Hoverbike – Design, Analysis and Prototype.

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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. A compact vehicle with a simplified design, it can be used in 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. The special design and technique leads to thrust vectoring thereby enabling the vehicle to fly or move in the direction of its choice. It is able to take-off vertically from the ground without any runway.

I. 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 ducted propellers at the end of both sides and in the middle there is a space kept for the pilot. In the modern aerospace industry, the focus is mainly fixed upon two sections : the Military and the transportation sector. Designing larger, more efficient, and more reliable aircrafts is the main focus of the transportation sector. And the military sector gives primary focus on the design of more efficient, effective and deadly weapons. A private sector exists in the aerospace industry which comprises of small engine planes, new age helicopters and the other numerous unique flying objects. Apart from the private sector, there are many commercial applications that could profit in a way due to the hoverbike. A hover bike may look like simple bike but is different. A bike with such capabilities has an easy process to operate it and may be applied as a means to travel in various purposes as it can operate without a runway and is perfectly capable of hovering from any terrain. Due to its ability to take-off and land vertically it has been generating a healthy interest in the military who are searching for such types of aerial vehicles. Such a bike is very mobile and due to its ability of quick deployment it is well-suited for a number of missions such as reconnaissance and surveillance which are performed by soldiers in a particular squad.

The lift which is generated by the duct is able to create a thrust force which is greater than the other comparable VTOL vehicles, which do not contain a duct and thus no hovering flight mode. This makes the vehicle aerodynamically efficient. In an ideal way, a vehicle of such capabilities may enable the people to navigate the land in a completely new and different manner.

II. PROBLEM DEFINITION

Need for a vehicle for easy transportation in places where uneven an improper roads formations traffics also for rescues and emergency services so as to move the rider from one place to another place very efficiently with a 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.

III. 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 the various components used in building a prototype and the assembly of such a vehicle so as to obtain optimum flight and stability. Emphasis is given on the general working of such a craft and the various factors related to it. The idea is the development of a hoverbike with the components and to ascertain its functioning and the parameters related to it.

IV.. CONSTRUCTIONAL DETAILS

Being a compact aerial vehicle the hoverbike is an able tool to survey and do reconnaissance as is necessary. For commercial purposes, a hoverbike is designed as simple as it is possible like a motor bike. A simple framework of bicopter propeller Hover Bike is used. The hoverbike frame comprises of high pitch type of propellers which are mounted upon high speed brushless electric motor which are powered by rechargeable Li-Po battery. It is designed such that it is able to take-off and land vertically from any type of terrain.

Components which are used in the building of a hoverbike prototype are the following :

- 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 is an alloy steel which contains strengthening agents as Chromium and Molybdenum. The carbon content in AISI 4130 is high thus enabling us to use it for the frame due to its high strength and light weight which helps to increase the thrust.

- **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 the component used to control the speed of the BLDC motor which have the capacity of 30 amperes. ESC are responsible for controlling the speed of the BLDC motors. When selecting ESCs, the first factor to consider is the size of ESC needed for setup. The size of the ESC is measured in the amount of amperage it supplies to your motor and not its actual physical size. 12A-40A is the standard range of ESCs for quad-copters and other multi-rotors. But according to our needs we can get smaller or larger ESCs. The selection of the right ESC for our needs may be done by considering the other components which we are going to use such as motors and propellers. The size of the ESC which we select according to our needs depends upon our bi-rotor setup and ESC of 30A.

- **Propellers**

The use of 1045 propeller is deemed optimal to be used with the brushless motors with 800 – 2200 rating. The 10 45 propeller provides smooth flights with longer flight duration which is ideal for aerial photography when used in combination with a low kv motor(800-1400 kv). When used with high kv motors with ratings more than 1400 kv the propeller offers faster flights. The 1045 propeller can be used with a variety of motors with ratings such as 1000kv, 1400kv, 1800kv and 2200kv and ESC of 30A. The dimensions of the propeller are such that 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.

