"Design and Fabrication of A.C.V. -A Review"

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Abstract— This paper presents detailed background of design and fabrication of Air Cushion Vehicle (A.C.V.). In design phase it covers total prerequisites for actual manufacturing. Comprehensive discussion is done on former research available and raw materials requirements.

Key words: Skirt, Blower, Propeller buoyancy tank etc

I. INTRODUCTION

Air cushion vehicle as we know them today started life as an experimental design to reduce the drag that was placed on boats and ships as they ploughed through water. The first recorded design for an air cushion vehicle was put forwarded by Swedish designer and philosopher Emmanuel Swedenborg in 1716. The craft resembled an upturned dinghy with a cockpit in the Centre. Apertures on either side of this allowed the operator to raise or lower a pair of oar-like air scoops, which on downward strokes would force compressed air beneath the hull, thus raising it above the surface. The project was short-lived because it was never built, for soon Swedenborg soon realized that to operate such a machine required a source of energy far greater than that could be supplied by single human equipment. Not until the early20th century was an ACV practically possible, because only the internal combustion engine had the very high power to weight ratio suitable for ACV.

Air cushion vehicle, it is a craft capable of travelling over land, water or ice and other surfaces both at speed, and when stationary. It operates by creating a cushion of high pressure air between the hull of the vessel and the surface below. Typically this cushion is contained between a flexible skirt. ACVs are hybrid vessels operated by a pilot as an aircraft rather than a captain as a marine vessel. They typically hover at heights between 200 mm and 600 mm above any surface and can operate at speeds above 37 km per hour. They can clean gradient up to 20 degree. Locations which are not easily accessible by landed vehicles due to natural phenomena are best suited for ACVs. Today they are commonly used as specialized transport in disaster relief, coast ground military and survey applications as well as for sports and passenger services. Very large versions have been used to transport tanks, soldiers and large equipment in hostile environment and terrain. In reverie areas, there is great need for a transport system that would be fast, efficient, safe and low in cost. Time is spent in transferring load from landed vehicle to a boat. With ACV there is no need for transfer of goods since it operates both on land and water. It is said to be faster than a boat of same specifications which makes it deliver service on time.

The ACV consists of fans and cushion. There is air pressure inside the cushion to enable the ACV to float and move smoothly in any land surface. The pressure inside the cushion needs to be maintained at all time while the lift fan capable to operate in the long duration to ensure the ACV can move forward at certain speed. The advantages of manned ACVs are; the ACVs able to operate in all types of climates such as in Arctic, in the Tropics and Asian climates. Furthermore, the manned ACV has less friction compared to other land or water transportation due to the air pressure inside the ACV's cushion.

II. CONCEPT

Air cushioning vehicles are very famous automobiles as it finds variety of applications in defence to scientific survey etc. The proposed project is all about manufacturing a small A.C.V. which will be capable of moving a person and vehicles own weight.

We are considering following objectives for this project :

1) It should be run on water surface.
2) It should be run on land or road surface.
3) It should be run on slippy surface or ice.
4) To keep minimum, the loss of cushion air.
5) Offer little resistance to the passage of obstacles beneath it.
6) To absorb large portion of energy this is produced on impact or collision with obstacles greater than cushion depth.

III. LITERATURE REVIEW

The purpose of this chapter is to provide some of the relevant background information regarding Air cushion vehicle .The ACV appears to be a simple structure comprise of propeller, skirt, Blower etc. The performance can be affected by various things including geometries of ACV and its component, the skirt material and type of skirt.

1) Rakesh Chandmal Sharma, Manish Dhingra, Rajeev Kumar Pathak, Manish Kumar, "AIR CUSHION VEHICLE CONFIGURATION, RESISTANCE AND CONTROL".

From this paper we study that, different types of aerostatic and aerodynamic craft. The craft configurations have also been discussed in this study. The all possible types of drag due to resistance of air cushion vehicles are discussed here. Finally the control aspect of air cushion vehicles is presented in this paper.

2) Ashish Bhateja, Nirmalpreet Singh, Sukhdarshan Singh and Ravinder Kumar, "Design and Fabrication of a Model Radio Controlled -Air Cushion Vehicle Utilize a Combined Single Trust and Lift System with a Body Shape of Box Made Out of Thermocol and with a Skirt Made Out of Plastic", (1, January 2013).

