Global Scientific JOURNALS

GSJ: Volume 9, Issue 5, May 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

DESIGN AND FABRICATION OF WORKING MODEL OF HOVERCRAFT

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ABSTRACT

The design and development of a hovercraft prototype with full hovercraft basic functions is reported. The design process is quite like that of boat and aircraft. In-depth research was carried out to determine the components of a hovercraft system and their basic functions, and in particular its principle of operation. Detailed design analysis was done to determine the size of component parts, quite in accordance with relevant standard requirements as applicable in the air cushion model. Test performance was carried out and the prototype was found to meet design expectations giving an air cushion of 0.5 inch. The test performance result gave an efficiency of 69% for the design. Further research is recommended to improve on the efficiency of the craft.

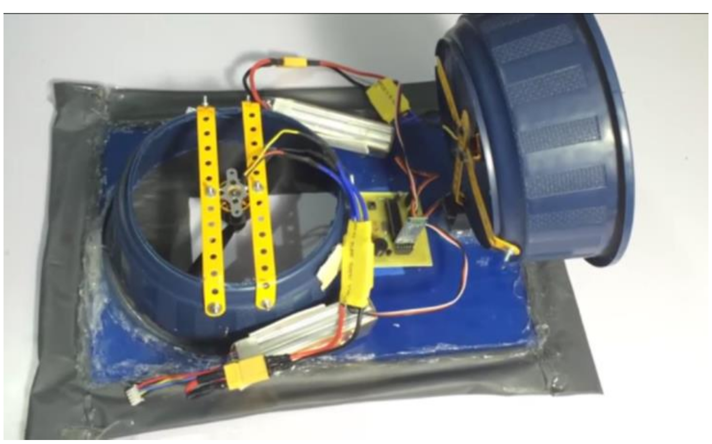
Key words: *Hovercraft, Design, Performance, Functions, Parts.*

1. INTRODUCTION

The most common problem of most of the hovercraft projects today is that it is not that efficient in taking turns with full power. So, this problem no longer exists now as we have introduced our High-Performance Hovercraft with power turning project. Hovercraft is a vehicle with no wheels but still capable of moving. This is made possible with the help of air balloon which makes it possible to hover as the amount of air in the balloon determines how long the hovercraft hovers.

The hovercraft can hover on both land as well as water using high powered fans and aerodynamic design. This project now makes it possible for the hovercraft to take turns with full power which was the biggest drawback in the previous hovercraft project. This project makes use of 2 motors and a propeller for floating and hovering, moving the hovercraft in different directions.

In order to reduce the friction below, it makes use motors which rotate at a very high RPM and thereby generating a force to make it hover on the surface smoothly. The other motor propeller which is mounted on the first motor is used to push the hovercraft in forward direction.



This project also makes use of 2 batteries and is a microcontroller-based circuit. This project is controlled by android application via which command is sent to hover the vehicle and to move the hovercraft in different directions after which, the other motor is set to push the hovercraft. The circuit also includes a Bluetooth receiver which is responsible for receiving and processing the commands received through android application. The microcontroller is then responsible for further processing the commands. Thus this system can hover the hovercraft and simultaneously moving it in the desired direction with full power.

2. TECHNICAL ISSUES

To completely understand the principle of the air cushion effect, assuming of dropping a 'cark' tablemat on to the tablecloth, so that it falls completely silent. If the mat is dropped perfectly horizontal, it is bought to a stop guide gently by the air trapped underneath it. Of course, the air escapes, but it makes temporary 'cushion'. In a hovercraft a similar cushion of air is maintained by pumping in a steady supply of air. There is always some leakage because the craft has to be free to more, but the designers use various methods to keep leakages as small as possible so that only minimum power is required to keep up the air supply.

The simplest arrangement for creating air cushion and reducing leakages is like a bowl turned upside down and fitted with engine and a propeller which sucks in air through a hole at the top and forces it into the hollow part beneath. Increasing air pressure pushes on the sides of the bowl. But the bowl is not elastic, and so instead of forcing the rubber to stretch, the air pressure forces the bowl up off the ground. Simple Hovercraft Air Cushion Supply As soon as the bowl rises, the air has a way of escape all-round the bottom edge, but as long as the fan keeps on pumping in air fast enough to keep with the pace of leakage, the bowl will remain supported and the faster the air is pumped in the higher the bowl will rise. Every load of the vehicle is supported by volume air underneath. All movement and motion are generated by either aerostatic or aerodynamic force or both.

A well-designed hovercraft is superior to boat over water because it has less drag and requires less horsepower to push it. This results in higher speeds and better fuel consumption. The hovercraft gets about twice the fuel mileage of a boat with similar size and capacity. It gives a smoother ride than a boat because it maneuvers above the water, not on it. It travels over water with no concern for depth or hidden obstacles. It will go against the current of river at the same ground speed as going along the current. The hovercraft also works very well in rapids or water where standing waves up to a meter high have been encountered for a medium scaled hovercraft.