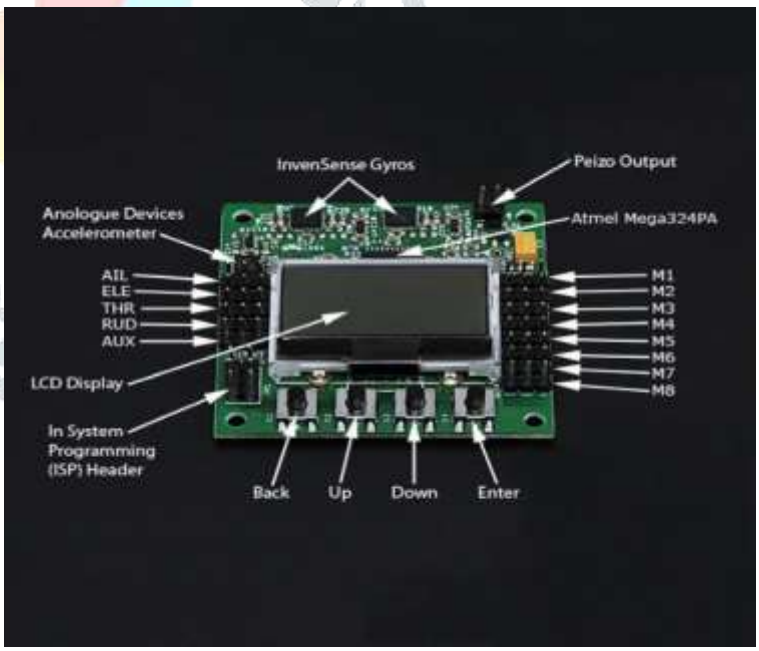
- **BATTERY LIPO 3s 2200 mAh**

We use the battery with a rating of 11.1V and a capacity of 3200mAH. It is a LiPo 3s battery and is capable of producing maximum discharge rates up to 30C continuously. The discharge rate comparison with other batteries in its range prove its high performance. The battery provides perfect balance in all parameters like weight, performance and power as required. Using engines used in road vehicles such as bikes or cars is not feasible as it leads to increase in overall weight and decreases the ease of operating the vehicle. The use of motors and batteries is suitable as it is energy efficient, environment friendly and reduces pollution. In modern days, various research have been conducted on improving batteries & electric motors so as to increase their efficiency and generate more power. 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**

To control and connect the circuits a general purpose microcontroller is used. The microcontroller gives us the ability to build our own flight controller by using parts we want in our flight controller 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 controller. The Power Distribution board distributes the required power to all the parts. KK2.1.5 Multi-Rotor flight 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**



RC transmitter and receiver are used to complete the circuit and give commands to the flight controller. It 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 needs of the user. AFHDS2A built-in multiple channel coding and error-correction, which improve the stability of the communication, reduce the error ratio and extend the reliable transmission distance.

V. METHODOLOGY

Here this part is divided in three stages

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

Blade Element Theory :

In the method of blade element theory, a number of independent In are made of the propeller by dividing it along its length. At each section, a force balance is applied which involves 2D section lift and drag with the thrust and torque produced by the section.

Thrust = Drag = $0.5\rho s^2$. ACD

WHERE ρ:Density of air s:
Speed
cd :Drag Coefficient
We know that as speed of the vehicle increases the power consumption too increases. Now thrust power in terms of thrust and speed can be expressed as

Thrust Power= Thrust x s = $0.5\rho s^3$. A. CD

Therefore hover bike are operated at constant speed due to scarcity of power supply .