From this paper we study that design which means create the design for; create or execute in an artistic or highly skilled manner. Main Objective of this project work to be carried out is to design a Radio controlled -Air cushion vehicle. More importantly main objection function is to implementing new ideas and concepts to make design safer, cost effective, to find alternative materials to make design lighter in weight, make design more aerodynamically and importantly more environmental friendly.Aims to manufacture autonomous and maximize maneuverability ACV & to make switching control of an R/C ACV. Stabilize and smooth switching, overall objective recommendation of

implementation of new modified design for various applications benefits.

3) By Michael Mc Peake (19/05/04), "A Research Paper on the History of the ACV".

From the paper we study that, the vehicle itself is very interesting, yet how it came to be may even be more interesting. It all started with one man in 1716. His name was Emanuel Swedenborg, and he was a Swedish designer and philosopher. Besides coming up with the idea of the ACV he also started his own religion in form of the New Jerusalem Church and wrote many religious papers of which he is most notably renowned for. Because Emanuel introduced the idea of the ACV way before it's time of possible implementation, he knew that it would be impossible to make it work, due to the fact that if he were to make an ACV, it would require a great deal of energy to make it hover. The ACV itself is not just a piece of machinery; it is a work of art.

4) Jeffy schleigh, "Construction of a ACV model and control of it motion". (05/2006)

From this paper we study that, there are two basic requirements. The first requirement is to design and construct a physical model of an ACV prototype. The second requirement is to control the motion of the constructed ACV prototype, such as following a track, which consists of straight lines and curves. There are three software systems available in the completion of this research project. These systems are Pro/ENGINEER, Solid Works and Robotics Invention System.

5) Zachary Kulis, "FEEDBACK CONTROL OF AN ACV OVER A WIRELESS LINK", (2006).

Form this paper we study Nonlinear under actuated systems (i.e. systems with fewer control inputs than configuration variables) present significant challenges for automatic control. This thesis explores feedback control of an under actuated ACV over a wireless communication channel using techniques from nonlinear control theory. A family of control laws stabilizing the ACV reduced dynamics–including zero velocity, constant forward/reverse velocity, and constant angular velocity stabilization–are derived. Lyapunov arguments are used to prove convergence of the reduced dynamics under the control laws. It is shown that heading cannot be stabilized by a continuously differentiable state feedback law. In response, two hybrid control algorithms for heading stabilization are proposed. Experimental and simulated results from a high fidelity model are shown to agree nicely.

6) Amit Tiwari, "to study and fabrication of aircushion vehicle", (March, 2015)

Form this paper we study that, An Air cushion vehicle is a vehicle that flies like a plane but can float like a boat, can drive like a car but will traverse ditches and gullies as it is a flat terrain. An air cushion vehicle also sometimes called an air cushion vehicle because it can hover over or move across land or water surfaces while being held off from the surfaces by a cushion of air. An ACV can travel over all types of surfaces including grass, mud, muskeg, sand, quicksand, water and ice. ACV prefers gentle terrain although they are capable of climbing slopes up to 20%, depending upon surface characteristics. Modern ACVs are used for many applications where people and equipment need to travel at speed over water but be able load and unload on land

7) Zhe Luo, Fan Yu, Bing-Cong Chen, "Design of a novel semi-tracked air-cushion vehicle for soft terrain", (2003).

Form this paper we study that, In order to improve the crossing ability and the tractive performance of a vehicle operating on soft and wet terrain, the travelling mechanism must be properly designed and the adaptation ability to the changes of prevailing operation conditions is obviously needed. Based on the previous researches and developments of a wheeled air-cushion vehicle and a semi-walking wheeled air-cushion vehicle, a new hybrid vehicle that combines air-cushion technology with a travelling mechanism, i.e. a semi-tracked air-cushion (STAC) vehicle has been developed. This paper proposed a new design principle for the semi-track air cushion vehicle. A novel structure, i.e. a flexible joint mechanism as the prototype suspension system, is particularly described. Based on theoretical analysis, an optimization model is established for minimizing total power consumption. Experiments have been carried out to investigate the relationships among load distribution ratio, slip ratio, clearance height, vehicle speed sand resistances and power consumption in given terrain conditions.

