the ability to carry supplies if extraction is impossible.
e) The hoverbike would be able to reach some areas inaccessible to road vehicles and helicopters.
f) The response time would be much quicker than a helicopter, and could save many lives.
g) It is designed with ducted fan, so that the slip of air is less. Hence its aerodynamic efficiency is so high.
h) It does not need any runway.
i) Is useful for the defense operation, emergency

8. Conclusion

The present research work is concluded that such type of bike is the need of today. HoverBike is a new, fun & safe mode of transport that virtually anyone can drive. Adventurous motorcyclists might be familiar with the thrill of getting airborne at the top of a rise, but the Hoverbike is set to take catching some air to a whole new level. When compared with a helicopter, the Hover bike is cheaper, more rugged and easier to use – and represents a whole new way to fly. When compared with a helicopter, the Hover bike is cheaper, more rugged and easier to use – and represents a whole new way to fly. So that cheaper better product will not only take over the existing market but also its open the way for those people whose not afford the costs of a typical helicopter. It is the symbol of future bike.

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