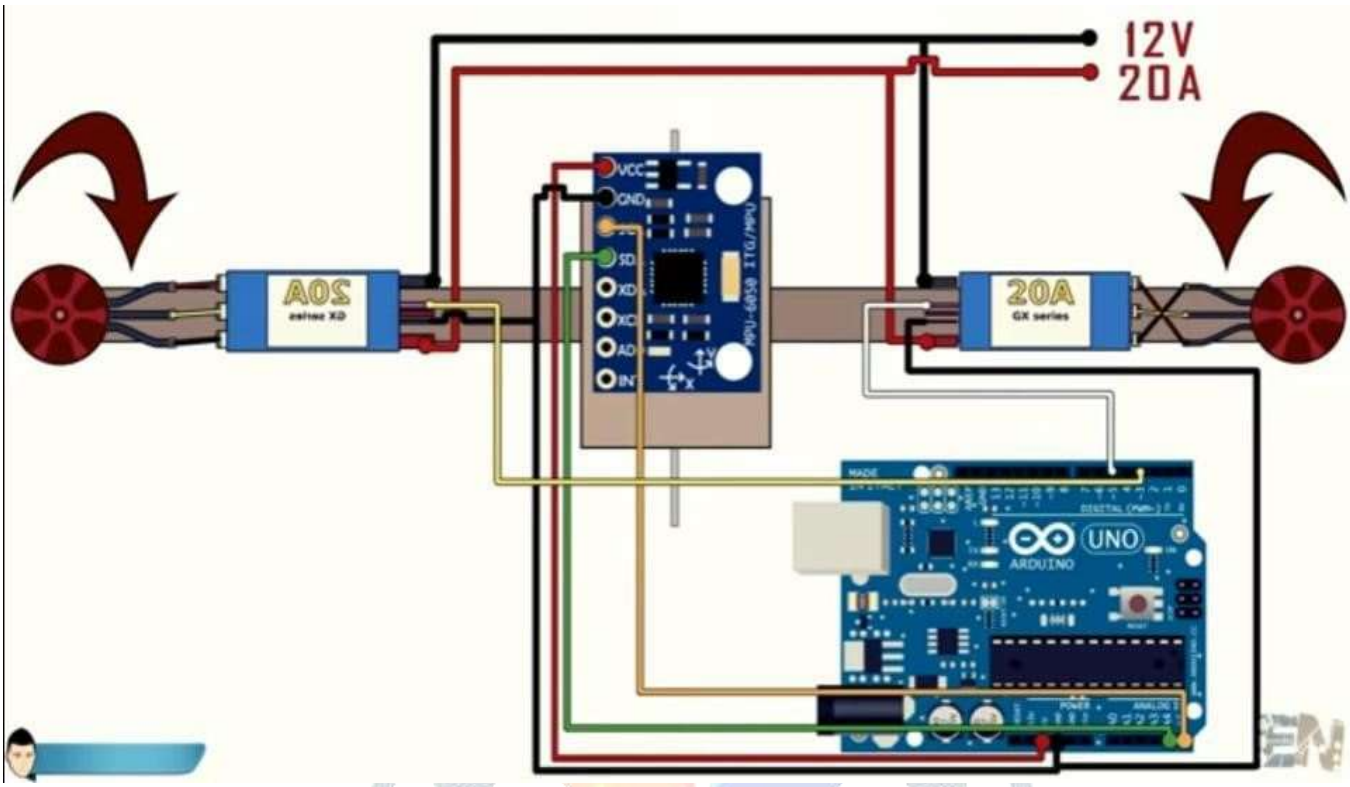
(We inferred that the motor speed was 22,000 kv and referring the propeller size 1045)

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(Rx 700) 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.



VI. TESTING RESULTS AND CONCLUSION

The work done on Hover Bike leads to the conclusion that hoverbike may be similar to a helicopter but is completely different. The hover bike is comparatively economical, more tough and easy-to-use vehicle representing a whole new way to travel. While testing the prototype, the understanding that the stability of quad-copter Hover Bike may be or probably is greater than a hover bike with bi-copter functionality, in flight, was achieved.

The replacement of engine leads to possible pollution control. It is achieved by replacing engine in hover bike with electric motor and rechargeable battery and the construction of Hover Bike is simplified. The use of components such as electric motor and rechargeable battery leads to a drawback driving the initial investment in a hoverbike on a higher side.

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

The motor speed = 2200rpm/kv = 22000rpm.
Thrust generated by the propellers = 1.2 kg
Total weight = 0.867 kg
Safety buffer/Dead weight = around 0.3kg
Flight Time = 15-29 minutes.(Rechargeable Battery)

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.

VII. ADVANTAGES

Hoverbike has the ability to land and take-off vertically since it doesn't need any runway. The use of battery implies that the Hover-craft leads to the proper management and preservation of fuels. Due to its ability to hover, the hoverbike may give access to certain areas which are inaccessible to vehicles which need road and even to helicopters as in uneven mountains. Hoverbike enables better connectivity ain lesser time as it is independent of roads. The journey which may be blocked due to rivers, snow, lakes, etc. is now possible with Hoverbike. It is highly efficient as a means of travel.

VIII. 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 and should undergo proper training before riding the hoverbike. More power is consumed since the drag is comparatively more.

IX. 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.

X. APPLICATION

The hoverbike may be utilised for various agricultural purposes like planting seeds, sprinkling pesticides on the crops. It can be used in policing duties. It may be possible to use the vehicle for the management of traffic. Film coverage of sports events and photography through an aerial view 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 the event of managing natural disaster and various crisis, carrying out search & rescue operations may prove quicker and fruitful. When the extraction of large quantity of stranded people is impossible, it can be used to provide them with supplies until a better solution can be found. The development of a full scale model is a possibility and an opportunity as a new means of transportation in the future.

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