8) Yu Guoxin; Lu Xinsen (Shanghai Jiao Tong University), "DYNAMIC ANALYSIS OF ACV STRUCTURES".

Form this paper we study that, a method is presented for dynamic analysis of ACV and its machinery and propulsion system. The dynamic behavior of the main hull structure of the ACV (buoyancy tank) is calculated by using the curved orthotropic shell element. The dynamic behavior of the machinery and propulsion system is calculated by using 3 dimensional beam elements. Dynamic substructure method is introduced to analyses the coupled vibration of the main hull structure and the machinery and propulsion system. The dynamic analysis of a complete ACV is thus preceded and the feasibility and the accuracy of the method offered are verified by a ready-made measurement.

9) M. M. El-khatib, W. M. Hussein, "Stabilization and Design of an ACV Intelligent Fuzzy Controller", (25-12-2013).

The objective of the paper is to design, stabilize, simulate and implement an autonomous model of a small ACV that can travel over any terrains. A real time layered fuzzy navigator for an ACV in a dynamic environment is proposed. It intelligently combines two behaviors to cope with obstacle avoidance as well as approaching a goal using a proportional navigation path accounting for ACV kinematics. State-space method is used to represent the dynamics of a ACV. MATLAB/Simulink software tool is used to design and verify the proposed algorithm. The fuzzy stabilizer is tuned such that its nonlinearity lies in a bounded sector results using the circle criterion theory. An application example for the proposed system has been suggested.

IV. RESEARCH METHODOLOGY

According to related literature review, we have to first work on basic small scale model. Based on this small scale model, we will work on design variables which will be of prime importance like flow rate, pressure,time etc. The available research and available work helps lot but fabrication of actual working model and raw materials may challenge in future.

V. SPECIFICATION OF SYSTEME REQUIRNMENT

Based on above research papers we come to know that selection of skirt material is very much important .Also research on blowers, plywood materials and fixtures etc. done .As per design requirements we did following comparisons.

Company	Grade	Cost		Availability	Water Resistance
		8mm	12mm		
National Plywood Company	A	Rs.90/sq.ft	Rs.120/sq.ft	Not Available	Yes
Flemingo Plywood Company	B	Rs.85/sq.ft	Rs.105/sq.ft	Available	Yes
Century Ply Company	A	Rs.87/sq.ft	Rs.111/sq.ft	Less Available	Yes
Internet Plywood Company	C	Rs.75/sq.ft	Rs.85/sq.ft	Available	No

Table 1: Comparison of plywood sheets

An ACV skirt is required to fulfill the following functions:

1) Contain the cushion of air beneath the craft at required Hover height.
2) Have the ability to confirm or contour effectively over obstacles so as to keep minimum, the loss of cushion air.
3) Return to its original shape after having been deformed.
4) Give adequate stability.
5) Offer little resistance to passage of obstacles beneath it.
6) Have the ability to absorb a large portion of the energy which is produced on impacts or collision with obstacles greater than hover height or cushion depth.

Material	Cost	Availability
6 Oz	$ 13.78 per linear yard	Not available
18 Oz	$ 16.83 per linear yard	Not available
Urethane-Coated Nylon Fabric	$17.95 per linear yard	Not available

Table 2: Comparison of skirt material

We are planning to use TU- 26 engine for the propulsion of the air cushion vehicle which has following specification. We used this engine because of the cost is low and specification are fulfill by the engine.

Engine Model	TU-26
Engine Type	Air-cooling,2-Stroke,Single Cylinder
Engine power	1.06 kw/5500r/min
Starting Method	Manually Drawing Wound Rope
Displacement	26cc
Form of Carburetor	Diaphragm
Ratio of Fuel and Lubricant	30:1
Packing Size	24*19*24cm
G.W/N.W	3./2.5kgs

Table 3: Specifications of 2 stroke petrol engine

Fig. 1: Centrifugal blower

Model	BL 77
Displacement	77 cc
Power (HP)	5.0
Fuel	Petrol + 2T
Air speed (m/sec)	125
Air rate (m^3/min)	20
Weight (kg)	10.2

Table 4: Specifications of centrifugal blower

VI. CONCLUSION

From above discussion it is seen that proposed project can be done successfully by using above reviews and specifications of materials.

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