Hovering Power

If the craft is to hover, the pressure of air forming the cushion must be 2,000 pounds or greater. This represents 19 pounds. Per sq. ft. Yes, only 19 pounds per square feet is required to lift the hovercraft which seems much smaller than you might imagine. From existing designs of Hovercraft that have been developed, it is possible to make some simple estimate of the power needed to lift a Hovercraft. Using 19 pounds per square foot it is estimated 4 horsepower for each sq. ft. of curtain or skirt area can maintain that hover.

Curtain area is its length times its height. A hovercraft 15 inch. long by 7 inches. wide would have a curtain length of 44 inch-twice the length plus twice the width.

If we want it to hover one foot high, we will need enough power to provide a curtain of 44 x 1 sq. ft. At 4 horsepower per sq, ft. we would need 176 horsepower Just to lift the craft up to hover one foot above the ground. Don't forget we now need to push the craft along as well so that engine is the minimum size we can use.

Rudders

When the hovercraft is finally able to move it will most definitely require steering capabilities. This is achieved through the use of rudders. These rudders can be controlled by a variety of devices including computers. The rudders must be well weighed out in order to avoid weighing down your hovercraft and well-shaped in order to move air as efficiently as possible.

Rudders cannot be too heavy otherwise they will weigh down the craft because they are located very close to the motor. The shape of the rudder dictates how well it will be able to move air.

Hovercraft Operation

Piloting a hovercraft is an interesting proposition. Since very little of it actually touches the ground, there isn't much friction, making it very difficult to steer and very susceptible to strong winds.

Imagine trying to drive around on top of an air-hockey puck! We've discovered that the best way to drive it is treating it like a jet ski, i.e. leaning back and forth and steering very carefully. It is also possible to do a 360-degree turn without stopping, which is quite a sight.

Aerodynamics

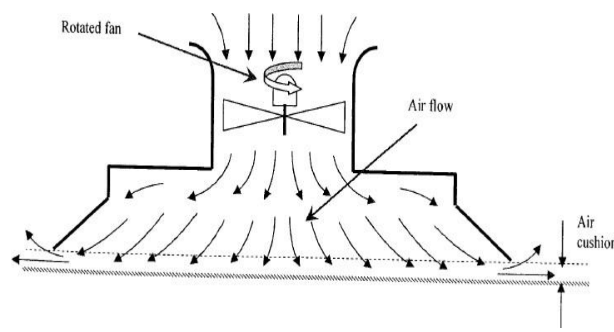
Aerodynamics is defined as the branch of fluid physics that studies the forces exerted by air or other gases in motion.

Examples include the airflow around bodies moving at speed through the atmosphere (such as land vehicles, bullets, rockets, and aircraft), the behavior of gas in engines and furnaces, air conditioning of buildings, the deposition of snow, the operation of air-cushion vehicles (hovercraft), wind loads on buildings and bridges, bird and insect flight, musical wind instruments, and meteorology.

For maximum efficiency, the aim is usually to design the shape of an object to produce a streamlined flow, with a minimum of turbulence in the moving air. The behavior of aerosols or the pollution of the atmosphere by foreign particles are other aspects of aerodynamics.

3. DESIGN CONCEPT

Item	Description	Qty
1	Atmega 328 Microcontroller	1
2	High Power Batteries	2
3	Hovercraft Base and Frame	1
4	Servo motor	1
5	Air/Water Resistant Material	1
6	Current limiters	1
7	Diodes and Capacitors	1
8	Resistors	1
9	High Power Motor	2
10	Propellors	2
11	Voltage Regulator	1
12	Bluetooth Decoder	1



4. PRINCIPLE OF OPERATIONS

The hovercraft floats above the ground surface on a cushion of air supplied by the lift fan. The air cushion makes the hovercraft essentially frictionless. Air is blown into the skirt through a hole by the blower. The skirt inflates and the increasing air pressure acts on the base of the hull thereby pushing up (lifting) the unit. Small holes made underneath the skirt prevent it from bursting and provide the cushion of air needed.

A little effort on the hovercraft propels it in the direction of the push and pressure is developed in the skirt. As soon as the assembly floats, a blower incorporated in the thrust engine blows air backwards which provides an equal reaction that causes the vehicle to move forward. Little power is needed as the air cushion has drastically reduced friction.

Steering effect is achieved by mounting rudders in the airflow from the blower or propeller. A change in direction of the rudders changes the direction of air flow thereby resulting in a change in direction of the vehicle. This is achieved by connecting wire cables and pulleys to a handle. When the handle is pushed it changes the direction of the rudders.

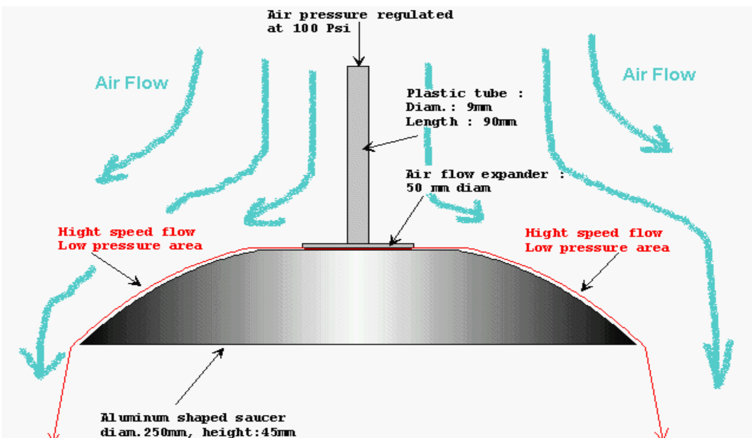
5. DESCRIPTION

The hovercraft works on air cushion. Air cushion is provided through a blower which pumps air into the skirt thereby inflating the skirt. The air pressure thus raises the craft up above the ground. The vehicle has two engines: the rear and the front. A stator fan is attached to the front or lift engine which directs air into the skirt to provide air pressure needed to lift the craft. The propeller attached to the rear or thrust engine develops the thrust needed to propel the craft.

The propeller is enclosed by the thrust duct which makes it possible to direct the air. The duct is bell-shaped such that it increases the velocity of air escaping the duct. The polyester skirt is PVC coated which gives it more strength to sustain the air pressure. It is made airtight. The hull is a platform which sustains the entire weight of the craft. A hole is made on the hull through which air enters the skirt.

Naudin's Coanda Saucer Experiment

Henri Coanda would later produce multiple patents utilizing the effect he observed and studied to generate propulsion for aircraft. An experiment by Von Glahn found that placing curved and flat plates near a nozzle would result in a ratio of lift to undeflected thrust of about 0.8-0.9, depending on the total deflection angle. Thus, a Coanda nozzle could achieve a 90˚ deflection of the jet-stream and result in a vertical lifting force on the order of 0.8 of the undeflected thrust. This shows that Coanda nozzles can produce lift as well as maintain thrust.



The lift is created on the curved surface of the nozzle where the lower pressure regions form. Coanda attempted to use this idea with jet engines to generate flow over outer curved surfaces of crafts he designed. His patent for a lenticular craft gives possible insight to the uses of the Coanda effect in the area of aircraft propulsion. The generation of this lift principle can also be seen in the experimental work of Jean-Louis Naudin. His Coanda saucer experiment using a simple concave object and high-speed airflow over the top of the object shows that a low-pressure region is generated above the craft. This low-pressure region creates lift and causes the craft to hover. The high-speed flow can create the low-pressure region by remaining attached to the craft as it flows around it.

6. APPLICATIONS

It will travel against a current of river with no reduction of speed.
A Hovercraft travel over the surface of water without concern for depth or hidden obstacles. It can travel with great speed of up to 60 knots. Hovercraft are unaffected by small waves and offer a comfortable smooth ride. It is safe around swimmers as there are no propellers in water.

Many Hovercraft have sufficient hover height, ranging from 8 in to 18 in to pass right over a person in water. The air cushion enables Hovercraft to operate over environmentally sensitive areas such as mudflats without disturbing the surface. The lack of wake on water minimizes the potential for bank erosion. It can load and unload people and equipment's on land
Unlike many boats, engine exhaust fumes are not directed into water and poisonous antifouling compounds are not required on Hovercraft.

7. CONCLUSION

The craft principle has been demonstrated using low cost material and has proved capable as a viable means of transport both on land and water after series of tests. The propulsion and lifting systems gave excellent performance and with good maneuverability.
Hovercrafts are generally simple mechanisms in theory. Yet the process from theory to manifestation is not as easy as it may seem. A plethora of problems exist and must be faced in order to attain a well-functioning hovercraft. The plans and designs must be flawless. One must take under consideration the weight and the shape of each component in order to avoid problems such as instability and dysfunction. This is a marvelous machine which greatly cuts down the friction which in turn helps it to attain greater speed and more stability.

Varieties of problems and factors must be considered in designing and constructing a hovercraft. The difficulties involved in maintaining stability and functional competency has limited the application to only transportation or for military purpose. The cost involved in the developing of a hovercraft is also another impediment to the widespread use of this machine.

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